CT Lung Screening Implementation Challenges: ALA/ATS Implementation Microsite

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Chair Radiation Oncology Lahey Hospital and Medical Center
November 2018
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
Why so slow?
Reimbursement
Stigma
Infrastructure
Who does what
Misinformation
Terminology
Resources
Quality
Training
Silos
## Reimbursement and Messaging

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>2016</th>
<th>2017</th>
<th>2018 TC</th>
<th>2018 Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>70498</td>
<td>Ct Angio, Neck Combo, Incl Image Process</td>
<td>$2,586.00</td>
<td>$300.14</td>
<td>$160.27</td>
<td>$1,163.70</td>
</tr>
<tr>
<td>71010</td>
<td>Chest X-Ray 1 Vw</td>
<td>$150.00</td>
<td>$58.96</td>
<td>$31.48</td>
<td>$67.50</td>
</tr>
<tr>
<td>71020</td>
<td>Chest X-Ray 2 Vw</td>
<td>$150.00</td>
<td>$58.96</td>
<td>$31.48</td>
<td>$67.50</td>
</tr>
<tr>
<td>71035</td>
<td>Chest X-Ray Spec Views</td>
<td>$298.00</td>
<td>$58.96</td>
<td>$31.48</td>
<td>$134.10</td>
</tr>
<tr>
<td>71110</td>
<td>X-Ray Ribs 3 Vw Bilat</td>
<td>$448.00</td>
<td>$93.44</td>
<td>$49.90</td>
<td>$201.60</td>
</tr>
<tr>
<td>71111</td>
<td>X-Ray Ribs, Chest 4+ Vw</td>
<td>$448.00</td>
<td>$93.44</td>
<td>$49.90</td>
<td>$201.60</td>
</tr>
<tr>
<td>71250</td>
<td>Ct Scan, Thorax, w/o Contrast</td>
<td>$1,671.00</td>
<td>$130.01</td>
<td>$69.43</td>
<td>$751.95</td>
</tr>
<tr>
<td>71260</td>
<td>Ct Chest Contrast</td>
<td>$2,586.00</td>
<td>$255.98</td>
<td>$136.69</td>
<td>$1,163.70</td>
</tr>
<tr>
<td>71275</td>
<td>Ct Angio, Chest, Combo, Incl Image Proc</td>
<td>$2,586.00</td>
<td>$300.14</td>
<td>$160.27</td>
<td>$1,163.70</td>
</tr>
<tr>
<td>72040</td>
<td>X-Ray Exam Neck Spine 3/Or Less</td>
<td>$298.00</td>
<td>$58.96</td>
<td>$31.48</td>
<td>$134.10</td>
</tr>
</tbody>
</table>

**CTLS Medicare Payment**
- **2016** - $112.49
- **2017** - $59.84
- **2018** - $52.56
- **2018 TC** - $189.71
- **2018 Global** - $242.28

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“Don’t mess with lung screening”
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
Pathway to Success

- Physician champions
- Multidisciplinary steering committee
- Access/volume assessment
- Primary care/physician/public education and outreach
- Database
- Standardized reporting system
- Program navigator

Infrastructure

- Physician champions
- Multidisciplinary steering committee
- Access/volume assessment
- Primary care/physician/public education and outreach
- Database
- Standardized reporting system
- Program navigator
Revenues and Expenses
Different Silos
Training

Radiology - Make the radiologist comfortable
  Mevis Lung Academy
  IELCAP VA PALS
  European 18 month implementation plan

Primary Care – Make primary care comfortable
  SDM Massachusetts Medical Society
  SDM tools Grannis

Specialist

Navigator
  State Quality Collaborative

Technologist

Smoking Cessation
Program Access and Structure

Centralized vs Decentralized

Program Volume

• # referred
• # qualified
• # screened

Is your program accessible?

ACR Registry Requirements

Required Elements

Exam details:
Facility ID number, patient name, exam date

General:
Smoking status in pack years
Smoking cessation counseling
Documentation of shared decision making
Height, weight, comorbidities, cancer history
Radiologist name, ordering provider and NPI
Indication for the exam
Exam modality, manufacturer, radiation exposure
CT exam results by Lung-RADS™ category
Other abnormalities- CT exam result S modifier
Prior history of lung cancer and years since diagnosis

Follow-up within 1 year
Documentation of an exam anytime within prior 12 months and date
Follow-up diagnostic for tissue:
- Tissue Diagnosis
- Tissue diagnosis method
- Location from which sample was obtained
- Histology
- Stage- Clinical or pathologic
- Overall stage
- T, N, M status
- Period of follow-up for incidence (in months)

Additional Risk Factors:
Education level, radiation exposure, occupational exposures, history of cancers associated with a higher risk of lung cancer, lung cancer in first-degree relative, other family history of lung cancer, COPD, pulmonary fibrosis, secondhand smoke exposure.
Name of person performing data collection for the exam, submission date.
Systems Approach

Division of labor
  cost efficient/effective
  volume for PCP, specialist, radiology
Triage to manage specialty volume
Additional Challenges

Who to screen
Identifying the high risk population
Scheduling
Quality metrics and benchmarking
Tracking
Compliance
Workflow and division of labor
Smoking cessation
Community outreach

Radiology
Care escalation
Smoking cessation
Access
Primary Care engagement
Identification of the high risk population
Who to compare to?
Who tracks and reviews metrics
Metric feedback
Workflow and division of labor
Community outreach
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%, 3%

Significant Incidental Findings

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

70%, 40%, 10%, 6%, 4%, 2%
"False" False Positive Rates
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
<table>
<thead>
<tr>
<th></th>
<th>Disease or Condition</th>
<th>No Disease or Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test Positive</strong></td>
<td>A True Positive</td>
<td>B False Positive</td>
</tr>
<tr>
<td><strong>Test Negative</strong></td>
<td>C False Negative</td>
<td>D True Negative</td>
</tr>
</tbody>
</table>

- False positive rate = \( \frac{B}{A + B + C + D} \)
- False discovery rate = \( \frac{B}{A + B} \)
“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.”
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
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%.

Table:

<table>
<thead>
<tr>
<th>Patients screened</th>
<th>2106 (85.9%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with nodular findings on scans</td>
<td>1257 (59.7%)</td>
</tr>
<tr>
<td>Patients with nodules to be tracked</td>
<td>1184 (56.2%)</td>
</tr>
<tr>
<td>Patients with suspicious findings not confirmed to be lung cancer</td>
<td>42 (2.0%)</td>
</tr>
<tr>
<td>Patients with confirmed lung cancer</td>
<td>31 (1.5%)</td>
</tr>
</tbody>
</table>

- 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).”
• Jan 2017 JAMA Internal Medicine article:

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

  o “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.”

  o “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%”
“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.”
“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%.”
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.

<table>
<thead>
<tr>
<th>Reported false positives as %</th>
<th>Remarks</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>96.4</td>
<td>National Lung Screening Trial Research Team, p. 399</td>
<td>(Exhibit A again)</td>
</tr>
<tr>
<td>96.1</td>
<td>Study also reports 90% sensitivity</td>
<td>National Lung Screening Trial Research Team (2011)</td>
</tr>
<tr>
<td>95.5</td>
<td>106 false positives among 111 with nodules &gt;0.5 cm</td>
<td>Swensen et al. (2003)</td>
</tr>
<tr>
<td>92.9–96.0</td>
<td>Rates depended on nodule size, p. 260.</td>
<td>Tiitola et al. (2002)</td>
</tr>
<tr>
<td>86.6–96.4</td>
<td>Rates depend upon assumed nodule size from 5.0 to 9.0 mm</td>
<td>Swensen et al. (2005)</td>
</tr>
<tr>
<td>94.6</td>
<td>Based on 14 detected cancers among 259 patients with abnormal CT scans</td>
<td>Henschke et al. (2013)</td>
</tr>
<tr>
<td>94.1</td>
<td>From Table 2, 1773 false positives among 1883 nodules detected</td>
<td>McWilliams et al. (2003)</td>
</tr>
<tr>
<td>93</td>
<td>Based on 8 lung cancers among 114 subjects with nodules &gt;5 mm</td>
<td>Mahadevia et al. (2003)</td>
</tr>
<tr>
<td>92.6</td>
<td>Based on 22 lung cancers among 298 patients with nodules</td>
<td>Novello et al. (2005)</td>
</tr>
<tr>
<td>92.1</td>
<td>Based on 22 cancers in 279 with suspicious nodules</td>
<td>Pastorino et al. (2003)</td>
</tr>
<tr>
<td>88.5–97</td>
<td>From Table 3, rate dependent upon risk</td>
<td>Sone et al. (2001)</td>
</tr>
<tr>
<td>87.6</td>
<td>Based on 29 malignancies among 233 positive results</td>
<td>Kovalchik et al. (2013)</td>
</tr>
<tr>
<td>75</td>
<td>Percent of patients with non-calculated nodules on CT</td>
<td>Henschke et al. (2002)</td>
</tr>
<tr>
<td>73.4</td>
<td>Based on 163 benign nodules among 222 evaluated by thin section CT</td>
<td>Manos (2013)</td>
</tr>
<tr>
<td>&gt;70</td>
<td>Reported value derived from Mayo clinic and ELCAP trials</td>
<td>Li et al. (2004)</td>
</tr>
<tr>
<td>62.1</td>
<td>Based on 18 false positives among 29 subjects; for nodules &gt;10 mm</td>
<td>Patz et al. (2004)</td>
</tr>
<tr>
<td>43.75</td>
<td>Based on 36 confirmed lung cancer cases among 64 patients</td>
<td>Diederich et al. (2002)</td>
</tr>
<tr>
<td>21–33</td>
<td>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.</td>
<td>Nawa et al. (2002)</td>
</tr>
<tr>
<td>19</td>
<td>p. 119</td>
<td>Croswell et al. (2010)</td>
</tr>
<tr>
<td>7.9 M/5.6 F</td>
<td>Sensitivity reported to range between 84.6% W to 90.6% M</td>
<td>Pedersen et al. (2009), Saghir et al. (2012)</td>
</tr>
<tr>
<td>1.7</td>
<td>Sensitivity reported at 94.6%, based on Volume CT scanning</td>
<td>Toyoda et al. (2008), van Klaveren et al. (2009)</td>
</tr>
</tbody>
</table>

**D:** 95.5% = \( \frac{106}{111} \neq \text{false positive rate} \\
**E:** 94.6% = \( \frac{259 - 14}{259} \neq \text{false positive rate} \\
**F:** 94.1% = \( \frac{1773}{1883} \neq \text{false positive rate} \\
**G:** 93% = \( \frac{114 - 8}{114} \neq \text{false positive rate} \\
**H:** 92.6% = \( \frac{298 - 22}{298} \neq \text{false positive rate} \\
**I:** 92.1% = \( \frac{279 - 22}{279} \neq \text{false positive rate} \\

**THESE ARE ALL FALSE DISCOVERY RATES**

Rescuing lives from lung cancer today and tomorrow
False Positives with Additional Testing and Anxiety.

Magnitude of Effect: In the United States, approximately 10% of women are recalled for further testing after a screening examination, however, only 0.5% of tested women have cancer; thus, approximately 9.5% of tested women will have a false-positive exam.[8,9] Approximately 50% of women screened annually for 10 years in the United States will experience a false positive; of these, 7% to 17% will undergo biopsies.[10,11] Additional testing is less likely when prior mammograms are available for comparison.

- False discovery rate = (10 – 0.5) / 10 = 95%
- False positive rate = 50%

Editorial
June 2017

Physician Adherence to Breast Cancer Screening Recommendations
Deborah Grady, MD, MPH1,2; Rita F. Redberg, MD, MSc1,3

“It is estimated that 50% of women who undergo 10 mammography screens will have a false-positive finding.”

Not using false discovery rate when discussing breast cancer screening
### Table 4. False-Positive and Surgical Harms Reported in Ovarian Cancer Screening Trials

<table>
<thead>
<tr>
<th>Source</th>
<th>Quality</th>
<th>False-Positive Screening Rate Across Entire Program, No. With False-Positive Screen/No. Without Cancer (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UKCTOCS, 2016(^{22,31,34}) (CA-125 ROCA)</td>
<td>Good</td>
<td>20 340/45 067 (44.2) across 2-11 rounds of screening(^{e})</td>
</tr>
<tr>
<td>UKCTOCS, 2016(^{22,31}) (TVU)</td>
<td>Good</td>
<td>NR(^{h})</td>
</tr>
<tr>
<td>PLCO, 2011(^{20,21,27})</td>
<td>Good</td>
<td>3285/34 041 (9.6) across 1-6 rounds of screening</td>
</tr>
<tr>
<td>UK Pilot, 1999(^{33})</td>
<td>Good</td>
<td>462/10 942 (4.2) across 1-3 rounds of screening</td>
</tr>
<tr>
<td>QUEST, 2007(^{29})</td>
<td>Fair</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Not using false discovery rate when discussing ovarian cancer screening*
Not using false discovery rate when discussing cervical cancer screening

Table 3. Colposcopy Referrals and False-Positive Rates as Harms of hrHPV Screening, Based on Randomized Clinical Trials (Key Question 2)
<table>
<thead>
<tr>
<th>Screening Round</th>
<th>False Positive Rate</th>
<th>False Discovery Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NLST</td>
<td>NLST LR</td>
</tr>
<tr>
<td>T0</td>
<td>26.3%</td>
<td>12.6%</td>
</tr>
<tr>
<td>T1</td>
<td>27.2%</td>
<td>5.3%</td>
</tr>
<tr>
<td>T2</td>
<td>15.9%</td>
<td>5.1%</td>
</tr>
<tr>
<td>Overall</td>
<td>23.3%</td>
<td>7.8%</td>
</tr>
</tbody>
</table>

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

Do you ever hear the false positive rate for mammography quoted as 95%??
“Based on solid evidence, approximately 96% of all positive, low-dose helical computed tomography screening exams do not result in a lung cancer diagnosis. False-positive exams may result in unnecessary invasive diagnostic procedures. Magnitude of Effect: Based on the findings from a large randomized trial, the average false-positive rate per screening round was 23.3%. A total of 0.06% of all false-positive screening results led to a major complication after an invasive procedure performed as diagnostic follow-up to the positive screening result. Over three screening rounds, 1.8% of participants who did not have lung cancer had an invasive procedure following a positive screening result.”

- NIH
2 Feb 2018
So What **ARE** the False Positive Rates for CT Lung Screening?

### 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

**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%

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

Brady J. McKee, MD; Shawn Regis, PhD; Andrea K. Borudny-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%
Major discrepancies in the reporting of significant incidental findings in CT lung screening due to lack of both general and specific standard definitions

"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."

"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%])."

"Unexpected findings which are either new or unknown and require some form of clinical or imaging investigation before the next recommended CTLS exam"
Systems Approach
• Intended for community hospitals and healthcare systems

• Highlights potential hurdles along with resources that will aid healthcare systems in establishing their own lung cancer screening program

• Twenty-five experts from 16 institutions representing all geographic regions of the country volunteered for the panel to develop the guide and website

• Available in the Fall of 2018, the website will allow users to interact with the guide in easy to navigate sections

• For more information visit Lung.org/screening-guide-news
Survey Q and A Format

• Questions submitted by participants from 16 sites
• Variety of screening settings
• Massachusetts state DPH survey
• [http://www.lungcancerscreeningguide.org/](http://www.lungcancerscreeningguide.org/)