Key Components of a Lung Cancer Screening Program: Maximizing Benefit-Harm balance

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Cumulative Numbers of Lung Cancers and of Deaths from Lung Cancer.

Cumulative Deaths from Lung Cancer.

Components of a screening program?

• Who?
• How often/How long?
• How is the CT done?
• What is an “abnormal scan”? 
• How is the CT reported?
• How are “positives” managed
• How is tobacco cessation integrated?
• How are referring providers, and patients educated?
• How do we measure performance?
Variability in risk among smokers
Lung Cancer Risk?

Kirk, Spock, McCoy, and Ensign Ricky are beaming down to the planet. Guess who’s not coming back.
Who is at risk?
http://www.brocku.ca/lung-cancer-risk-calculator

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>characteristics to be entered</td>
<td>enter values</td>
<td>centered or referent</td>
<td>coefficient</td>
<td>contribution to estimate</td>
<td>ORs</td>
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<td>age in years</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
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<td>0</td>
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<td>native Hawaiian/Pacific Islander (0=No; 1=Yes)</td>
<td>0</td>
<td>0</td>
<td>1.027152</td>
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<td>smoking status</td>
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<td></td>
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<td>0 = Former-smoker</td>
<td>0</td>
<td>0</td>
<td>0.2597431</td>
<td>0</td>
<td>1.30</td>
</tr>
<tr>
<td>1 = Current-smoker</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>average number of cigarettes smoked per day**</td>
<td>50</td>
<td>-0.202154161</td>
<td>-1.822605</td>
<td>0.368447387</td>
<td>nonlinear</td>
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<tr>
<td>duration smoked (years)</td>
<td>30</td>
<td>27</td>
<td>0.0317321</td>
<td>0.0951963</td>
<td>1.03</td>
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<td>years ago quit smoking. enter zero for current smokers</td>
<td>2</td>
<td>10</td>
<td>-0.0309572</td>
<td>0.2469576</td>
<td>0.97</td>
</tr>
<tr>
<td>model constant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>probability of lung cancer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.012</td>
</tr>
</tbody>
</table>

### Table. Projected Likelihood Over 6 Years of Lung Cancer Death With or Without Screening per 1000 Persons Screened*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Risk Factors</th>
<th>Deaths From Lung Cancer (Without Screening) per 1000 Persons, n</th>
<th>Deaths From Lung Cancer (With Screening) per 1000 Persons, n</th>
<th>Lung Cancer Deaths Averted per 1000 Persons, n</th>
<th>Persons Needed to Be Screened Annually for 3 y to Prevent 1 Death From Lung Cancer Over 6 y, n</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Typical&quot; participant in the NLST</td>
<td>62-year-old male current 1.5-PPD smoker for 35 y</td>
<td>19.5</td>
<td>15.6</td>
<td>3.9</td>
<td>256</td>
</tr>
<tr>
<td>Minimum eligible participant in the NLST</td>
<td>55-year-old female former 1-PPD smoker for 30 y who just quit</td>
<td>4.0</td>
<td>3.2</td>
<td>0.8</td>
<td>1236</td>
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<tr>
<td>High-risk participant eligible for the NLST</td>
<td>70-year-old current 2-PPD smoker for 55 y</td>
<td>60.9</td>
<td>48.7</td>
<td>12.2</td>
<td>82</td>
</tr>
<tr>
<td>Minimum eligible participant by NCCN guidelines</td>
<td>50-year-old male former 1-PPD smoker for 20 y who quit 10 y ago with an occupational asbestos exposure history</td>
<td>1.6</td>
<td>1.3</td>
<td>0.3</td>
<td>3180</td>
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<tr>
<td>Low-risk eligible participant for Sequoia Hospital lung screening program</td>
<td>40-year-old female former 1-PPD smoker for 10 y who quit 15 y ago</td>
<td>0.10</td>
<td>0.08</td>
<td>0.02</td>
<td>35 186</td>
</tr>
</tbody>
</table>

NCCN = National Comprehensive Cancer Network; NLST = National Lung Screening Trial; PPD = packs per day.
* Assuming the program includes 3 y of annual screening.
<table>
<thead>
<tr>
<th>Minimum Pack-Years at Screening, n</th>
<th>Minimum Age at Which to Begin Screening, y</th>
<th>Time Since Last Cigarette, y</th>
<th>Population Ever Screened, %</th>
<th>Lung Cancer Deaths Averted, %</th>
<th>Lung Cancer Deaths Averted, n</th>
<th>Total CT Screens,n</th>
<th>Radiation-Induced Lung Cancer Deaths, n</th>
<th>Overdiagnosis, %</th>
<th>CT Screens per Lung Cancer Death Averted, n</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>60</td>
<td>25</td>
<td>13.0</td>
<td>11.0</td>
<td>410</td>
<td>171,924</td>
<td>17</td>
<td>11.2</td>
<td>437</td>
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<tr>
<td>40</td>
<td>55</td>
<td>25</td>
<td>13.9</td>
<td>12.3</td>
<td>458</td>
<td>221,606</td>
<td>21</td>
<td>11.1</td>
<td>506</td>
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<tr>
<td>30</td>
<td>60</td>
<td>25</td>
<td>18.8</td>
<td>13.3</td>
<td>495</td>
<td>253,095</td>
<td>21</td>
<td>11.9</td>
<td>534</td>
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<tr>
<td><strong>30</strong></td>
<td><strong>55</strong></td>
<td><strong>15</strong></td>
<td><strong>19.3</strong></td>
<td><strong>14.0</strong></td>
<td><strong>521</strong></td>
<td><strong>286,813</strong></td>
<td><strong>24</strong></td>
<td><strong>9.9</strong></td>
<td><strong>577</strong></td>
</tr>
<tr>
<td>20</td>
<td>60</td>
<td>25</td>
<td>24.8</td>
<td>15.4</td>
<td>573</td>
<td>327,024</td>
<td>25</td>
<td>9.8</td>
<td>597</td>
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<tr>
<td>30</td>
<td>55</td>
<td>25</td>
<td>20.4</td>
<td>15.8</td>
<td>588</td>
<td>342,880</td>
<td>25</td>
<td>10.0</td>
<td>609</td>
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<td>20</td>
<td>55</td>
<td>25</td>
<td>27.4</td>
<td>17.9</td>
<td>664</td>
<td>455,381</td>
<td>31</td>
<td>10.4</td>
<td>719</td>
</tr>
<tr>
<td>10</td>
<td>55</td>
<td>25</td>
<td>36.0</td>
<td>19.4</td>
<td>721</td>
<td>561,744</td>
<td>35</td>
<td>9.5</td>
<td>819</td>
</tr>
</tbody>
</table>

Relation between Risk and Benefit

Superficial View

Risk of fatal lung cancer

Screening is beneficial

Increasing Risk Factors for Lung Cancer
Relation between Risk and Benefit

More Realistic View?

Risk-Benefit break even point

Specific Risks

Ability to undergo treatment

Increasing Risk Factors for Lung Cancer (e.g. age, smoking)

Risk of dying of smoking-related comorbid disease

Risk of developing lung cancer

Risk of harms from biopsy, procedures

Risk of harm from radiation
Components of a screening program?

• **Who?**
  - Individuals at high risk for lung cancer
  - Age 55-80, Heavy (>30 pack-year) current or former (within 15 years) smoker
  - Individuals who cannot tolerate diagnostic work up or surgical treatment of lung cancer should not be screened
  - Screening programs should collect data on all enrolled subjects related to their risk of developing lung cancer
Components of a screening program?

- Who?
- How often/How long?
- How is the CT done?
- What is an “abnormal scan”? 
- How is the CT reported?
- How are “positives” managed?
- How is tobacco cessation integrated?
- How are referring providers, and patients educated?
- How do we measure performance?
How often and for how long?

Clinical Guideline

Recommendation: The USPSTF recommends annual screening for lung cancer with low-dose computed tomography in adults aged 55 to 80 years who have a 30 pack-year smoking history and currently smoke or have quit within the past 15 years. Screening should be discontinued once a person has not smoked for 15 years or develops a health problem that substantially limits life expectancy or the ability or willingness to have curative lung surgery. (B recommendation)

Population: This recommendation applies to asymptomatic adults aged 55 to 80 years who have a 30 pack-year smoking history and currently smoke or have quit within the past 15 years.
How often and for how long

- Should be offered annually until age 80
- Should no longer be performed if the patient develops comorbid illness limiting life expectancy or unacceptably increasing the risk of procedure-related complications
  - The annual lung cancer screen should be scheduled a year from the most recent chest CT whether this was the prior screening CT or an interval CT performed for symptom evaluation or nodule surveillance.
Components of a screening program?

- Who?
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## Radiation Comparison

<table>
<thead>
<tr>
<th>Radiation Type</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-dose CT</td>
<td>1-2 mSv</td>
</tr>
<tr>
<td>CT, full body</td>
<td>10-12 mSv</td>
</tr>
<tr>
<td>CT, chest</td>
<td>4-8 mSv</td>
</tr>
<tr>
<td>Background Radiation, sea level</td>
<td>3 mSv/yr</td>
</tr>
<tr>
<td>Background Radiation high-altitude</td>
<td>6 mSv/yr</td>
</tr>
<tr>
<td>Mammogram</td>
<td>1-2 mSv</td>
</tr>
<tr>
<td>Frequent flying (100-450k/yr)</td>
<td>1-7 mSv</td>
</tr>
<tr>
<td>CXR</td>
<td>0.1-0.6 mSv</td>
</tr>
<tr>
<td>DEXA</td>
<td>0.01-0.05 mSv</td>
</tr>
<tr>
<td>Dental x-ray</td>
<td>0.02 mSv</td>
</tr>
</tbody>
</table>
Components of a screening program?

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• How do we measure performance?
Frequency of a positive result and cases of lung cancer diagnosed within 12 mo of baseline enrollment.

From: Definition of a Positive Test Result in Computed Tomography Screening for Lung Cancer: A Cohort Study

Volumetric nodule measurement

74-Day Doubling Time
What is an abnormal scan?

• A lung cancer screening program should have a consistent policy about the size of nodule to be used to label the test as positive
  – **If > 4 mm size cutoff, then data should be collected prospectively on nodule detection and on patient adherence to follow up scans

• Program should collect data about the number and size of lung nodules that are detected
Components of a screening program?

- Who?
- How often/How long?
- How is the CT done?
- What is an “abnormal scan”? 
- How is the CT reported?

- How are “positives” managed?
- How is tobacco cessation integrated?
- How are referring providers, and patients educated?
- How do we measure performance?
How is the CT reported?

• A structured reporting system is a MUST
• Dr. Kazerooni will cover this extensively in her talk
• LUNGRads is modeled after BiRADS (mammography reporting format)
Components of a screening program?

- Who?
- How often/How long?
- How is the CT done?
- What is an “abnormal scan”?*
- How is the CT reported?

- How are “positives” managed?
- How is tobacco cessation integrated?
- How are referring providers, and patients educated?
- How do we measure performance?

*Note: “abnormal scan” refers to findings or results that require further investigation or action.
How are “positives” managed

- A lung cancer screening program must include clinicians with expertise in the diagnostic management of lung nodules
  - Knowing what not to biopsy is more important than knowing HOW to biopsy

- Have an approach to communication with the ordering provider and/or patient

- Track nodule management, and

- Collect data on use of, and outcomes from, surveillance and diagnostic imaging, and invasive procedures
Components of a screening program?

- Who?
- How often/How long?
- How is the CT done?
- What is an “abnormal scan”?
- How is the CT reported?
- How are “positives” managed?
- How is tobacco cessation integrated?
- How are referring providers, and patients educated?
- How do we measure performance?
TOBACCO CESSATION IS THE MOST EFFECTIVE MEANS TO THE END SOUGHT THROUGH LUNG CANCER SCREENING

Effective tobacco cessation cuts risk for lung cancer mortality up to 90%
How effective?

LDCT screening

- Absolute risk of 1.9%
- Screened group lung cancer mortality rate was 1.6%
- 20% RRR, but
- Need to screen 320 people to save one life
- Cost? 50-70k

Tobacco cessation

- Absolute risk of 1.9% in NLST
- ~80-90% RRR
- ~80-90% RRR
- Need to get 60 people to quit tobacco to save one life from lung cancer
- Cost? $300-$3000
How is tobacco cessation integrated?

• A lung cancer screening program must be integrated with a smoking cessation program

• Should collect data related to the smoking cessation interventions that are offered to active smokers and their effectiveness at follow up visits
Components of a screening program?

• Who?
• How often/How long?
• How is the CT done?
• What is an “abnormal scan”?
• How is the CT reported?
• How are “positives” managed?
• How is tobacco cessation integrated?
• How are referring providers, and patients educated?
• How do we measure performance?
Lung cancer screening decision aids should be created, tested, and validated. Physician facing decision support can and should be built into EMRs.
Components of a screening program?

• Who?
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• What is an “abnormal scan”?
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