Lung Cancer Screening & Public Health

ACR® AMERICAN COLLEGE OF RADIOLOGY
QUALITY IS OUR IMAGE

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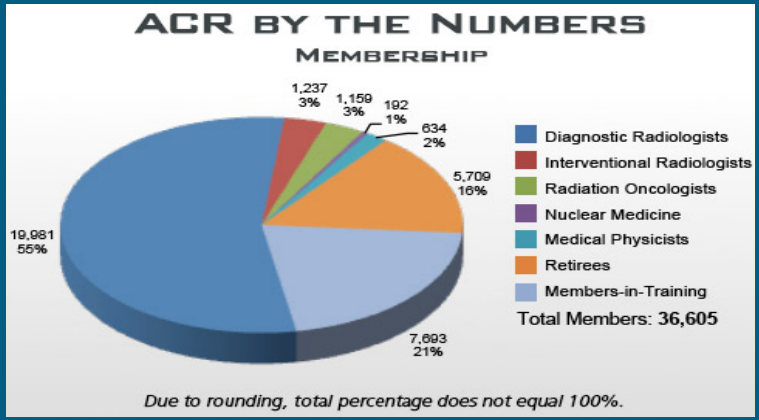
Site PI NLST

Disclosure

- None

American College of Radiology

- For over three quarters of a century, the ACR has devoted its resources to making imaging safe, effective and accessible to those who need it.
- Represents more than 36,000 diagnostic radiologists, radiation oncologists, interventional radiologists, nuclear medicine physicians and medical physicists.
- Mission: To serve patients and society by maximizing the value of radiology, radiation oncology, interventional radiology, nuclear medicine and medical physics by advancing the science of radiology, improving the quality of patient care, positively influencing the socioeconomics of the practice of radiology, providing continuing education for radiology and allied health professions and conducting research for the future of radiology.



ACR Activities in Quality & Safety

- Accreditation programs in diagnostic imaging and radiation oncology since 1987
- Over 170 Practice Guidelines & Technical Standards to guide radiologic practice have been developed since 1990
- Appropriateness Criteria to guide referring providers in choosing the right exam or therapy for their patient's since 1992
- Registries that provide benchmarking to radiologists have been offered since 2008

ACR: Lung Cancer Screening Activities

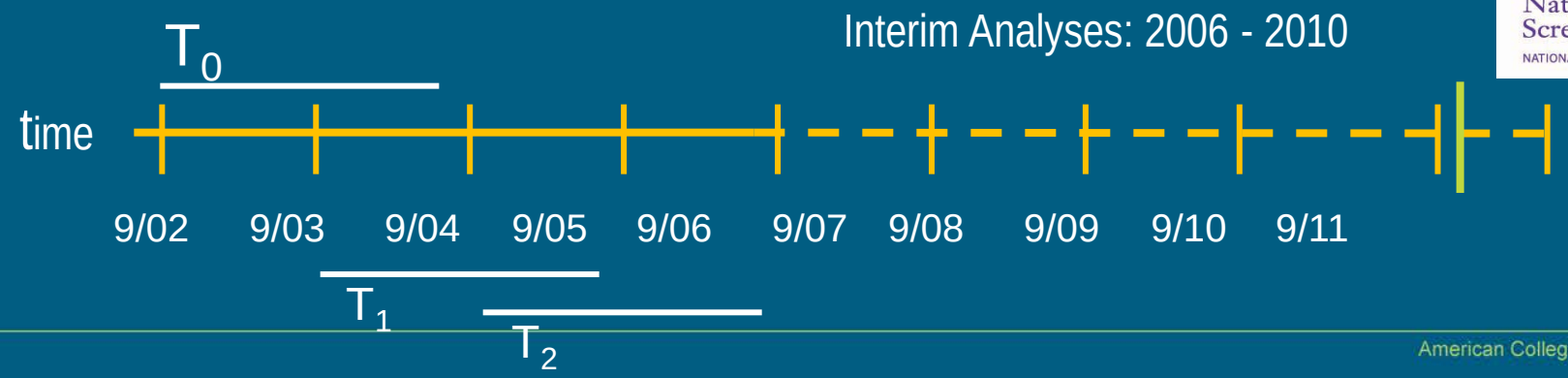
- Practice Guideline for the Performance and Interpretation of Lung Cancer Screening CT
- LUNGRADS: a structured reporting and management system based on BIRADS
- ACR Designated Lung Cancer Screening Center program through the ACR CT Accreditation Program
- Appropriateness Criteria for lung cancer screening, modeled after USPSTF and NCCN
- Educational programs for radiologists and providers; and for public awareness

ACR Supports the USPSTF Recommendation for Lung Cancer Screening

- Screen annually for lung cancer with low-dose CT
- Asymptomatic adults aged 55 to 80 years who have a 30 pack-year smoking history and currently smoke or have quit smoking within the past 15 years
- Data from NLST and modeling study convened by the USPSTF <u>is definitive</u>

NLST: Trial Design and Power

- Randomized Controlled Trial of 53,454 individuals
  - High Risk: Age 55-74 yrs | 30 pack-yrs | former smokers of ≤ 15 yrs
  - 90% power to detect 20% difference in lung cancer mortality; α = 0.05
  - 1:1 randomization to LDCT or CXR | 3 annual screens
  - Median follow-up for outcomes ~ 6.5 years (maximum: 7.4)
  - Vital status known for 97% LDCT | 96% CXR



National Lung Screening Trial: NLST

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

N Engl J Med 2011; 365:395-409 | August 4, 2011

The National Lung Screening Trial Research Team*

20% lung cancer mortality reduction
6.9% all cause mortality reduction

screen 320 individuals to save 1 from lung cancer death

8 years & > 50,000 subjects randomized to LDCT vs CXR

NLST
National Lung Screening Trial
NATIONAL CANCER INSTITUTE

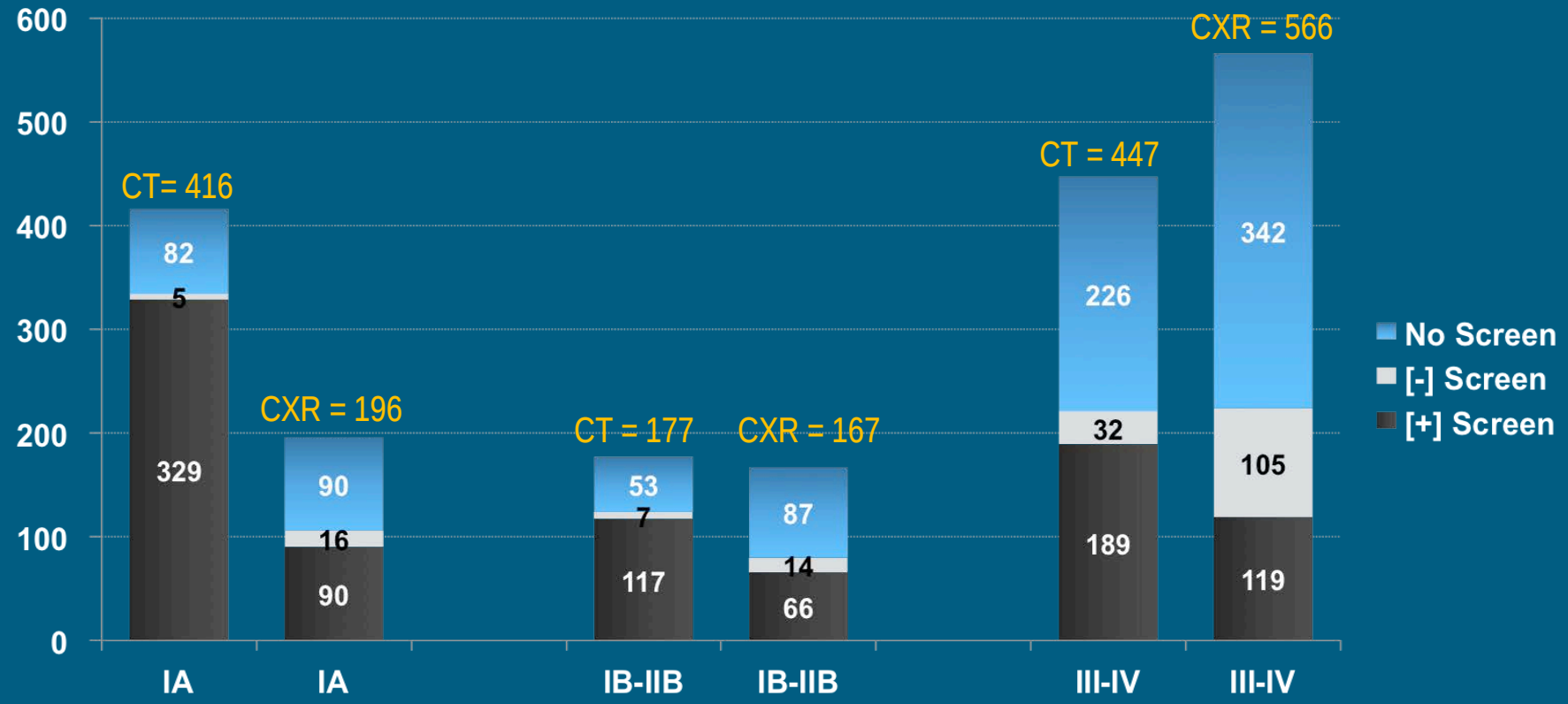
NLST: Lung Cancers Diagnosed

Screen Result and Time Period	CT (%)	CXR (%)
Total T0-T2 Screen [+] lung cancers	649 (61.2%)	279 (29.6%)
Total T0-T2 Screen [-] lung cancers	44 (4.2%)	137 (14.6%)
Total *NO* screen lung cancers	367 (34.6%)	525 (55.8%)
Total lung cancers in arm	1060 (100.0%)	941 (100%)

892 *NO* screen cancers include: post-screen time period (N = 802 | 90%)
never screened (N= 35) | due for screen (N = 55)

NLST Investigators; NEJM 2011;365:396-409

NLST: Stage Distribution of Lung Cancers



numbers reflect only lung cancers of *known* stage

NLST: Diagnostic Follow-up of *Positive* Screens

Category	LDCT				CXR			
	T0 (%)	T1 (%)	T2 (%)	Total (%)	T0 (%)	T1 (%)	T2 (%)	Total (%)
Total positives	7191 (100%)	6901 (100%)	4054 (100%)	18,146 (100%)	2387 (100%)	1482 (100%)	1174 (100%)	5043 (100%)
Confirmed lung cancer	270 (3.8%)	168 (2.4%)	211 (5.2%)	649 (3.6%)	136 (5.7%)	65 (4.4%)	78 (6.6%)	279 (5.5%)

PPV

Non-invasive Procedures	T0 (%)	T1 (%)	T2 (%)	Total (%)	T0 (%)	T1 (%)	T2 (%)	Total (%)
Imaging Exam	81.1%	37.4%	51.3%	57.9%	85.6%	66.5%	78.9%	78.4%
CXR	18.2%	9.1%	16.6%	14.4%	36.9%	26.2%	31.8%	32.6%
Chest CT	73.1%	30.4%	41.1%	49.8%	65.8%	51.2%	62.0%	60.6%
PET or PET-CT	10.3%	5.2%	10.0%	8.3%	7.6%	7.2%	9.8%	8.0%

Invasive Procedures	T0 (%)	T1 (%)	T2 (%)	Total (%)	T0 (%)	T1 (%)	T2 (%)	Total (%)
Percutaneous FNA/Core	2.2%	1.1%	2.4%	1.8%	3.5%	2.5%	4.5%	3.5%
Bronchoscopy	4.6%	2.6%	4.8%	3.8%	4.6%	3.8%	5.4%	4.5%
Surgical procedure(s)	4.2%	2.9%	5.6%	4.0%	5.2%	3.5%	5.8%	4.8%
Mediastinoscopy	0.9%	0.5%	0.6%	0.7%	0.9%	0.8%	1.7%	1.1%
VATS	1.2%	0.8%	2.5%	1.3%	0.9%	0.8%	1.7%	1.1%
Thoracotomy	2.8%	2.2%	4.2%	2.9%	4.1%	3.0%	3.8%	3.7%

NLST Investigators; NEJM 2011;365:396-409

NLST: Complications in Positive Screens

Major complications:

Respiratory or Cardiac failure | MI | PE

Surgical complications: BPF | Empyema | Injury to vital organ

	CT lung cancer		CT NO cancer		CXR lung cancer		CXR No cancer	
	N	%	N	%	N	%	N	%
Positive screens	649	100	17,053	100	279	100	4,674	100
Major complication	75	11.6	12	0.1	24	8.6	4	< 0.1
Death 60 days after *invasive* procedure	10	1.5	6	< 0.1	10	3.8	0	0

Overall complications were low

Complications in patients with no cancer diagnosis were minimal

ACR Supports the USPSTF Recommendation for Lung Cancer Screening

- Large population at risk for lung cancer
- Lung cancer is the 2nd leading cause of death in the U.S.
- It is the leading cause of cancer death for men and women
- Screening for other cancers, including breast and colon cancer has significantly reduced deaths from these cancers
- The benefits of screening outweigh the risks

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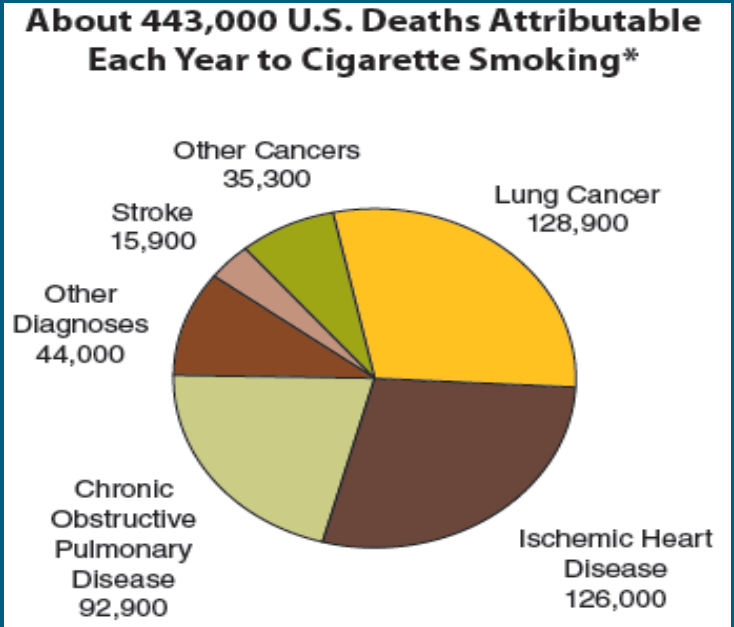
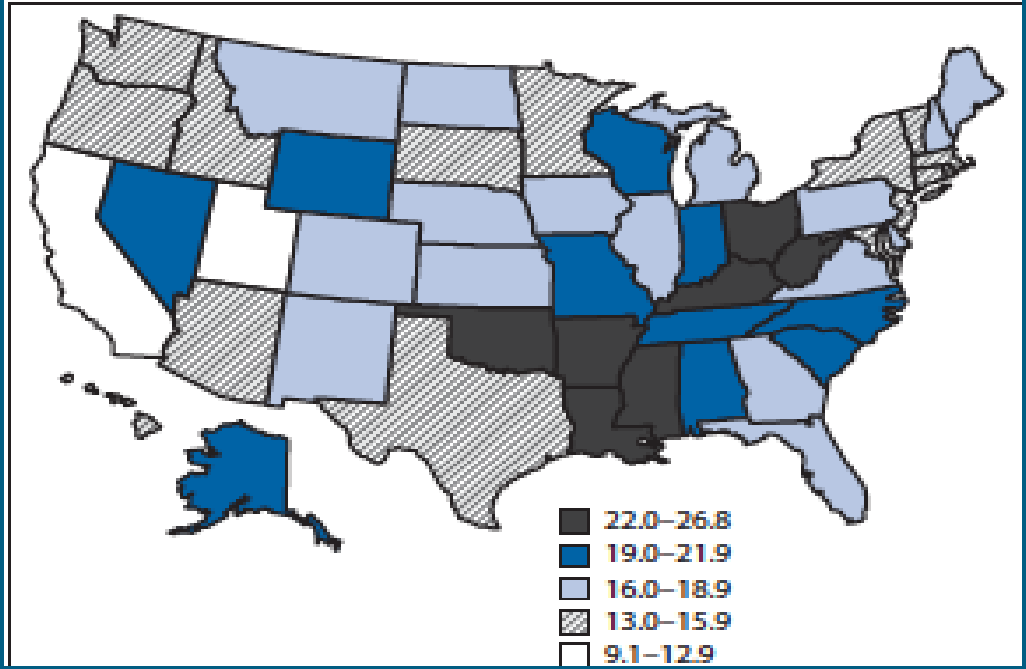
Lung Cancer Risk

- Large population at risk due to cigarette smoking and second hand smoke exposure
  - ≈ 60 million current smokers (19.3% of U.S. adults in 2010; 3 million fewer than 20.9% in 2005
  - ≈ 30 million former smokers
  - Tobacco: leading cause of preventable death & illness; responsible for 1 in 5 deaths



Smoking in the U.S.

CDC. **Vital Signs: Current Cigarette Smoking Among Adults Aged ≥ 18 Years — United States 2005-2010**. Morbidity and Mortality Weekly Report 2011;60(35):1207-1211



Low: Utah & California High: Kentucky & West Virginia

Current Cigarette Smoking Status Among Adults Aged 18 and Over
United States 2012

	all adults aged 18 and over	all current smokers	everyday smokers	some-day smokers	former smokers	non smokers
Sex						
Total	234,921,000	42,098,000	33,021,000	9,078,000	51,622,000	139,327,000
Male	113,071,000	22,983,000	17,870,000	5,113,000	28,457,000	60,738,000
Female	121,850,000	19,115,000	15,150,000	3,965,000	23,165,000	78,589,000
Age (years)						
45-64	82,038,000	15,911,000	13,175,000	2,736,000	20,980,000	44,516,000
65-74	23,760,000	2,663,000	2,215,000	448000	9,525,000	11,345,000
75 and over	18,089,000	1,019,000	799000	200,000	9,466,000	9,466,000

National Health Interview Survey 2012; US Department of Health and Human Services, CDC, NCHS

Leading New Cancer Cases and Deaths – 2013 Estimates

Estimated New Cases*		Estimated Deaths	
Male	**Female**	**Male**	**Female**
Prostate 238,590 (28%)	Breast 232,340 (29%)	Lung & bronchus 87,260 (28%)	Lung & bronchus 72,220 (26%)
Lung & bronchus 118,080 (14%)	Lung & bronchus 110,110 (14%)	Prostate 29,720 (10%)	Breast 39,620 (14%)
Colon & rectum 73,680 (9%)	Colon & rectum 69,140 (9%)	Colon & rectum 26,300 (9%)	Colon & rectum 24,530 (9%)
Urinary bladder 54,610 (6%)	Uterine corpus 49,560 (6%)	Pancreas 19,480 (6%)	Pancreas 18,980 (7%)
Melanoma of the skin 45,060 (5%)	Thyroid 45,310 (6%)	Liver & intrahepatic bile duct 14,890 (5%)	Ovary 14,030 (5%)
Kidney & renal pelvis 40,430 (5%)	Non-Hodgkin lymphoma 32,140 (4%)	Leukemia 13,660 (4%)	Leukemia 10,060 (4%)
Non-Hodgkin lymphoma 37,600 (4%)	Melanoma of the skin 31,630 (4%)	Esophagus 12,220 (4%)	Non-Hodgkin lymphoma 8,430 (3%)
Oral cavity & pharynx 29,620 (3%)	Kidney & renal pelvis 24,720 (3%)	Urinary bladder 10,820 (4%)	Uterine corpus 8,190 (3%)
Leukemia 27,880 (3%)	Pancreas 22,480 (3%)	Non-Hodgkin lymphoma 10,590 (3%)	Liver & intrahepatic bile duct 6,780 (2%)
Pancreas 22,740 (3%)	Ovary 22,240 (3%)	Kidney & renal pelvis 8,780 (3%)	Brain & other nervous system 6,150 (2%)
All sites 854,790 (100%)	All sites 805,500 (100%)	All sites 306,920 (100%)	All sites 273,430 (100%)

*Excludes basal and squamous cell skin cancers and in situ carcinoma except urinary bladder.

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ACR Supports the USPSTF Recommendation for Lung Cancer Screening: Caveat

- Recommend against discontinuing screening if individuals have quit for 15 years
- Risk of smoking-related cancers is predominantly related to total exposure and gradually decreases over time, meaning these individuals may remain at significant risk
- Creates an implementation dilemma for individuals covered for initiation of lung cancer screening, then no longer covered after they have succeeded in smoking cessation for more than 15 years; could potentially lead to a paradox of incentives that “encourages” a patient to restart smoking to maintain coverage
- In the NLST cost effectiveness analysis from NLST presented last June at the NCI, the cost effectiveness of CT screening for lung cancer remains in line within the cost per QALY range of other screening tests in place today, even if the relative risk falls to 60% of the risk of the NLST enrolled population

ACR Also Supports Lung Cancer Screening for NCCN Category 2 Individuals

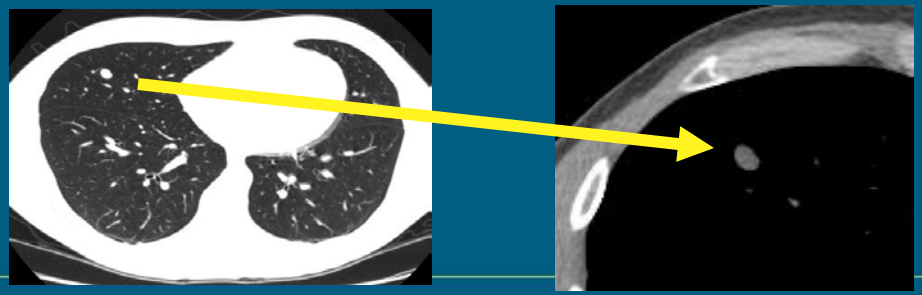
- Other individuals at HIGH RISK for lung cancer
  - > 50 years of age
  - > 20 pack years smoker or second hand exposure
  - One additional risk factor (other than second hand smoke)
    - Occupational exposure, specifically to agents that are identified as carcinogens targeting the lungs, including silica, cadmium, asbestos, arsenic, beryllium, chromium, diesel fumes, nickel, coal smoke and soot
    - Cancer history, due to the increased risk of developing lung cancer among survivors of lung cancer, lymphomas, cancers of the head & neck, and smoking-related cancers
    - Documented high radon exposure
    - Family history of lung cancer
    - Disease history of COPD or pulmonary fibrosis

ACR: LUNG RADS

- A structured reporting and management system based on BIRADS
- Categories of negative screen, and positive based on probability of malignancy with recommended management
- Designed to aid radiologists and providers use a consistent structure for reporting screening CT findings and standardization for managing abnormal findings
- Takes into account most recent evidence

Lung Cancer CT Screening: Minimizing Risk

- False Positive (FP) Screens:
  - 40% of NLST subjects had at least one FP over the 3 years
  - among patients with a positive screen who underwent a diagnostic procedure, approximately 1.4% experienced a complication
  - uncertainty raised about best management protocol for FPs



ORIGINAL RESEARCH

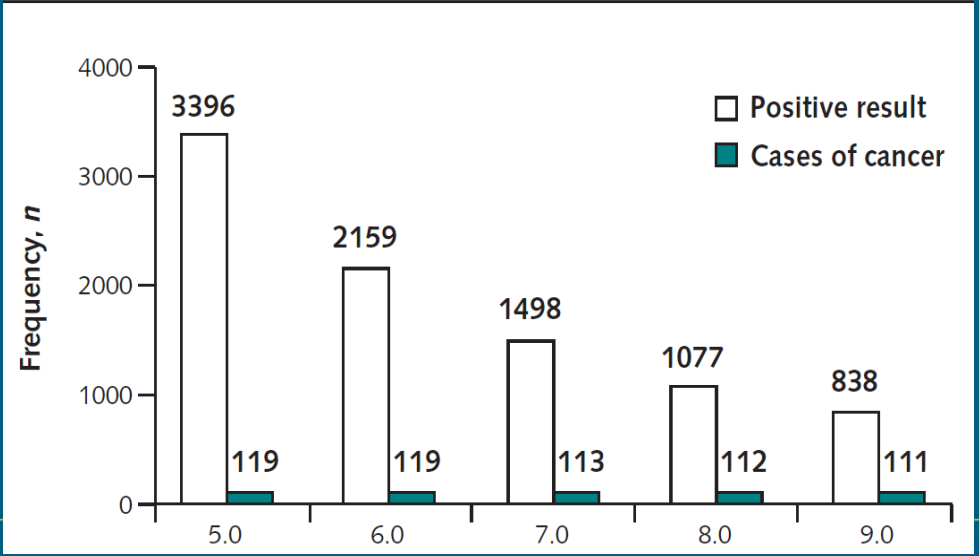
Annals of Internal Medicine
2013;158:246-252

Definition of a Positive Test Result in Computed Tomography Screening for Lung Cancer

A Cohort Study

Claudia I. Henschke, PhD, MD; Rowena Yip, MPH; David F. Yankelevitz, MD; and James P. Smith, MD, for the International Early Lung Cancer Action Program Investigators*

Figure. Frequency of a positive result and cases of lung cancer diagnosed within 12 mo of baseline enrollment.

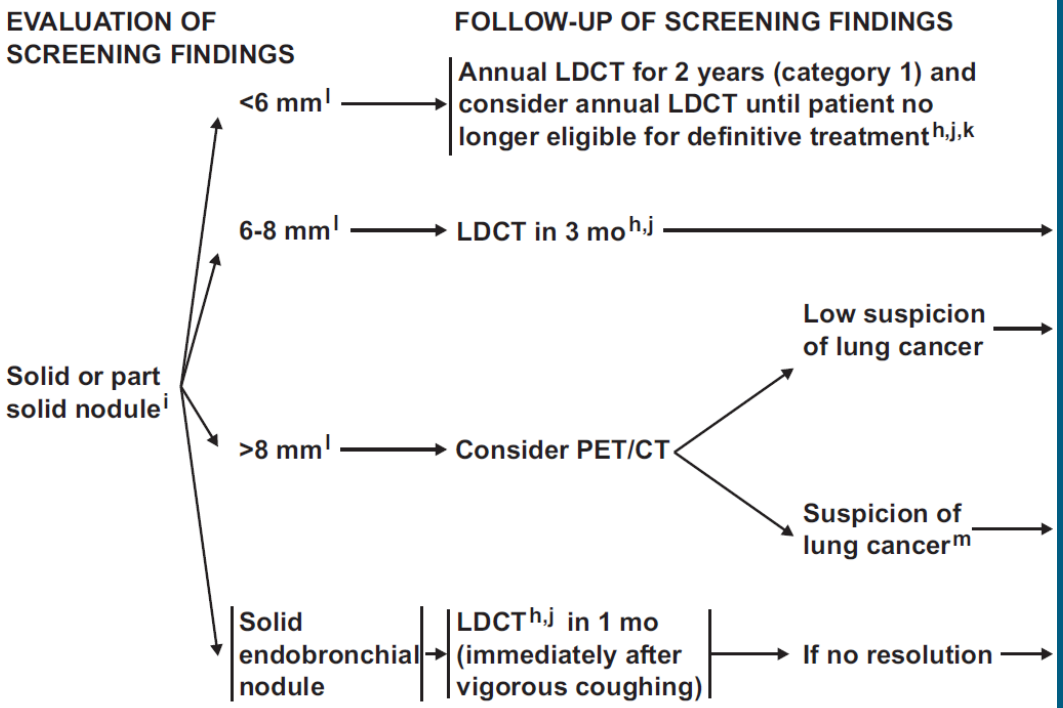


Raising the Size Threshold for a Positive Screen

- Will further minimize harm by:
  - Decreasing false positive test results
  - Decrease the number of individuals requiring additional testing
  - Decrease patient anxiety
  - Decrease the cost of a program of lung cancer screening
  - Further improve the cost effectiveness of screening

National Comprehensive Cancer Network®

NCCN Guidelines Version 1.2014 Lung Cancer Screening



ACR: LUNGRADS

Category	Category Descriptor	Primary Category	Findings	Management	Probability of Malignancy
Incomplete		0	prior chest CT examination(s) being located for comparison part or all of lungs cannot be evaluated	Additional lung cancer screening CT images and/or comparison to prior chest CT examinations is needed	n/a
Negative	No nodules, nodules with no growth (benign behavior) and nodlues with a very low likely of becoming clinically actiive cancer	1A	no lung nodules	Return to annual screening	< 1%
		1B	lung nodule(s) unchanged for ≥ 2 years solid nodule(s): < 6 mm part solid nodule(s), any size, unchanged for ≥ 1 year non solid nodule(s) if either < 20 mm or ≥ 20 mm if unchanged for ≥ 1 year		
Benign	Benign non-cancerous lung nodules	2	1) nodule(s) with specific calcifications: complete, central, popcorn, concentric rings 2) fat containing nodule(s) 3) AVM	Return to annual screening	Nearly 0%

ACR: LUNGRADS

Category	Category Descriptor	Primary Category	Findings	Management	Probability of Malignancy
Probably Benign	Probably benign finding(s) - short term follow up suggested	3A	solid nodule(s): ≥ 6 to < 8 mm OR growing and < 8 mm	6 month low dose chest CT; if unchanged return to annual screening schedule	1-2%
		3B	solid nodule(s): ≥ 8 to < 10 mm part solid nodule, any size, with solid component ≥ 6 mm to < 8 mm (1 or more) non solid nodule(s) ≥ 20 mm to < 30 mm	4 month low dose chest CT; if unchanged return to annual screening schedule	2-5%
Suspicious	Findings for which additional diagnostic testing and/or tissue sampling is receommended	4A	part solid nodule, any size, with a growing < 8 mm solid component non solid nodule ≥ 30 mm	4 month low dose chest CT in addition to the recommendations under 4b	5-95%
		4B	solid nodule(s) ≥ 10 mm OR growing and ≥ 8 mm part solid nodule with solid ≥ 8 mm or of any size if there is a new or growing solid component category 3 nodules with additional suspicious findings	diagnostic chest CT with IV contrast, *PET/CT and/or tissue sampling depending on the probabllity of malignancy and comorbidities. *Note: PET/CT should only be used for solid nodules and part solid nodules with a solid component ≥ 8 mm	95%
			endobronchial nodule	diagnostic chest CT with IV contrast followed by bronchoscopy	??
Other	Clinicially Significant or Potentially Clinically Signifiant Findings (non lung cancer)	S	any finding of potential significance	As appropriate to the specific finding	

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Lung Cancer Screening CT: Other Findings

- NLST: Incidental clinically significant findings in 7.5%
  - May lead to additional health benefits
  - May have contributed to the nearly 7% reduction in all cause mortality seen in NLST

Table 7. Cause of Death on the Death Certificate, According to Screening Group.*

Cause of Death	Low-Dose CT Group	Radiography Group	Total
		number/total number (percent)	
Neoplasm of bronchus and lung†	427/1865 (22.9)	503/1991 (25.3)	930/3856 (24.1)
Other neoplasm	416/1865 (22.3)	442/1991 (22.2)	858/3856 (22.3)
Cardiovascular illness	486/1865 (26.1)	470/1991 (23.6)	956/3856 (24.8)
Respiratory illness	175/1865 (9.4)	226/1991 (11.4)	401/3856 (10.4)
Complications of medical or surgical care	12/1865 (0.6)	7/1991 (0.4)	19/3856 (0.5)
Other	349/1865 (18.7)	343/1991 (17.2)	692/3856 (17.9)

ACR Designated Lung Cancer Screening Centers

- **Defines Recommended Screening Population**
- **Smoking Cessation**
  - A mechanism must be in place to refer patients for smoking cessation counseling or to provide smoking cessation materials.
- **Equipment**
  - CT equipment specifications and performance must meet state and federal requirements and applicable ACR Practice Guidelines and Technical Standards.

ACR Designated Lung Cancer Screening Centers

- **Personnel Qualifications**
  - Lung cancer screening interpreting physicians all meet the following: 200 chest CT cases in prior 36 months
  - Medical physicists and radiologic technologist continue to meet the requirements of the CT accreditation program.
- **Follow up System**
  - Must use structured reporting system that includes management recommendations
  - Screening facilities that elect to accept self-referral individuals must have procedures for referring them to a qualified health care provider if abnormal findings are present.
  - Follow the ACR Practice Guideline for Communication of Diagnostic Imaging Findings

Smoking Cessation

- Smoking reduction and cessation both reduce the risk of lung cancer19 and are an essential element to any lung cancer screening program
- While adding smoking cessation increases the cost of a lung cancer screening program in total, several studies have shown that the inclusion of smoking cessation increases the QALYs gained in this high risk population, and improves the cost-effectiveness of lung cancer screenings by 20-50 percent
- A mechanism must be in place to refer patients for smoking cessation counseling or to provide smoking cessation materials.
- Incorporated into the ACR Guideline for the Performance and Interpretation of Lung Cancer Screening and the ACR Designated Lung Cancer Screening Center program

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Site PI NLST