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U.S. Public Perception and Knowledge of Lung Cancer Screening

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U.S. Public Perception and Knowledge of Lung Cancer Screening

Abstract
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First Supervisor
Tara Sacco

Subject Categories
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U.S. Public Perception and Knowledge of Lung Cancer Screening

By

Jessica M. Luciano, BSN, RN

Submitted in partial fulfillment of the requirements for the degree

Master’s in Advanced Practice Nursing

Supervised by Tara L. Sacco MS, RN, CCRN-K, AGCNS-BC, ACCNS-AG

Wegmans School of Nursing

St. John Fisher College

August 2017
Title: U.S. Public Perception and Knowledge of Lung Cancer Screening

Student Signature: Jessica M. Luciano  08/01/2017

Jessica M. Luciano

The above student has successfully completed this capstone as partial fulfillment of the requirements for the MS in Advanced Practice Nursing degree from the Wegmans School of Nursing at St. John Fisher College.

Advisor Signature: "signature"

Date: 08/10/17

This capstone fulfills the requirements of capstone seminars and assists in meeting the program outcomes for the MS in Advanced Practice Nursing degree from the Wegmans School of Nursing at St. John Fisher College.

Second reader Signature: "signature"

Date: 08/7/17
December 20, 2016

Jessica Luciano
St. John Fisher College

Dear Ms. Luciano:

Thank you for submitting your research proposal to the Institutional Review Board.

I am pleased to inform you that the Board has approved your Expedited Review project, “U.S. Public Perception and Knowledge of Lung Cancer Screening”.

Following federal guidelines, research related records should be maintained in a secure area for three years following the completion of the project at which time they may be destroyed.

Should you have any questions about this process or your responsibilities, please contact me at irb@sjfc.edu.

Sincerely,

Eileen Lynd-Balta

Eileen Lynd-Balta, Ph.D.
Chair, Institutional Review Board

ELB: jdr
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U.S. Public Perception and Knowledge of Lung Cancer Screening

In the United States, lung cancer causes more deaths than any other type of cancer and more deaths than breast, colorectal, and prostate cancer combined (Howlader et al., 2015). Typically, patients with lung cancer do not exhibit symptoms until their cancer reaches an advanced stage (American Cancer Society, 2016). More than half of lung cancer cases are diagnosed at an advanced stage; the 5-year survival rate for these cases is 4%. When lung cancer is diagnosed in an early, localized stage, the 5-year survival rate is 55%. In order for lung cancer to be detected at an earlier stage, and therefore improve survival rates, a screening program targeted at those at the highest risk for lung cancer would need to be implemented. In order for a screening program such as this to be successful, there would need to be public buy-in and awareness so that appropriate patients would actually participate in screening. While lung cancer screening modalities have been studied in depth (National Lung Screening Trial Research Team, 2011), the public perception and knowledge of lung cancer screening has not been explored as extensively.

Background and Significance

The National Lung Screening Trial (NLST) was a landmark randomized control trial in lung cancer screening research (NLST Research Team, 2011). Subjects in this study included 53,454 patients from 33 United States medical facilities. The NLST researchers demonstrated a 20% decrease in lung cancer mortality when high-risk patients were screened with low-dose computed tomography (LDCT) yearly as opposed to being screened with annual chest x-rays. However, there were high rates of false-positive screens and recalls for further imaging in the first year of screening. The false-positive screening rates and subsequent repeat imaging rates dropped dramatically (to a level equivalent with mammography and colonoscopy false-positive
screening and repeat imaging rates) in ensuing years of screening when baseline imaging was available for comparison. The NLST researchers also found that screening with LDCT may lead to the diagnosis of lung cancers that would never have been clinically harmful. However, they also discovered that LDCT screening leads to the diagnosis of lung cancers in earlier stages when the cancer can be eradicated with surgery alone.

Based largely on the NLST researchers’ findings, the U.S. Preventative Task Force (USPSTF) published recommendations in favor of screening high-risk patients for lung cancer with LDCT annually (Centers for Disease Control and Prevention, 2016). High risk patients include 55-80 year olds who have smoked at least the equivalent of one pack of cigarettes per day for 30 years and either currently smoke or have quit smoking within the last 15 years. This is noted to be a grade B screening recommendation (USPSTF, 2016) which provides a “high certainty that the net benefit is moderate” or a “moderate certainty that the net benefit is moderate to substantial” (USPSTF, 2016, Grade Definitions After July 2012). Per the Patient Protection and Affordable Care Act (2010), private insurers must cover USPSTF grade A and B recommendations.

The U.S. public’s attitude toward and knowledge of lung cancer screening has been minimally studied both before and after the release of the USPSTF lung cancer screening guideline in 2013. Silvestri, Nietert, Zoller, Carter, and Bradford (2007) found that, compared to non-smokers, smokers were more doubtful that finding lung cancer early would improve survival and were less likely to participate in screening with LDCT. They also found that only half of smokers would agree to surgical resection of lung cancer detected by screening. Retrouvey, Patel, and Shaves (2015) found that 87% of participants were unaware of the USPSTF guideline and that all of those who were eligible for screening wanted to be screened. Crothers, et al.
(2016) and Mishra et al. (2016) found that current and former smokers lacked knowledge about the purpose of lung cancer screening, wanted to know more about screening, were receptive to screening, and wanted increased communication with clinicians about screening. Multiple investigators have found that barriers to lung cancer screening include: lack of awareness that this screening exists, fear of false-positive results, fear of unnecessary invasive intervention, fear of radiation, cost, and inconvenience. These same authors discovered that facilitators of lung cancer screening include: explanation of screening risks and benefits, knowledge of mortality reduction and published supportive data, increased perceived level of lung cancer risk, and encouragement from family and healthcare providers (Khasnavis, Rosenkrantz, and Prabhu, 2017; Retrouvey, et al., 2015; Sin, Ha, and Taylor, 2016; Sinicrope et al., 2010).

The only U.S. studies that addressed public perception of lung cancer screening since the publication of the USPSTF lung cancer screening guideline have mainly been qualitative (Crothers, et al., 2016; Khasnavis, et al., 2017; Mishra, et al., 2016; Sin, et al., 2016), selective for those with a history of heavy smoking (Crothers, et al., 2016; Mishra, et al., 2016), or selective for Korean immigrants (Sin, et al., 2016). There has only been one small quantitative study of the general U.S. public perception and knowledge of lung cancer screening since 2013 (Retrouvey, et al., 2015). This author seeks to add to this quantitative body of knowledge.

**Theoretical Framework**

This study is built upon Ajzen’s (1991) Theory of Planned Behavior. This theory postulates that an individual’s intention to carry out a given behavior can be predicted by the individual’s attitude about the probability of the behavior returning the expected outcome and the individual’s perception of the risks and benefits of the outcome. Actuation of the behavior
depends upon the individual’s intention and ability to carry it out. The theory refers to an individual’s ability to carry out a behavior as behavioral control. Six constructs make up an individual’s behavioral control: behavioral beliefs, attitude toward the behavior, normative beliefs, subjective norm, control beliefs, and perceived behavioral control. All six constructs ultimately lead to the intention to carry out the behavior or not and actual behavioral control influences whether the behavior is actually carried out.

In this study, the Theory of Planned Behavior was applied to a sample of the U.S. public in regards to the behaviors of cancer screening in general and lung cancer screening in particular. The public’s behavioral beliefs (beliefs about treatment and survival outcomes related to cancer screening), attitudes toward the behavior (perception of lung cancer screening), control beliefs (willingness to be screened based on the accuracy and cost of lung cancer screening), and self-reported willingness to actuate the behavior (of being screened and surgically treated for lung cancer) were measured with the questionnaire.

**Purpose**

The purpose of this study was to assess American public perception of early cancer detection, understanding of lung cancer risk, and attitude toward lung cancer screening and intervention. Based upon this assessment of perception and knowledge, the need for public education on lung cancer risk, lung cancer screening modalities and guidelines, and the effectiveness of lung cancer screening and intervention was surmised.

**Methodology**

Approval for this study was granted by St. John Fisher College’s institutional review board and data were collected between January and March of 2017. A non-experimental, cross-
sectional descriptive design was employed. A brief description of the study and a link to the survey being used to collect data were posted on the primary investigator’s Facebook page. Sharing of the link to the survey was encouraged so that participants outside of the primary investigator’s audience could be reached. Before beginning the survey, the participants were presented with an explanation of informed consent which was implied by completing the online survey. The survey (see Appendix A) was adapted from Flynn, Peters, and Morgan (2013) with their permission. The survey collected demographic data (age, gender, state/territory of residence, ethnicity, education level, income, and personal smoking history) and addressed the variables of perception of early cancer detection in general, understanding of lung cancer risk, and attitude toward lung cancer screening and intervention. Responses were used to identify associations and make comparisons between demographic characteristics, smoking status, and the studied variables.

Results

Sample

Snowball sampling was employed via Facebook. In order to participate in the survey, subjects had to be 18 years of age or older and they had to live in a U.S. state or territory. There were a total of 96 respondents; one respondent was excluded because they lived outside the U.S. and three were excluded due to incomplete survey responses. The final sample included 92 respondents. Seventy-seven percent of respondents resided in New York, 77% of respondents were female, and 95% of respondents were Caucasian. The age and income characteristics of the sample are depicted in Figure 1 in Appendix B and Figure 2 in Appendix C, respectively. Thirty-eight percent of the sample had smoked more than 100 cigarettes in their lifetime, 7% were
current smokers, and 33% were former smokers. A total of three respondents were eligible for lung cancer screening based on their responses. In regards to the sample’s cancer screening history, 74% of participants reported having been screened for some type of cancer in the past. The most common cancers participants were screened for included breast, cervical, colon, and skin cancer. Few participants reported having been screened for leukemia, prostate, lung, and mouth cancer (see Figure 3 in Appendix D). Of the respondents who reported a past oncologic history, four had had breast cancer, three had had skin cancer, one had had lung cancer, one had had chronic lymphoid leukemia, and one had had parotid gland cancer.

Data Analysis

Data was analyzed using the SPSS 24 and both parametric and nonparametric analyses were performed based on statistical assumptions being met for comparisons and correlations. Descriptive analyses of means, frequencies, and percentages were calculated for demographic characteristics and survey response. Chi-square ($\chi^2$) analysis of nominal data were conducted for comparisons between groups. Correlation assessments occurred in the following manner: Pearson’s ($r$) correlations for normally distributed, scaled data; Spearman’s rho ($r_s$) for scaled data with normality violations; and phi coefficients ($\Phi$) and Cramer’s V ($\Phi_{Cramer}$) for nominal associations.

The majority of participants reported that early detection of cancer saved lives “most of the time” and led to more effective treatment “most of the time” (see Table 1 in Appendix E). Most participants believed that early detection of lung cancer made a person’s chance of survival “very much higher” or “somewhat higher” (see Table 2 in Appendix F). Additionally, those who believed that early detection of cancer saved lives were significantly more likely to believe that
early cancer detection led to more effective treatment and that early lung cancer detection
improved survival rates ($r=0.462; p=0.000$ and $r=0.297; p=0.005$, respectively, see Table 3 in
Appendix G). Also, those who believed early detection of cancer led to more effective treatment
were significantly more likely to believe that early lung cancer detection improved survival rates
($r=0.392; p=0.000$, see Table 3 in Appendix G). Neither current nor past smokers were
significantly more or less likely than non-smokers to believe that early cancer detection saved
lives, led to more effective treatment, or to believe that early lung cancer detection improved
survival rates. Current and former-smokers were significantly more likely than non-smokers to
believe that they were at risk for lung cancer ($\chi^2=19.291; p=0.000$, see Table 4 in Appendix H).

An unexpected finding in this sample was that current smokers with a longer history of
smoking were significantly more likely to have a higher income ($r_s=0.947; p=0.014$, see Table 5
in Appendix I). This finding has not been reported elsewhere and may be unique to this sample.
Also, current smokers were significantly less likely than former smokers or non-smokers to agree
to being screened for lung cancer if the test was only 90% accurate ($\chi^2=9.924; p=0.007$, see
Table 4 in Appendix H). There were no significant differences between these groups when asked
if they would agree to being screened if the test was 70% accurate or if they would agree to be
screened if the test costed $250. Participants who had been screened for any type of cancer in the
past were significantly more likely than those with no past history of any cancer screening to
agree to be screened if the test costed $250 ($\chi^2=4; p=0.046$) and to agree to surgical resection of
detected lung cancer ($\chi^2=6.942; p=0.008$). As participant age increased, willingness to pay $250
for screening significantly decreased ($\Phi_{Cramer}=0.379; p=0.046$). Current smokers were
significantly less likely than former smokers and non-smokers to agree to surgical resection if
their screening test revealed lung cancer ($\chi^2=27.93; p=0.000$, see Table 4 in Appendix H). There
was not a significant correlation between personal perception of lung cancer risk and willingness to participate in screening or surgical intervention. Only 12% of those who believed they were at risk for lung cancer had also been told this by a healthcare professional.

**Discussion**

This study was limited by its small sample size and its homogeneous sample of mainly Caucasian females from New York State. This is likely the result of most respondents being friends with the primary investigator of the same aforementioned demographic groups on Facebook. The lack of heterogeneity prevents this sample from being truly representative of the general U.S. public. There were also a relatively small number of current smokers and only three respondents who would be eligible for lung cancer screening based on USPSTF guidelines in the sample. This limits the ability to generalize the results of this study to current smokers and those eligible for screening. The design of this study (a non-experimental, cross-sectional descriptive design) lacked randomization and rigor which renders the results and relationships discovered vulnerable to confounding factors.

In this sample, the perception of early cancer detection in general and early lung cancer detection in particular was mainly positive. Most respondents felt that early detection of cancer (including lung cancer) saved lives. It was also apparent that most current and former smokers believed that they were at risk for lung cancer. Many, however, had not been told this by a healthcare professional similarly to Flynn, Peters, and Morgan's (2013) findings. This could be because the respondents overestimated their lung cancer risk or because their healthcare providers are not accurately communicating their risk status to them. Either way, this finding supports the need for increased education regarding lung cancer risk stratification and risk
communication for both patients and providers as well as the need for a shift in clinician practice toward transparent and direct communication of lung cancer risks to patients.

As current smokers were less likely than any other group in this study to agree to participate in lung cancer screening or surgical intervention, there may be a lack of knowledge that screening can decrease lung cancer mortality by 20% (NLST, 2011). This conclusion would be consistent with the lack of public awareness of lung cancer screening demonstrated by other researchers (Crothers, et al., 2016; Khasnavis, et al., 2017; Mishra, et al., 2016; Retrouvey, et al., 2015; Sin, et al., 2016). Alternatively, former smokers and non-smokers may overestimate the benefits of screening and intervention. It is also possible that current smokers may be less likely to agree to interact with the healthcare system in general for other reasons (e.g. fear of judgment for smoking, fear of pressure to quit smoking, or fear of malignant findings).

The finding that only 50% of current smokers in this sample were willing to undergo surgical resection of screening-detected lung cancer is identical to the findings of Silvestri, et al. (2007), six years before the publication of the USPSTF lung cancer screening guideline. This illustrates that smokers are either no more informed about decreased lung cancer mortality resulting from screening with LDCT than they were in 2007 or that smokers remain unwilling to undergo surgical resection for other reasons independent of this knowledge. In contrast to Silvestri et al.’s findings, current and former smokers in this sample were not significantly less likely than never smokers to believe that early lung cancer detection improves survival rates. This finding may represent a small movement in favor of lung cancer screening (but not necessarily surgical intervention) among former and current smokers over time. In order for patients to make a well-informed decision about lung cancer screening, it is important to ensure that they are well-educated about the potential risks and benefits of lung cancer screening and
intervention. The need for more public education about these risks and benefits is supported by the findings of this study.

Further research is needed to discern the factors which decrease current smokers' willingness to participate in lung cancer screening and surgical resection of screening-detected lung cancer. Studies of more rigorous, quantitative design with larger, more heterogeneous samples including participants who are eligible for screening are needed to bolster the body of evidence surrounding LDCT lung cancer screening. Future researchers should also continue to explore the most effective methods of patient education regarding the challenging topic of the sensitivity, specificity, risks, and benefits of LDCT lung cancer screening in order to produce the most well-informed patient choices.

In terms of policy implications, the fact that as age of participants in this sample increased, willingness to pay $250 for a LDCT chest scan significantly decreased signals a need for cost containment. As a grade B recommendation, private insurers must cover costs incurred in accordance with the USPSTF lung cancer screening guideline (Patient Protection and Affordable Care Act, 2010). The Centers for Medicare and Medicaid Services (2015) have also agreed to cover LDCT lung cancer screening under guidelines similar to those proposed by the USPSTF. However, insurance coverage is not always synonymous with zero out-of-pocket expenses. For this reason, policy makers and the healthcare industry must work to keep out-of-pocket costs for lung cancer screening down in order to foster the participation of older adults.

Conclusion

Although the overall perception of this sample, including former and current smokers, was that general cancer screening and lung cancer screening in particular led to improved
survival outcomes; current smokers (who are generally at the highest risk for lung cancer) were the least willing to participate in screening and surgical intervention. These findings are similar to those discovered by Silvestri, et al. (2007) before the publication of the USPSTF lung cancer screening guideline. There is a lack of understanding as to whether current smokers are reluctant to be screened and operated on due to a lack of knowledge of decreased mortality or due to other factors. This phenomenon will require further research to be understood so these hindering factors can be addressed. Lung cancer screening with LDCT has been demonstrated to decrease lung cancer mortality by 20% (NLST Researcher Team, 2011). However, if those at the highest risk for lung cancer are not being screened and subsequently treated, this decrease in mortality will never be fully realized.

Most researchers have discovered a lack of patient awareness of LDCT lung cancer screening guidelines (Crothers, et al., 2016; Khasnavis, et al., 2017; Mishra, et al., 2016; Retrouvey, et al., 2015; and Sin, et al., 2016). The majority of participants in this sample believe that early detection of lung made one’s chance of survival “very much higher” or “somewhat higher”. Based on this finding and the lack of awareness of lung cancer guidelines demonstrated by other researchers, the general public may overestimate the benefits of lung cancer screening and underestimate the risks if they do not truly understand which factors put people at the highest risk for developing lung cancer. For this reason, public education regarding the risks and benefits of lung cancer screening along with eligibility guidelines is sorely needed in order for patients and their families to make the best-informed decision possible regarding lung cancer screening.
References


Appendix A

U.S. Public Perception and Knowledge of Lung Cancer Screening

Questionnaire Adapted from Flynn, Peters, & Morgan (2013)

1) What is your age?

   Less than 18 years old (does not meet inclusion criteria)
   18-24 years old
   25-34 years old
   35-44 years old
   45-54 years old
   55-64 years old
   65-74 years old
   75 years or older

2) What U.S. state or territory do you live in?

   I do not live in the U.S. (does not meet inclusion criteria)
   Drop-down menu of U.S. states and territories

3) What gender do you most identify with?

   Male
   Female
   Transgender

4) Which ethnicity do you most identify with?

   White or Caucasian
   Hispanic or Latino
   Black or African American
   Native American or American Indian
   Asian
Pacific Islander
Other
Prefer not to answer

5) What is the highest level of education you have completed?
   Some high school, no diploma
   High school graduate, diploma or the equivalent (for example: GED)
   Some college credit, no degree
   Trade/technical/vocational training
   Associate degree
   Bachelor’s degree
   Master’s degree
   Doctoral degree

6) What was your total household income before taxes during the past 12 months?
   Less than $25,000
   $25,000 to $34,999
   $35,000 to $49,999
   $50,000 to $74,999
   $75,000 to $99,999
   $100,000 to $149,999
   $150,000 to $199,999
   $200,000 or more

7) In general, compared to other people your age, would you say that your health is...
   Excellent
   Very Good
   Good
Fair
Poor

8) Has a doctor ever told you that you have had any cancer?
   Yes
   No

9) If you have had cancer, what kind of cancer? Select all that apply.
   None
   Lung cancer
   Breast cancer
   Bowel cancer
   Skin cancer
   Prostate cancer
   Cervical cancer
   Other

10) Have you smoked over 100 cigarettes in your life?
    Yes
    No

11) Do you currently smoke cigarettes?
    Yes
    No

12) For current smokers: On average how many cigarettes do you smoke per day?
    For former smokers: On average how many cigarettes did you smoke per day?
    0–9 cigarettes
    10–19 cigarettes
    20–29 cigarettes
30–39 cigarettes
40+ cigarettes
Not applicable

13) For current smokers: For how many years have you smoked this amount?
For former smokers: For how many years did you smoke this amount?

0–9 yrs
10–19 yrs
20–29 yrs
30–39 yrs
40–49 yrs
50+ yrs
Not applicable

14) Have you ever had a screening test for any cancers? Select all that apply.

Yes, breast cancer (mammogram)
Yes, prostate cancer (prostate-specific antigen blood test)
Yes, cervical cancer (Pap smear)
Yes, bowel cancer (stool sample and/or colonoscopy)
Yes, skin cancer (skin check)
No

15) How often would you say that early detection of cancer saves lives?

Always
Most of the time
Some of the time
Never
Don’t know
16) How often does finding cancer early mean that a person can have more effective treatment?

Always
Most of the time
Some of the time
Never
Don’t know

17) Would a person’s chance of surviving be higher if lung cancer were detected at an early stage?

Very much higher
Somewhat higher
Not at all higher
Depends on the person/type of cancer
Don’t know

18) Has a doctor or other health professional ever told you that you are at high risk for lung cancer?

Yes
No

19) Do you think that you are at risk for lung cancer?

Yes
No

A new low-dose CT scan has been developed which can find small cancers in the lung. If this scan finds cancer early, when it is small, the chances of curing the cancer is very high.

20) If you were told that you were at risk for lung cancer, would you consider having this scan done to determine the presence of lung cancer?

Yes
No
The scan is not 100% accurate. Some small fast-growing cancers can be missed and some non-harmful benign nodules might be further investigated when they do not need to be.

21) If the scan was 90% accurate would you consider having this scan done to determine the presence of lung cancer?

   Yes
   No

22) If the scan was 70% accurate would you consider having this scan done to determine the presence of lung cancer?

   Yes
   No

23) If you had to pay $250 to have the scan, would you consider having this scan done to determine the presence of lung cancer?

   Yes
   No

24) If this scan showed that you had lung cancer would you consider having surgery for treatment?

   Yes
   No
Figure 1

Age of Study Participants

<table>
<thead>
<tr>
<th>Age (in years)</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-24</td>
<td>10</td>
</tr>
<tr>
<td>25-34</td>
<td>30</td>
</tr>
<tr>
<td>35-44</td>
<td>10</td>
</tr>
<tr>
<td>45-54</td>
<td>20</td>
</tr>
<tr>
<td>55-64</td>
<td>15</td>
</tr>
<tr>
<td>65-74</td>
<td>5</td>
</tr>
<tr>
<td>75 or more</td>
<td>2</td>
</tr>
</tbody>
</table>
Appendix C

Figure 2

Annual Household Income of Study Participants (before taxes)

![Bar chart showing the number of participants by income category.]

Number of Participants

Income (in U.S. dollars)
Less than $25,000   $25,000 to $34,999   $35,000 to $49,999   $50,000 to $74,999   $75,000 to $99,999   $100,000 to $149,999   $150,000 to $199,999   $200,000 or more

0  5  10  15  20  25
Appendix D

Figure 3

*Types of Past Cancer Screening Reported by Study Participants*
Appendix E

Table 1

*Participants' Perceptions of Cancer Screening Effectiveness*

<table>
<thead>
<tr>
<th>Response</th>
<th>How often would you say that early detection of cancer saves lives? (% of participants)</th>
<th>How often does finding cancer early mean that a person can have more effective treatment? (% of participants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always</td>
<td>12</td>
<td>32.6</td>
</tr>
<tr>
<td>Most of the time</td>
<td>64.1</td>
<td>55.4</td>
</tr>
<tr>
<td>Some of the time</td>
<td>20.7</td>
<td>12</td>
</tr>
<tr>
<td>Never</td>
<td>1.1</td>
<td>0</td>
</tr>
</tbody>
</table>
Appendix F

Table 2

*Participants' Perceptions of Early Stage Detection's Effect on Lung Cancer Mortality*

<table>
<thead>
<tr>
<th>Response</th>
<th>(% of participants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Would a person's chance of surviving be higher if lung cancer were detected at an early stage?</td>
<td></td>
</tr>
<tr>
<td>Very much higher</td>
<td>48.9</td>
</tr>
<tr>
<td>Somewhat higher</td>
<td>30.4</td>
</tr>
<tr>
<td>Not at all higher</td>
<td>2.2</td>
</tr>
<tr>
<td>Depends on the person/type of cancer</td>
<td>12</td>
</tr>
<tr>
<td>Don't know</td>
<td>5.4</td>
</tr>
</tbody>
</table>
Appendix G

Table 3

Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>How often would you say that early detection of cancer saves lives?</th>
<th>How often does finding cancer early mean that a person can have more effective treatment?</th>
<th>Would a person’s chance of surviving be higher if lung cancer were detected at an early stage?</th>
</tr>
</thead>
<tbody>
<tr>
<td>How often would you say that</td>
<td>1.000</td>
<td>0.462*</td>
<td>0.297*</td>
</tr>
<tr>
<td>early detection of cancer saves</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lives?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How often does finding cancer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>early mean that a person can have</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>more effective treatment?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Would a person’s chance of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>surviving be higher if lung cancer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>were detected at an early stage?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Reported correlation coefficients are Pearson’s $r$.

*p < 0.01
## Appendix H

### Table 4

*Participant Willingness to be Screened and Treated for Lung Cancer Based on Smoking Status*

<table>
<thead>
<tr>
<th></th>
<th>Never Smoker</th>
<th>Former Smoker</th>
<th>Current Smoker</th>
<th>$\chi^2$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Believe they are at risk for lung cancer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (%)</td>
<td>5.6</td>
<td>33.3</td>
<td>66.7</td>
<td>19.291</td>
<td>0.000</td>
</tr>
<tr>
<td>No (%)</td>
<td>94.4</td>
<td>66.7</td>
<td>33.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If at risk for lung cancer, would be screened for lung cancer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (%)</td>
<td>96.2</td>
<td>100</td>
<td>80</td>
<td>2.260</td>
<td>0.072</td>
</tr>
<tr>
<td>No (%)</td>
<td>3.8</td>
<td>0</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If at risk for lung cancer, would be screened for lung cancer if scan was 90% accurate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (%)</td>
<td>98.1</td>
<td>100</td>
<td>75</td>
<td>9.924</td>
<td>0.007</td>
</tr>
<tr>
<td>No (%)</td>
<td>1.9</td>
<td>0</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If at risk for lung cancer, would be screened for lung cancer if scan was 70% accurate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (%)</td>
<td>86.8</td>
<td>86.7</td>
<td>80</td>
<td>0.183</td>
<td>0.913</td>
</tr>
<tr>
<td>No (%)</td>
<td>13.2</td>
<td>13.3</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If at risk for lung cancer, would pay $250 to be screened</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (%)</td>
<td>86.8</td>
<td>70</td>
<td>60</td>
<td>4.565</td>
<td>0.102</td>
</tr>
<tr>
<td>No (%)</td>
<td>13.2</td>
<td>30</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If the scan showed lung cancer, would have surgery for treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (%)</td>
<td>100</td>
<td>96.7</td>
<td>50</td>
<td>27.930</td>
<td>0.000</td>
</tr>
<tr>
<td>No (%)</td>
<td>0</td>
<td>3.3</td>
<td>50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$p < .05$ for statistical significance
## Table 5

### Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>Cigarettes smoked per day (current smoker)</th>
<th>Years smoking that number of cigarettes per day (current smoker)</th>
<th>Cigarettes smoked per day (former smoker)</th>
<th>Years smoking that number of cigarettes per day (former smoker)</th>
<th>Highest level of education completed</th>
<th>Annual household income (before taxes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cigarettes smoked per day (current smoker)</td>
<td>1.000</td>
<td>0.213</td>
<td>n/a</td>
<td>n/a</td>
<td>-0.112</td>
<td>0.725</td>
</tr>
<tr>
<td>Years smoking that number of cigarettes per day (current smoker)</td>
<td>1.000</td>
<td>n/a</td>
<td>n/a</td>
<td>-0.572</td>
<td></td>
<td>0.947*</td>
</tr>
<tr>
<td>Cigarettes smoked per day (former smoker)</td>
<td>1.000</td>
<td>0.492**</td>
<td>0.075</td>
<td>0.040</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Years smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------------</td>
<td>---------------</td>
<td>---------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.264</td>
<td>-0.221</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>that number of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cigarettes per day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(former smoker)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest level of education</td>
<td></td>
<td>1.000</td>
<td>0.225*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>completed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual household income</td>
<td></td>
<td></td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(before taxes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. Reported correlation coefficients are Spearman’s rho. Correlation coefficients could not be calculated between current and former smokers, this is denoted by “n/a”.

*p < 0.05, **p < 0.01
U.S. Public Perception and Knowledge of Lung Cancer Screening
Jessica Lucctino, BA, BSN, RN
Supervised by Tara L. Suco MS, RN, CCRN-K, AGCNS-BC, AGONS-AG

Introduction
- NLST researchers (2011): 20% decrease in lung cancer mortality when high-risk patients were screened with low-dose computed tomography (LDCT) yearly as opposed to being screened with annual chest x-rays
  - Lead to U.S. Preventive Services Task Force (USPSTF) lung cancer screening guideline (2013): people age 55-80 years with a smoking history of 20 pack-years who currently smoke or quit smoking within the past 15 years are eligible for annual LDCT chest scan
  - Retrosurvey Patel, and Shieves (2015): only 87% of participants were aware of USPSTF lung cancer screening guideline, all who were eligible wanted to be screened
  - Crothers, et al. (2016) and Misha et al. (2016): current and former smokers lacked knowledge about the purpose of lung cancer screening, wanted to know more about screening, were receptive to screening, and wanted increased communication with clinicians about screening

Purpose
To assess the U.S. public’s perception of early cancer detection, understanding of lung cancer risk, and attitude toward lung cancer screening and intervention. Based upon this assessment of perception and knowledge, the need for public education on lung cancer risk, lung cancer screening modality and guidelines, and the effectiveness of lung cancer screening and intervention was assessed.

Methodology
- Questionnaire adapted from Flynn, Peters, and Morgan (2013)
  - Demographics
  - Health status
  - Oncologic history
  - Smoking history
  - Current smoking status
  - History of cancer screening
  - Perception of cancer screening’s effect on survival and treatment
  - Perception of personal lung cancer risk
  - Willingness to have annual LDCT chest scan if at risk for lung cancer if scan very accurate, 90% accurate, 10% accurate, cost justified
  - Willingness to have surgical treatment of detected lung cancer
  - Distributed on Facebook
  - Sharing encouraged ➔ snowball sampling

Sample
- Inclusion criteria: ≥ 18 years old, live in U.S. state or territory
- 96 respondents, 92 were eligible
- 77% female
- 77% from New York state
- 95% Caucasian
- 38% had smoked > 100 cigarettes
- 33% former smokers
- 7% current smokers
- 74% reported history of some type of cancer screening.

Data Analysis
- SPSS 24
- Parametric and nonparametric analyses
- Descriptive analyses of means, frequencies, and percentages calculated for demographic characteristics and survey response
- Chi-square ($\chi^2$) analysis of nominal data conducted for comparisons between groups
- Correlation assessments:
  - Pearson’s ($r$) correlations for normally distributed, scaled data
  - Spearman’s rho ($\rho$) for scaled data with normality violations
  - Phi coefficients ($\phi$) and Cramer’s V ($V_{c_{max}}$) for nominal associations
Results

- Majority reported that early detection of cancer saves lives "most of the time." and led to more effective treatment "most of the time." and that early detection of lung cancer made a person's chance of survival "very much higher" or "somewhat higher" - no difference between smokers and non-smokers.
- Current and former smokers were significantly more likely than non-smokers to believe that they were at risk for lung cancer (\(p=0.009, p=0.0000\))
- Only 2% of those who believed they were at risk for lung cancer had also been told this by a healthcare professional.
- As participant age increased, willingness to pay $250 for screening significantly decreased (\(p=0.0279, p=0.0304\)).

Implications

Education

- Finding: only 12% of those who believed they were at high risk for lung cancer were told this by a healthcare provider.
  - Education regarding lung cancer risk must be developed for both patients.
- Finding: Current smokers are less likely to agree to screening and survival intervention.
  - Education regarding the risks and benefits of lung cancer screening must be developed and promoted for this population.
- Those who are not at a high risk for lung cancer may overestimate the benefits of lung cancer screening. More general public education initiatives on the topic should be explored.

Practice

- Healthcare providers must attempt to increase/improve communication with patients regarding their lung cancer risk status.

Research

- Finding: Current smokers are less likely to agree to screening and survival intervention.
  - Few patients with lung cancer are being referred for screening.
  - Few patients with lung cancer are being referred for surgical intervention.

Policy

- Finding: As age increases, willingness to pay $250 for screening significantly decreases.
  - Private insurers must cover lung cancer screening as it is a recommended U.S. Preventive Services Task Force recommendation (USPSTF grade B recommendation, 2014). Centers for Medicare and Medicaid have approved their own version of guidelines (EMS, 2015).

Dissemination Plans

- Submit manuscript to Public Health Nursing with the hope of inspiring community health initiatives to educate the public about lung cancer risk stratification and the risks and benefits of lung cancer screening.

References

Jessica Luciano

Literature Matrix #1

Topic: Efficacy of lung cancer screening

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>The purpose of this study was to determine if the use of low-dose helical computed tomography (CT) in comparison with single-view posteroanterior (PA) chest radiography (chest x-ray) as a screening modality could decrease the number of deaths caused by lung cancer.</td>
</tr>
<tr>
<td>Number of Subjects</td>
<td>Subjects included 53,454 patients from 33 US medical centers (10 Lung Screening Study (LSS) centers and 23 American College of Radiology Imaging Network (ACRIN) centers) whom were considered high-risk for developing lung cancer. Subjects had to be 55-74 years old when the groups were randomized. They had to have at least a 30 pack-year cigarette smoking history and/or have quit smoking cigarettes within 15 years of the study. Patients who had been diagnosed with lung cancer in the past, had a chest CT within 18 months of the study, had hemoptysis, or had inexplicably lost more than 6.8 kg within one year of the study were excluded. 95% of low-dose CT group subjects and 93% of chest x-ray group subjects adhered to the screening protocol across the three years. Vital status was known for 97% of the low-dose CT group and 96% of the chest x-ray group.</td>
</tr>
<tr>
<td>Sample Characteristics</td>
<td>In regards to demographics and smoking history, the control (chest x-ray) and experimental (low-dose CT) groups were essentially identical.</td>
</tr>
<tr>
<td>Year of Data Collection</td>
<td>Participants were enrolled from August 2002-April 2004. Screening occurred between August 2002 and September 2007. Data regarding incidence of lung cancer and mortality due to lung cancer or other causes were collected through the end of 2009.</td>
</tr>
<tr>
<td>Study Design</td>
<td>This study was a randomized controlled trial. Subjects were randomly assigned to two different screening modality groups. 26,722 patients were to have three yearly lung cancer screenings with low-dose CT. 26,732 patients were to have three yearly lung cancer screenings with PA chest x-rays.</td>
</tr>
<tr>
<td>Data Collection Method</td>
<td>Screening tests were performed according to a protocol developed by medical physicists involved in the study. The CT machines and level of exposure had to meet the standards set forth by the medical physicists. Chest x-rays could be on film or digital. All screening machines had to meet the standards set forth by the American College of Radiology. The radiologists and technicians associated</td>
</tr>
</tbody>
</table>
with the study had to be certified and specially trained to gather and interpret the images. Images were interpreted independently and then in comparison with other images from the study. CT scans that revealed non-calcified nodules of 4 mm or more were considered positive (suspicious for lung cancer). Chest x-rays that showed any non-calcified nodules were considered positive. Adenopathy and effusion on either type of image could also be considered positive. During the third round, abnormalities that were stable across all three years could be considered negative. The radiologists had to notify the patient and their provider of positive results within four weeks. Information regarding diagnostic procedures and any ensuing complications were collected from the medical records of those participants with positive screening tests. Pathological and histological information was retrieved from the medical records of those participants who were diagnosed with lung cancer. Either annually or semiannually, subjects were contacted. If they did not respond, their name and social security numbers were submitted to the National Death Index. Any death certificates were analyzed by an end-point verification team (who were unaware of the subjects’ group assignments) to verify whether lung cancer was their cause of death.

**Data Analysis Method**

The study was estimated to have 90% power to note a 21% increase in deaths from lung cancer in the experimental group. Confidence intervals of incidence ratios (number of events [events being the incidence of lung cancer or death from any cause]: person-years at risk for that event) were calculated with asymptotic methods using a Poisson distribution for the number of events and a normal distribution for the ratio’s logarithm. Confidence intervals for mortality ratios were calculated using the same weighted method used to measure the trial’s end point (efficacy versus futility of using low-dose CT to decrease lung cancer mortality). The primary end point was measured using weighted logrank statistic (no weight at beginning of trial to full weight at 4 years in the trial or after). The Lan-DeMets approach along with the O’Brien-Fleming spending function were used to form efficacy and futility parameters. The number of subjects that had to be screened in order to prevent one death from lung cancer was calculated by taking the reciprocal of the absolute risk reduction in the control versus experimental groups.

**Results**

24.2% of low-dose CT and 6.9% of chest x-ray screenings were positive. 96.4% of low-dose CT and 94.5% of chest x-ray positive screenings were false positives (according to follow-up procedures). 1,060 cases of lung cancer (645 cases per 100,000 person years) were diagnosed in the low-dose CT group. 649 of those cases were diagnosed as a result of a positive screening test during the trial, 44 cases were diagnosed after a negative screening
during the trial, 367 cases were diagnosed in those who missed screening during the trial or had a positive screening after the trial was over. 941 cases of lung cancer (572 cases per 100,000 person-years) were diagnosed in the chest x-ray group. 279 of those cases were diagnosed as a result of a positive screening test during the trial, 137 cases were diagnosed after a negative screening during the trial, 525 cases were diagnosed in those who missed screening during the trial or had a positive screening after the trial was over. There were 356 deaths from lung cancer (247 deaths per 100,000 person-years) in the low-dose CT group and 443 deaths from lung cancer (309 deaths per 100,000 person-years) in the chest x-ray group. Most lung cancers caught by screening were stage 1A or 1B (the most treatable stages); more of these were detected on low-dose CT than chest x-ray. Neither screening modality was very successful at detecting small-cell lung cancer in its early stages. The relative rate of mortality due to lung cancer was decreased by 20% with low-dose CT.

**Implications**

This study presents compelling evidence in favor of screening a specific group of asymptomatic patients at high-risk for lung cancer with low-dose CT in order to help prevent lung cancer mortality. The demonstrated decrease in mortality is significant. This study does demonstrate a high rate of false positive scans that often led to further diagnostic procedures. However, the study also demonstrates that physical harm caused by these diagnostic procedures was very rare. The indication for further testing is expensive and can cause the patient undue stress. The study was performed in LSS and ACRIN centers which may have better screening, diagnostic, and treatment techniques than average healthcare centers; this could alter patient outcomes. In the discussion, this study sites a need for further research on the topic and does not recommend that agencies base their recommendations solely on this study.

**Strengths and Weaknesses**

Strengths of the study include the use of random assignment, a huge sample size, very low rate of attrition, and certified radiologists, technicians, and screening machinery. Interventions taken after a positive screening test reflect community care because the study did not require or recommend specific action. Weaknesses include that the National Cancer Institute (NCI) funded the study and as a result, findings may be biased. The volunteers for this study may differ from the general population as they may already be more inclined to be attentive to their health and their need for care and screenings if they volunteered to be in this type of study.
### Citation


### Purpose
The purpose of this study was to detect whether screening with low-dose CT annually can lower deaths due to lung cancer by greater than 25%. There were several other secondary purposes that were not explored in the article.

### Number of Subjects
Subjects included 4,104 volunteers recruited with newspaper advertisements. Subjects were 50-70 year old current and former smokers. They had to have at least a 20 pack-year cigarette smoking history. Former smokers had to have quit after the age of 50 and been abstinent from smoking for less than 10 years. They had to be able to climb 36 steps without stopping. Their forced expiratory volume had to be greater than or equal to 30% of the predicted volume within the first second of spirometry. Subjects who weighed more than 130 kg, had a history of cancer diagnosis and/or treatment, had lung tuberculosis, had an illness which decreased their life expectancy to less than 10 years, or had a chest CT for any reason in the preceding year were excluded. The average annual participation rate was 95.5% in the low-dose CT group (experimental group) and 93% in the control group. The difference in average participation was significant between the two groups in rounds two and three. The study was unable to follow-up with 29 subjects total (15 of them were from the experimental group) due to emigration. Person-years of follow-up were not significantly different between the groups.

### Sample Characteristics
There were no significant differences between the control and experimental groups in regards to demographics, social status, pulmonary function, or tobacco history.

### Year of Data Collection
Participants were enrolled between March 2004 and October 2006. Screening was completed in March 2010. They were followed-up with for 10 years post-randomization (this was done whether they...
<table>
<thead>
<tr>
<th><strong>Study Design</strong></th>
<th>This study was a randomized controlled trial. Subjects were randomly assigned to the control and experimental groups. There were 2,052 subjects in each group.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data Collection Method</strong></td>
<td>Initial screening CT scans were performed on the experimental group within a month of randomization. The experimental group had four more annual CT scans after the prevalence round. All the participants from both groups were brought to the screening clinic (at Gentofte University Hospital in Copenhagen, Denmark) annually to complete pulmonary function tests and the Consequences of Screening (COS)-Lung Cancer questionnaire. The COS is a core-questionnaire developed and validated in Denmark to measure psychosocial status in cancer screening patients. Specific questions regarding lung cancer screening were developed during group interviews in the prevalence round of this study and were added to the questionnaire making it the COS-Lung Cancer questionnaire. The questionnaire was used to measure the psychosocial consequences of false-positive screenings. Spirometry was performed according to the European Respiratory Foundation’s standards with a computer system. Absolute and predicted values were gathered using European reference equations. Annual CT scans were performed on the experimental group with a MDCT scanner. All scans were performed the same way and took images of the same areas. Two board-certified radiologists read all of the scans and came to a consensus if they disagreed initially. Lung nodules were classified into categories 1-5 according to size, growth, and morphology. Scans in categories 1-2 were considered screening test negative and scans in categories 3-5 were considered screening test positive (category 3 scans were indeterminate and were repeated 3 months later, categories 4-5 and growing nodules were referred for diagnostic evaluation). Subjects with nodules greater than 15 mm, growing nodules (increase in volume of at least 25% between CT scans), and nodules of suspicious morphology were referred for diagnostic evaluation after their case was discussed at a weekly follow-up meeting between radiologists, a chest surgeon, and a pulmonologist. Before subjects underwent invasive procedures, a CT with contrast was done to ensure the necessity of further intervention. Subjects then underwent bronchoscopy, transthoracic needle aspiration biopsy, endoscopic ultrasound, endobronchial ultrasound, mediastinoscopy, video-assisted thoracic surgery (VATS), and/or had a thoracotomy at Gentofte University Hospital or Bispebjerg University Hospital in Copenhagen. Multi-specialty, board-certified teams decided on treatment according to Danish lung cancer guidelines. Specimens from invasive procedures were evaluated by one pathologist utilizing guidelines form the EU-US pathology panel and World</td>
</tr>
</tbody>
</table>
Health Organization classifications. Any control group subjects who were incidentally diagnosed with lung cancer during the study received community-standard care. The Danish Civil Registration System was searched annually to assess the vital status of each participant. If a participant had died, the cause of death was found in the Danish Causes of Death Register. If possible, the medical records of the deceased were obtained and reviewed by a local death review board.

### Data Analysis Method

The study was estimated to have 80% power to detect a 25% decrease in lung cancer mortality 10 years post-randomization when combined with the results of the NELSON (Nederlands Leuven Screening Onderzoek) CT screening trial. The sample size needed was calculated to be 2,000 per group (which was reached). Disease prevalence and participation was compared between the experimental and control groups using the $X^2$ test. The null hypothesis which compared average follow-up years in the two groups was tested using the two sample t-test. Mortality rates were evaluated using the log-rank test and Kaplan-Meier plot. The study utilized a 95% confidence interval. P-values less than 0.05 were considered statistically significant.

### Results

False positive screens rates were 7.9%, 1%, 1.2%, 0.9%, and 1.3% from baseline to year five, respectively (the baseline year is the highest because many nodules proved to be benign based on scans in subsequent years). Follow-up scan rates were 7.6%, 1%, 1.2%, 0.9%, and 1.3% from baseline to year five, respectively (the baseline year is the highest because many nodules proved to be benign based on scans in subsequent years). 7 VATS procedures were performed on subjects whose nodules were later found to be benign. In the low-dose CT group, the average detection rate was 0.70%. There were 69 lung cancers diagnosed; 3 were small cell and 66 were non-small cell. Of the diagnoses, 48 (70%) were early stage and potentially curable and 22 (30%) were late-stage. In the control group who were not offered screening by the study, 24 were diagnosed with lung cancer; 7 were small-cell and the rest were presumably non-small cell. Eight of the diagnoses were early stage and 16 were late stage. One control group participant found to have early stage lung cancer was screened by his primary care physician and this was considered contamination in the study. There were significantly more lung cancers diagnosed in the experimental group and significantly more of those diagnoses were early stage than in the control group. There was not a significant difference in the number of late stage cancers found in either group. At the end of the study, a total of 103 subjects had died; 61 (2.97%) were from the screening group and 42 (2.05%) were from the control group. Of the deaths, 26 were caused by lung cancer; 15 (0.73%) were from the screening group and 11 (0.54%) were from the control.
group. No significant differences in mortality were found between groups.

**Implications**

This study does not support lung cancer screening in its current state; this is possibly because of its small sample size and relatively short follow-up timeframe. Its results have yet to be combined with those of the NELSON trial so it would not have the power to detect the decrease in mortality it had sought to detect whether or not mortality rates were statistically significant in this study. The authors make mention of efforts to lengthen follow-up time of this study and combine results of all European lung cancer screening trials to gain statistical power in favor of lung cancer screening. This study suggests that annual screening may lead to over diagnosis and treatment of lung cancers which may never have grown to the point of causing symptoms or death if left alone. Based on this study alone as it stands, annual lung cancer screening would not necessarily be warranted. There are, however, other larger trials which do illustrate a significant decrease in lung cancer mortality with annual screening by low-dose CT.

**Strengths and Weaknesses**

Strengths of the study include the use of random assignment, a very low rate of attrition, two board certified radiologists and one board-certified pathologist (a small number of evaluators leads to an increase in reliability of results due to a decrease in variability of opinion), standardized disease classifications recommended by outside sources (pathology, staging, etc.), standardized screening devices (CT machines and computer software), a previously validated questionnaire (COS questionnaire), and a low rate of contamination (control group receiving CT scans). Weaknesses include that the study’s results would have to be combined with the NELSON trial results to detect the difference they were looking for. Also, although the sample size met the calculated required size, it is too small to be evaluated in its own because the necessary sample size was calculated in relation to the NELSON trial sample size. Subjects were volunteers recruited via newspaper advertisements and may not completely accurately represent the population because they may be more motivated to engage in preventative healthcare in the first place. This Danish study may not be completely applicable to the US population either.
| Purpose | The purpose of this study was to detect a 25% decrease in lung cancer deaths 10 years after randomization in its participants with moderate to high risk of lung cancer who underwent three rounds of CT screening. |
| Number of Subjects | Subjects included 15,428 people from several regions in the Netherlands and Belgium gathered with population-based recruitment. Subjects were invited to participate in the study based on their health and tobacco history (which was gathered in initial questionnaires sent to all men born from 1928-1953 in certain regions of the Netherlands and all men and women born from 1928-1953 in certain regions of Belgium). Subjects were 50-75 year old current and former smokers. They had to have smoked more than 15 cigarettes per day for over 25 years or more than 10 cigarettes per day for over 30 years. Former smokers had to have been abstinent from smoking for 10 years or less. Respondents were excluded if they rated their health moderate or bad and couldn’t climb two flights of stairs. Respondents who weighed 140 kg or more excluded. Respondents who had had renal cancer, breast cancer, melanoma, lung cancer diagnosed within five years, lung cancer diagnosed longer than five years ago still being treated, or had a chest CT within one year were also excluded. Of the 7,557 subjects screened in round one, 7,289 subjects returned for screening in round two (some participants were excluded from continuing the study due to lung cancer diagnosis during or after round one). |
| Sample Characteristics | The articles did not make mention of demographic or tobacco history differences between control (no intervention) and experimental (CT scan) groups. No control group characteristics are
<table>
<thead>
<tr>
<th><strong>Year of Data Collection</strong></th>
<th>Recruitment was completed from 2003-2005. Round one and two CT scans were performed from 2004-2008. Round three CT scans should have been completed in 2010 if the study went as planned (no further articles have been published past round two, yet).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Study Design</strong></td>
<td>This study was a randomized controlled trial. Subjects were randomly assigned to the control and experimental groups. There were 7,557 subjects in the experimental group. The number of participants in the control group was not specified but as there were 15,428 subjects at the time of randomization, there should have been approximately 7,871 subjects in the control group.</td>
</tr>
<tr>
<td><strong>Data Collection Method</strong></td>
<td>Subjects in the experimental group were to undergo a screening CT scan at baseline (round one), one year post-baseline (round two), and three years post-baseline (round three). At all screening sites across all rounds, screening conditions were the same (a 16-detector CT scanner was used to collect data and the same kind of workstation and software was used to analyze the data). Nodules were classified based on calcification, volume, diameter, volumedoubling time, and whether they’d been detected on a previous scan. Results were read independently by 13 first and two second readers (who were radiologists). The first readers had zero-20 years of experience and the second readers had six years of experience. If the first and second readers disagreed about a finding, they came to a consensus or consulted a third radiologist if they could not come to a consensus. CT scans were considered positive if the solid part of any non-calcified nodule was more than 9.8 mm in diameter. If the solid part was 4.6-9.8 mm in diameter or a non-solid nodule was more than 8 mm in diameter, the CT scan was considered indeterminate. Indeterminate scans were repeated in three months. If the nodule’s volume-doubling time was less than 400 days on the follow-up scan, the screening was negative. All participants with positive screenings were referred to a chest doctor. If the participants were diagnosed with lung cancer they were treated and were excluded from continuation of the trial. If the participants were not diagnosed with lung cancer after seeing the chest doctor, they returned for the second round of the trial a year after the baseline scan. During the second round, nodules found were compared to those seen in round one. New indeterminate nodules were scanned again in six weeks. Previously detected nodules were considered negative if they hadn’t grown or their volume-doubling time was more than 600 days. Previously detected nodules were considered positive if a new solid part had formed in a previously non-solid nodule or if the volume-doubling time was less than 400 days. Previously detected nodules were considered indeterminate if</td>
</tr>
</tbody>
</table>
their volume-doubling time was 400-600 days and a repeat scan was performed in a year. If the volume-doubling time of indeterminate nodules was less than 400 days on the follow-up scan, the screening was considered positive. Participants with negative screens in round two were invited to have a scan two years later (three years post-baseline) in round three. Interval cancers (cancers diagnosed after a negative screening test in the trial) were found through the national pathology database, participants, participants’ doctors, and the National Cancer Registry.

Data Analysis Method

Assuming 1:1 randomization, a one-sided alpha significance level of 0.05 (the study’s hypothesis is directional), 95% experimental group compliance, and 5% control group contamination, the study was estimated to have 80% power to detect a 20-25% decrease in lung cancer mortality 10 years post-randomization with 17,300–27,900 participants. The study alludes to combining results with the Danish lung cancer screening trial which has about 4,000 subjects so that it can detect this decrease. On its own, this study does not have enough participants to detect a 20-25% decrease in lung cancer mortality. Diagnostic sensitivity was calculated as the ratio between true positive screenings and the sum of true positive screenings and false negative screenings. Diagnostic sensitivity, specificity, and both positive and negative predictive values were calculated at the participant level, meaning that the values reflect the data from the study and have not been extrapolated. The study utilized a 95% confidence interval. P-values less than 0.05 were considered statistically significant.

Results

In round one, 79.2% of scans were negative, 19.2% were indeterminate, and 1.6% were positive. After follow-up scans of indeterminate nodules, 97.4% of all the subjects’ screenings were considered negative and 2.6% were considered positive. Of the 196 subjects with positive scans, 177 were referred to a chest doctor (the others weren’t referred due to a decision made by the tumor board, an administrative error, or already ongoing treatment with another practitioner). Of those 177 subjects, 70 were diagnosed with lung cancer (39.5%). Of the lung cancers, 63.9% were stage I. The subjects with positive screenings but without lung cancer either had benign disease (100 subjects) or metastases of other cancers (7 subjects). Round one’s lung cancer detection rate was 0.9% with 94.6% sensitivity, 98.3% specificity, 35.7% positive predictive value, and 99.9% negative predictive value (99.7% after accounting for round two results). Four stage IV interval cancers were found between rounds one and two (three of those subjects had negative baseline scans and one had an indeterminate baseline and negative follow-up scan). The 126 subjects with positive screenings but negative work-ups in round one were all eventually diagnosed with pulmonary adenocarcinoma. In round two, 92.2% of screenings
were negative, 6.6% were indeterminate, and 1.2% were positive. Of the follow-up scans, 38 were positive so positive screenings totaled 1.8%. Of the 128 participants with positive screenings, 118 were referred for work-up (one died of colon cancer, the rest were not referred because of a decision made by the tumor board, an administrative error, or already ongoing treatment with another practitioner). Of the 118 subjects referred for work-up, 45.8% were diagnosed with lung cancer; the rest had benign disease or a different type of cancer. Of the lung cancers diagnosed in round two, 73.7% were stage I. There were two interval cancers found between rounds two and three. In round two, the lung cancer detection rate was 0.8% with 96.4% sensitivity, 99% specificity, a positive predictive value of 42.2%, and a negative predictive value of 99.9%.

### Implications

This article does not report on the mortality rates of its subjects as the 10 year post-randomization mark will not be fully reached until 2018. Therefore, it is difficult to comment on the implications of the study in relation to its hypothesis that screening individuals at moderate to high risk for lung cancer will decrease lung cancer mortality by 25% 10 years post-randomization. Also, this study has not ascertained the number of subjects needed to reach 80% power in support of its hypothesis. It will have adequate power if its results are combined with those of the Danish lung cancer screening trial (assuming that that trial recruits the number of subjects it proposed). This article does illustrate strong negative predictive power of CT scan lung cancer screening in the limited time frame represented (99.7-99.9%). This would indicate that if a patient’s screenings are negative, they were almost surely free of lung cancer at the time of the scan. As the p-values were not reported in the article itself, one cannot say that the negative predictive value is necessarily statistically significant, though. The relatively high percentage of stage I lung cancers which were found (in comparison to greater stage cancers) is also promising (63.9-73.7%). However, without p-values, one cannot say that the detection of cancers in an early, dissectionable stage was statistically significant in the study. Many of the implications that this study may have cannot be evaluated until the 10 year post-randomization point is reached and information such as p-values are made available.

### Strengths and Weaknesses

Strengths of the study include the use of random assignment, a low rate of attrition (at least in the experimental group, the control group is not mentioned), the use of more than one independent reader per CT scan (inter-rater reliability), the use of specific inclusion and exclusion criteria (to eliminate confounding variables), and standardized equipment and scanning conditions (reliable instrumentation). Weaknesses include that the study’s
results would have to be combined with the Dutch lung cancer screening trial results to detect the difference they were looking for. Only 16% of the experimental group was female and this does not represent the percentage of females in the population of the Netherlands or Belgium so the results may not be easily generalized to women. The low percentage of females is likely the result of only mailing questionnaires to men in the targeted age range in the Netherlands. This study from the Netherlands/Belgium may not be completely applicable to the US population, either. Differences and similarities in demographics and tobacco history between the experimental and control groups were not disclosed in this article. This is acceptable at this point because there was no comparison between the groups being made in terms of data. However, at a later date when the groups are being compared, this information will be necessary.
Jessica Luciano

Literature Matrix #4

Topic: Efficacy of lung cancer screening

| Purpose | The purpose of this study was to determine if screening with multislice-CT (MSCT) could decrease lung cancer mortality by at least 20% and at what cost (amount of undesired side effects needed to reach a 20% decrease in mortality). |
| Number of Subjects | Subjects included 4,053 “heavy-smoking” men and women from areas within 70 km of Heidelberg, Germany. Subjects had to be 50-69 years old. They had to have smoked at least 15 cigarettes per day for at least 25 years or at least 10 cigarettes per day for at least 30 years. Ex-smokers had to meet the aforementioned criteria and had to have quit within the last 10 years. Participants could not have had a cancer diagnosis within the last 5 years, a medical issue that would prevent surgical lung cancer treatment, or a medical issue that left them with a life expectancy of less than 10 years. Control group compliance has been more than 90% so far. |
| Sample Characteristics | In regards to demographics and smoking history, the control and experimental groups were essentially identical (probably due to block randomization). |
| Year of Data Collection | Randomization occurred between October 2007 and April 2011. The article presents data collected up to April 2014 but data collection was not completely finished at that point. The data collection should have been completed in 2015. |
| Study Design | This study was a randomized controlled trial. Subjects were assigned to the experimental and control groups by block randomization which was stratified by age, gender, and smoking status. There were 2,029 subjects in the experimental group and 2,023 subjects in the control group. |
| Data Collection Method | Population-based recruitment was carried out. Letters of intent and questionnaires were sent to individuals ages 50-69 years old who might meet eligibility criteria based on information from local registries. The study was also publicized and shared with local pulmonologists. Those whose questionnaires met eligibility criteria were invited to come to the German Cancer Research Center. All consenting subjects were asked to undergo a blood draw and were offered a 20 minute quit-smoking counseling session with 1 of 2 especially trained psychologists in a private room. Those who |
partook in the counseling session also received a follow-up phone call. Those who were randomized into the experimental group were immediately brought back to the radiology department for a MSCT. The experimental group underwent a MSCT at the time of randomization and then 4 more annual MSCTs if they were invited back. Two different CT scanners were used. Data was evaluated by especially trained radiologists within 10 days of collection and results were mailed to participants. Data was also evaluated using a computer software system to detect and measure nodules. Screens which showed no nodules or nodules less than 5 mm were considered negative and those participants were invited back for another MSCT in 12 months. All other screens were considered suspicious and repeat scans were done in a certain time frame depending on the size of the nodule (immediately, in 3 months, or in 6 months). Radiologists could deem a screen negative or suspicious based on their expertise and certain criteria if they felt the algorithm didn’t fit a particular subject’s case. Upon repeat screening, those whose nodules had disappeared or had a volume doubling time (VDT) greater than 600 days were considered negative and invited to come back for another yearly screening. Those whose nodules had a faster doubling time or larger nodule were recalled immediately, in 3 months, or in 6 months. Those who were recalled immediately were told to see a pulmonologist of their choice for further work up. The pulmonologists were not influenced by the trialists and carried out care according to current guidelines. In subsequent rounds of MSCT screening, all new nodules were considered suspicious and those participants were recalled according to the same nodule size criteria as the initial round. Known nodules were considered negative if they had disappeared or their VDT was greater than 600 days. Known nodules that had grown or had faster VDT were either recalled immediately, in 3 months, or in 6 months depending on the size of the nodule and VDT. The same procedures from the first round were followed. Follow-up is being performed via annual mailed questionnaires and population and cancer registries.

<table>
<thead>
<tr>
<th>Data Analysis Method</th>
<th>A 95% confidence interval was used on absolute figures and percentages. Fishers’s exact test was used to test difference in proportions between groups. Trends were evaluated with the Jonckheere trend test.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results</td>
<td>In round 1, 1,488 participants (73.4 %) had a negative screen. There were 540 (26.6%) suspicious screens. Radiologists deemed 72 of those screens benign and kept those subjects on the yearly screening schedule. There were almost 400 subjects in the early recall group (almost 20%). There were 22 lung cancers found; more than 80% of them were in an early stage. In rounds 2-4 the early recall rate dropped to 3-4%. The early recall rate would have</td>
</tr>
</tbody>
</table>
remained the same or higher if there had not been baseline CTs for comparison. The detection rate dropped from 1.1% in round 1 to 0.5% to 0.6% in rounds 2-4. Four interval cancers (6.5%) have occurred so far. Lung cancer incidence has been 363 cases per 100,000 person years in the control group and 674 cases per 100,000 person years in the experimental group. So far there have been 58 screen-detected lung cancers; 16 were stage II or higher. The proportion of late stage lung cancers remained basically equal between the experimental and control groups for the first 2 years, then the experimental group began having less, but not statistically significantly less. The same non-statistically significant trend was found for overall mortality (death due to any cause).

<table>
<thead>
<tr>
<th>Implications</th>
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<tbody>
<tr>
<td>This study illustrates the importance of being able to compare baseline screening images with subsequent screening images in order to make a screening program more feasible. If comparison was not possible, the false-positive screening rate would render lung cancer screening insensitive and ineffective. This study also illustrates that while the divergence in diagnosis of early versus late stage lung cancers and overall mortality in the experimental and control groups is not statistically supported this early in the follow-up process, the trend is beginning to emerge. It seems that while lung cancer screening would be an expensive and potentially psychologically taxing process to implement in the beginning, it could potentially become as effective and feasible as mammography as long as there are screening images for comparison.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strengths and Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strengths of the study include the use of block random assignment (which made the experimental and control groups nearly identical), very low rate of attrition, using the same instruments and measuring program, and having especially trained psychologists and radiologists. Interventions taken by pulmonologists reflect community care because the study did not require or recommend specific action. Weaknesses include the small sample size that does not have the power to detect the decrease in lung cancer mortality that it intends to unless pooled with other European studies. Also, smoking cessation counseling was offered to all participants but was not required. This can represent a confounding variable because perhaps those who received counseling stopped smoking and therefore prevented or slowed the emergence of lung cancer. This would make it difficult to claim that MSCT screening was the reason for a decrease in lung cancer mortality. This German study may not be completely applicable in the US where lung cancer treatment guidelines may differ.</td>
</tr>
</tbody>
</table>
Jessica Luciano

Literature Matrix #5

**Topic:** Efficacy of lung cancer screening

<table>
<thead>
<tr>
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<th></th>
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<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>The purpose of this study was to evaluate the efficacy of low-dose CT (LDCT) screening in reducing lung cancer mortality.</td>
</tr>
<tr>
<td><strong>Number of Subjects</strong></td>
<td>Subjects included 3,206 men and women from the Florence, Pisa or Pistoia districts of the Tuscany region of Italy belonging to one of 269 general practitioners who agreed to be part of the study. Subjects had to be 55-69 years old. They had to have at least a 20 pack-year smoking history. Ex-smokers had to meet the aforementioned criteria and had to have quit within the last 10 years. Participants could not have had a previous cancer diagnosis other than non-melanoma skin cancer and could not have any general conditions precluding thoracic surgery. Experimental group subjects were 85.1% compliant in the second round and 82.3% and 79.8% compliant in the third and fourth rounds, respectively.</td>
</tr>
<tr>
<td><strong>Sample Characteristics</strong></td>
<td>In regards to demographics and smoking history, the control and experimental groups were essentially the same.</td>
</tr>
<tr>
<td><strong>Year of Data Collection</strong></td>
<td>Years of data collection were not disclosed.</td>
</tr>
<tr>
<td><strong>Study Design</strong></td>
<td>This study was a randomized controlled trial. Subjects were randomly assigned to the experimental and control groups. There were 1,613 subjects in the experimental group and 1,593 subjects in the control group.</td>
</tr>
<tr>
<td><strong>Data Collection Method</strong></td>
<td>Letters of intent, questionnaires, and consents for randomization were sent to the patients of 269 general practitioners ages 55-69 years old living in Florence, Pisa, or Pistoia. Eligible subjects were randomized. Control group subjects were notified of their status and invited to participate in a voluntary smoking cessation program. Experimental group subjects were contacted and had an appointment with a pneumologist who explained the CT screening procedure and management of positive screenings. They were also offered the voluntary smoking cessation program. If consent was obtained, subjects were scheduled for their first CT scan. The experimental group underwent a CT at the time of randomization and then 3 more annual CTs if they were invited back. Five different CT scanners were used following international recommendations. Each scan was read independently by 2 radiologists and consensus was reached in case of disagreement. Three radiologists read the CTs first and then 15 other radiologists...</td>
</tr>
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</table>
completed the second readings. All the radiologists had 4 or more years experience in chest CT. Electronic calipers were used to measure nodules. Scans were considered negative if there were no nodules, solid non-calcified nodules were \(< 5 \text{ mm}, or non-solid nodules were } < 10 \text{ mm. These subjects were notified and scheduled for their next annual CT in 1 year. Scans were considered positive if solid non-calcified nodules were } \geq 5 \text{ mm, non-solid nodules were } \geq 10 \text{ mm, or there was a partially solid nodule present. These subjects were referred to a pneumologist and received follow-up CT scan, PET scan, fine needle aspiration, or bronchoscopy as seen fit. Those with malignancy were not permitted to continue with annual screening. Those who had false-positive screens were invited back for annual CT screening. Follow-up is being performed via 4 years post-randomization phone interviews and the local cancer registry.

<table>
<thead>
<tr>
<th>Data Analysis Method</th>
<th>There were no reported p-values or confidence intervals. The only statistics mentioned were absolute numbers and proportions of absolute numbers.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results</td>
<td>In round 1, 30.3% of scans were considered positive. This rate dropped to 15.7% in subsequent rounds. In round 1, 21 lung CAs were found in 20 subjects. In subsequent rounds, 20 lung CAs were found in 18 subjects. There were 2 incident lung CAs diagnosed.</td>
</tr>
<tr>
<td>Implications</td>
<td>There was a total of 23 stage I lung CAs diagnosed. After round 1, there were 4 stage II-IV lung CAs diagnosed. A total of 966 follow-up CTs were performed as part of positive screening management. This study illustrates the importance of being able to compare baseline screening images with subsequent screening images in order to make a screening program more feasible. If comparison was not possible, the false-positive screening rate would render lung cancer screening insensitive and ineffective. This study also illustrates the ability of CT scan to detect early stage lung CAs which are more amenable to curative surgical resection.</td>
</tr>
<tr>
<td>Strengths and Weaknesses</td>
<td>Strengths of the study include the use random assignment, low rate of attrition, using the same 5 CT scanners, and having experienced radiologists. Weaknesses include the small sample size that does not have the power to detect a decrease in lung cancer mortality unless pooled with other European studies. Guidelines regarding management of positive screening tests were not particularly clear. Also, smoking cessation counseling was offered to all participants but was not required. This can represent a confounding variable because perhaps those who received counseling may have stopped smoking and therefore prevented or slowed the emergence of lung cancer. This would make it difficult to claim that CT screening was the reason for a decrease in lung cancer mortality. The statistics and data offered are very simple and parametric analyses are not offered. There is no information regarding death rates among study participants. This Italian study may not be completely applicable in</td>
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the US where lung cancer treatment guidelines may differ.
Jessica Luciano

Literature Matrix #6

Topic: Efficacy of lung cancer screening

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Purpose</td>
<td>The purpose of this study was to evaluate the effects spiral CT screening on lung cancer mortality and on the stage distribution and resectability rates in a high-risk population.</td>
</tr>
<tr>
<td>Number of Subjects</td>
<td>Subjects included 2,472 Italian men. Subjects had to be 60-74 year old men. They had to have at least a 20 pack-year cigarette smoking history and/or have quit smoking cigarettes within the last 10 years. Exclusion criteria included: severe co-morbidity, life expectancy &lt;5 years, severe heart failure, chronic respiratory insufficiency, O2 saturation &lt; 94% at rest, renal dialysis, uncontrolled hypertension, severe vascular disease, uncompensated diabetes, severe metabolic disturbances, inability complete follow-up protocol, dementia, drug or alcohol addiction, schizophrenia or other severe psychiatric disorder, previous malignancy to any organ site (except non-melanoma skin cancer) within the last 10 years, or early squamous cancer of the larynx or oral cavity in the last 5 years. The control group had 93.67% compliance.</td>
</tr>
<tr>
<td>Sample Characteristics</td>
<td>In regards to demographics and smoking history, the control and experimental groups were essentially identical. The experimental group did have more respiratory co-morbidities, though (35% vs. 31% in the control group, P = 0.0321).</td>
</tr>
<tr>
<td>Year of Data Collection</td>
<td>Participants were enrolled between March 2001 and February 2006. All CT scans were completed by 2010. Active follow-up was completed in February 2012 and vital status follow-up was completed in May 2013.</td>
</tr>
<tr>
<td>Study Design</td>
<td>This study was a randomized controlled trial. Subjects were randomly assigned to the experimental and control groups with stratification based on the medical center they were assigned to (there were 3 centers carrying out the study). 1,276 subjects were assigned to the experimental group which was to undergo 4 annual CT scans. 1,196 subjects were in the control group.</td>
</tr>
<tr>
<td>Data Collection Method</td>
<td>Subjects were gathered via general practitioners, mass mailings, advertising pamphlets, and mass media. Subjects were screened for eligibility and enrolled via phone interviews. A baseline medical interview, physical exam, and vital signs were completed by a physician to ensure eligibility. All subjects received a baseline chest x-ray (CXR) and sputum sample and those randomized to the</td>
</tr>
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</table>
The experimental group also had a baseline CT scan. CT scans were carried out using the same procedure and standardized settings. All subjects returned yearly for 4 years for a physical exam and medical history update. Cross-contamination was assessed via questionnaire. CXRs were considered positive if a non-calcified lung shadow, a hilar mass, an enlarged mediastinum, pleural effusion or thickening, or lytic bone lesion was present. CT scans were considered positive if non-calcified pulmonary nodules ≥ 10mm or smaller but showing spicular margins, non-nodular lesions like a hilar mass, focal ground-glass opacities (GGOs), major atelectasis, endobronchial lesions, mediastinal adenopathy, or pleural effusion or pleural masses were present. CT scans were considered negative if calcified lesions, scarring, smooth nodules < 5mm, pleural plaques, diffuse emphysema, bullae, widespread ground-glass opacities, bronchiectasis, or pulmonary fibrosis were present. Two experienced radiologists each read the scans independently and came to a consensus upon disagreement. Follow-up high resolution CT scans, oral antibiotics, PET scans, bronchoscopies, fine needle aspirations, and thoracic surgery were all done in response to positive screening based on nodule size and characteristics. Those whose nodules were found to be benign were invited to continue with the study. The experimental subjects were to undergo 1 baseline CT scan and 4 subsequent annual CT scans.

**Data Analysis Method**

The required sample size (2,400) was calculated assuming a 50% decrease in mortality in the experimental group. The groups’ proportions were compared with the $X^2$ and/or Fisher’s exact test if needed. The groups’ means were compared with the t-test. Confidence intervals were determined with the Gaussian approximation method. Survival rates were calculated using the Kaplan-Meier method and compared using Cox regression analysis. The confidence intervals of hazard ratios were calculated using the Wald method.

**Results**

In the experimental group, lung cancer was detected in 1 subject with sputum cytology, in 66 subjects with CT scan, and in 37 for other reasons. In the experimental group, 59 subjects died of lung cancer, 120 died of other causes, and 1 died of unknown cause. In the control group, 10 subjects were diagnosed with lung cancer via CXR or sputum cytology and 62 were diagnosed for other reasons. In the control group, 55 subjects died of lung cancer and 121 died of other causes. There was a statistically significant higher number and proportion of stage I lung cancers in the experimental group versus the control group (47 vs. 16; $P = 0.0002$). Both arms had the same number of stage II-IV lung cancers (n=50). The lung cancer mortality rates were almost identical in both groups (experimental: 543 per 100,000 person-years, control: 544 per 100,000 person-years).
<table>
<thead>
<tr>
<th>Implications</th>
<th>This study does not support the use of CT scan screening to decrease lung cancer mortality. The study has many limitations, however, and cannot be the sole informant of a change in practice. The study did illustrate the ability of CT scan screening to detect early stage lung cancer.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strengths and Weaknesses</td>
<td>Strengths of the study include the use of random assignment, very low rate of attrition, and 2 experienced radiologists. Weaknesses include a very small sample size (the results of this study have to be pooled with other European studies to illustrate any strong findings), the use of strictly male subjects (findings cannot be generalized to women and do not reflect any community population), and the change in CT scanners in 2003.</td>
</tr>
</tbody>
</table>
Jessica Luciano

Literature Matrix #7

Topic: Efficacy of lung cancer screening

| Citation | Pastorino, U., Rossie, M., Rosatoe, V., Marchiano, A., Sverzellatiag, N., Morosib, C., ... La Vecchia, C. (2012). Annual or biennial CT screening versus observation in heavy smokers: 5-year results of the MILD trial. European Journal of Cancer Prevention, 21, 308-315. doi: 10.1097/CEJ.0b013e328351e1b6 |
| Purpose | The purpose of this study was to evaluate the impact of annual or biannual lung cancer screening with low-dose CT (LDCT) vs. no screening on mortality. The predictive and diagnostic value of tissue and biomarkers in conjunction with LDCT was also assessed. |
| Number of Subjects | Subjects included 4,099 Italian subjects. Subjects had to be ≥ 49 years old. They had to have at least a 20 pack-year smoking history. If they were a former smoker, they had to have quit ≤ 10 years ago. Subjects could not have a history of cancer within the last 5 years. There was 95.1% adherence to screening in the biannual LDCT group and 96.1% adherence to screening the annual LDCT group. |
| Sample Characteristics | The control and experimental groups were essentially the same except the control group contained 89.7% active smokers and the experimental groups only contained 68.6% active smokers. No p value was reported for these differences. |
| Year of Data Collection | Participants were enrolled between September 2005 and January 2011. Follow-up was conducted through November 2011 via telephone calls and the Cancer Registry Office database of Lombardy. |
| Study Design | There was a pilot study conducted initially, but this study was a randomized controlled trial. Subjects were stratified by reference center, age, and length of smoking history and then randomly assigned to the experimental and control groups. 1,186 subjects were assigned to the biannual LDCT experimental group. 1,190 subjects were assigned to the annual LDCT experimental group. 1,723 subjects were in the control group. |
| Data Collection Method | Subjects were gathered via advertisements, articles, and television broadcasts. They were evaluated for eligibility by phone, fax, email, or the web. After consent was obtained and random assignment occurred, the control group partook in a smoking cessation program as well as a pulmonary function test and a blood sample. The experimental groups also participated in the smoking cessation program, pulmonary function test, and blood sample with the addition of a LDCT scan. CT scans were performed using the same type of scanner, which was regularly calibrated, and the same methods. Two radiologists assessed the scans independently and a |
third radiologist was consulted in case of disagreement. A maximum of 4 nodules were recorded per CT scan and completely calcified nodules were discounted. Nodules < 4.8 mm were considered negative and the participant was invited to return in 1 or 2 years depending on their group assignment. Nodules between 5-8 mm were considered suspicious and those subjects underwent another LDCT in 3 months. Nodules that had grown ≥ 25% in those 3 months were considered malignant. Nodules that had grown < 25% in those 3 months were considered negative and those subjects were asked to return to the regular schedule. Nodules > 8 mm were considered very suspicious and those subjects were referred for follow-up including a PET scan or lung biopsy. Vital status follow-up was carried out via telephone calls and the Cancer Registry Office database of Lombardy. The death certificates of deceased participants were obtained through the Istituto Nazionale di Statistica. Vital status for all but 2 participants was confirmed by the end of the study leaving 99.9% of subjects for analysis.

**Data Analysis Method**
The required sample size was 10,000 subjects (with a screening period of 10 years and a follow-up of 100,000 person-years) to detect a 30% reduction in lung cancer mortality (calculated via power analysis). These numbers were not obtained due to a lack of funding and support from multiple screening centers. Statistical analysis was performed by an independent research center. Lung cancer incidence, lung cancer death incidence, and all cause death incidence were calculated by subtracting the Kaplan-Meier estimator from 1. Between group differences were measured with the log-rank test. The hazard ratios with 95% confidence intervals were calculated with the Cox proportional hazard models.

**Results**
In the first round of LDCT scans, 158 biannual and 177 annual subjects had suspicious or positive scan, leading to a 14 and 15% recall rate. 49 lung cancers were detected via screening; 20 in the biannual group and 29 in the annual group. 17 of those cancers were detected on the first LDCT scan. There were 10 interval cancers in the experimental groups overall. 63% of the cancers were stage 1 and there was an 84% resectability rate overall. 20 lung cancers were detected in the control group. Cumulative lung cancer incidence was 310.9/100,000 in the control group, 457/100,000 in the biannual group, and 620.2/1000,000 in the annual group. Lung cancer mortality rates were 108.5/100,000 in the control group, 108.8/100,000 in the biannual group, and 216/100,000 in the annual group. There was a statistically significant difference in 5-year lung cancer incidence between the 3 groups (with annual LDCT being the highest, then biannual, then control). In comparison to the control group, the experimental groups had a statistically significant excess diagnosis. There was no significant difference in lung cancer mortality among the groups. The selective implementation of PET
scans was related to only a 9% surgical intervention in the setting of benign disease compared to 27% in the NELSON trial. Lung cancer incidence was higher in the annual group than the biannual group and there was not a discrepancy in cancer stages between the groups. This suggests that waiting a longer period of time between screenings does no increase risk of advanced disease. Results also suggest that discounting ground-glass opacities unless they develop a solid portion does not increase risk of advanced disease or mortality because ground glass opacities were not biopsied in this study and no discrepancies in outcomes were seen between subjects with and without ground glass opacities.

| Implications | This study does not support the use of CT scan screening to decrease lung cancer mortality. This study suggests the utility of PET scans in decreasing unnecessary surgical intervention upon identification of suspicious nodules. This study also suggests that ground glass opacities need not be considered suspicious unless they develop a solid portion. All of these findings need to be supported by larger studies to indicate a need for practice change. |
| Strengths and Weaknesses | Strengths of the study include the use of stratified random assignment, very low rate of attrition, specific guidelines for suspicious and non-suspicious nodules as well as their follow-up, and calibrated, consistent equipment and methods. Weaknesses include a small sample size that cannot detect the intended 30% decrease in lung cancer mortality and a sizable difference in active versus former smokers between groups. This study may not be generalizable to the US as it was performed in Italy. |
**Jessica Luciano**

**Literature Matrix #8**

**Topic: Efficacy of lung cancer screening**

| Purpose | The purpose of this study was to evaluate the impact of low-dose CT (LDCT) screening on the 10-year lung cancer-specific survival rate of subjects with stage I lung cancer. |
| Number of Subjects | Subjects included 59,023 people from around the world. 31,567 subjects received baseline LDCT scans. 27,456 subjects received annual screening with LDCT scans. Subjects were asymptomatic, ≥ 40 years old, were at risk for lung cancer due to smoking history, exposure to secondhand smoke, or occupational exposure to certain compounds, and were fit to undergo thoracic surgery. |
| Sample Characteristics | The median age of participants was 61 years old (range 45-80) and median pack-years was 30 (range 0-141). |
| Year of Data Collection | Data was collected between 1993 and 2005. |
| Study Design | This was a quasi-experimental partially one-group, partially time series design because there was no randomization, no control group, and data was collected from some subjects just once while data on others was collected at different points in time. |
| Data Collection Method | Data was collected at medical centers in the US, Europe, Israel, China, and Japan and then transmitted to the database at Weill Medical College of Cornell University. All institutions had to follow the I-ELCAP protocol for screening but were free to choose their enrollment criteria. In baseline LDCT scans, a solid or partly solid non-calcified nodule ≥ 5 mm, a non-solid non-calcified nodule ≥ 8 mm, or a solid endobronchial nodule were considered positive. A LDCT scan was repeated in 3 months or a PET scan was done immediately for 5-14 mm nodules. If they had grown at 3 months or the PET was positive, a biopsy was performed. If the PET was negative, a LDCT scan was repeated in 3 months. An immediate biopsy or PET scan or 3 month repeat LDCT scan could be elected for nodules ≥15 mm. If infection was suspected, subjects were given 2 weeks of antibiotics. If the baseline scan was negative, a LDCT scan was performed again in 1 year. In annual LDCT scans, any new non-calcified nodule was considered positive. If new nodules were < 3 mm, a repeat scan was done in 6 months. If they were 3-5 mm, a repeat scan was done in 3 months. If they were > 5 mm, 2 weeks of antibiotics were given and a repeat scan was done in a month. If the nodule did not resolve or grew, it was biopsied or a PET scan was done. If the results were indeterminate, a LDCT |
scan was done in 3 months. If the results were negative, subjects were invited back for regular annual screening. If the annual scan was negative, a LDCT scan was performed again in 1 year. Any subjects diagnosed with lung cancer were referred to a physician who could decide how to proceed but had to document all proceedings as well as cancer spread and death for the next 10 years in the database. Lung cancers had to be reviewed by the 5 member pathology-review board of experienced pulmonary pathologists. Cause and date of death of those participants that died were obtained from their physicians and/or family members.

**Data Analysis Method**

Lung cancer-specific survival time from the date of diagnosis was calculated into a Kaplan-Meier curve for all lung cancer cases (regardless of treatment) and then all stage I lung cancer cases (a different curve was calculated for treatment within a month vs. no treatment). SAS was used to calculate standard error measurements.

**Results**

13% of the baseline CT group and 5% of the annual CT group had a positive screening. 535 biopsies led to the diagnosis of 492 cancers, 479 of which being primary lung cancers. 5 interim cancers were found within 1 year of baseline screening. 411 of the subjects diagnosed with lung cancer had surgical resection and 57 received radiation or radiation and chemotherapy. 16 received no treatment.

The estimated 10-year survival rate for all subjects with lung cancer regardless of staging or treatment was 80% (95% confidence interval [CI]). As of May 2006, 75 of the 484 subjects with lung cancer (including the interim cases) had died (15%) (2 died within 4 weeks of surgery). 412 of the 484 case of lung cancer were stage 1 (85%) and their estimated 10-year survival rate was 88% regardless of treatment (95% CI). 375 of the 412 subjects with stage I lung cancer underwent surgical resection. As of May 2006, 39 of the 412 subjects had died (9%). 302 of the 412 participants had surgery within a month of diagnosis and their estimated 10-year survival rate was 92% (95%). All of the 8 patients with stage I lung cancer who didn’t have surgery or radiation or chemotherapy died within 5 years after diagnosis.

**Implications**

This study illustrates the ability of CT scan to detect early stage lung cancer which can then be treated and therefore improve survival rates. This study also makes a compelling argument regarding the cost-effectiveness of CT screening in comparison to late stage lung cancer treatment and mammogram screening.

**Strengths and Weaknesses**

Strengths of the study include the huge sample size, specific guidelines for suspicious and non-suspicious nodules, implementation of I-ELCAP protocol in all institutions, and the 5 member pathology-review panel of experts. Weaknesses include a quasi-experimental design (weakens internal validity), the flexibility of enrollment criteria among institutions, and the use of family members to ascertain cause of death (they may not be
reliable).
**Jessica Luciano**

**Literature Matrix #9**

**Topic:** Current Perception and Practice of Lung Cancer Screening

| Purpose | The purpose of this study was to evaluate primary care providers’ knowledge, attitudes, and beliefs regarding lung cancer screening with low-dose computed tomography (LDCT). |
| Number of Subjects | Subjects included 10 primary care providers from the Research Involving Outpatient Settings (RIOS) network of New Mexico. |
| Sample Characteristics | All participants practiced family medicine. Two participants were physician assistants. Four participants were women. All of the providers practiced at separate clinics. Six of the clinics were urban, four of the clinics were rural, and eight of the clinics were federally qualified health centers. All the clinics serviced underserved minority populations in New Mexico. Subjects were identified via purposeful sampling. Researchers sought out clinicians serving LDCT screening eligible patients in rural and urban settings. |
| Year of Data Collection | Data was collected between February and September of 2014. |
| Study Design | This is a descriptive, qualitative study. |
| Data Collection Method | One week before the interviews, participants received an informed consent form, a design and results summary of the National Lung Screening Trial (NLST) study, a graphic display of NLST results, and a screening guideline summary of multiple national organizations. Participants were allowed to refer to these materials during their 60 minute interview. Based on an interview guide, participants were questioned about their knowledge, attitudes, and beliefs about LDCT screening. Participants were also questioned about their perceptions of: patient receptivity to screening, smoking cessation, and relapse prevention, influences, barriers, and facilitators of decision making, and cultural influences on screening and smoking in Hispanic, minority, and underserved populations. Participants were also questioned about the feasibility of discussions regarding screening and smoking cessation with their patients. Thematic saturation was reached after 10 interviews. Nine of the interviews were conducted in person. The interviews were audio-recorded and transcribed. Participants received a $50 gift card for participating. |
| Data Analysis Method | Researchers described their data analysis method as “content-driven immersion and crystallization”. Each researcher read 2-3 transcripts |
and identified preliminary themes. The lead qualitative analysts created a coding structure. The transcripts were run through a qualitative data analysis program for coding. Researchers reviewed results from the program to define the major themes.

| Themes | Identified analytic themes included: current practices for smoking cessation and lung cancer screening, interpreting NLST evidence, perspectives on screening guidelines, “implementing screening”, “screening counseling”, and “ethical considerations”. Under the theme of “current practices”, providers stated they usually screened for smoking and provided counseling for cessation. They believed 10-40% of their patients would be eligible for LDCT screening. Some reported using chest x-rays as a scare tactic for their patients. None reported using LDCT screening and they were uncertain of national screening guidelines and standards. Under the theme of “interpreting”, a few providers were in support of LDCT screening, but most were skeptical and concerned about the efficacy of screening as well as potential harms. Most participants were concerned about patient access to screening due to costs and transportation needs. Under the theme of “perspectives”, some participants were unaware of changes to national screening guidelines. Some participants believed the guidelines should be followed while others believed that the evidence was not sufficient for practice change. All participants mentioned that improved outcomes may be the result of better treatment options rather than the screening. Under the theme of “implementing”, most participants were not inclined to offer screening yet. However, they predicted the guidelines would eventually be enacted in their practice and they would have to comply to avoid legal implications. Participants did not believe that New Mexico had the infrastructure necessary to support the guideline requirements. They also believed the populations they served would be burdened by the economic and time demands of screening. Participants felt that implementing screening would be time-consuming and stressful and would require changes in their workflow. Under the theme of “screening counseling”, participants were concerned about presenting complicated results to their patients with low health literacy. Participants didn’t feel comfortable enough with the screening process to be able to effectively counsel their patients and ensure informed consent. Under the theme of “ethical considerations”, one participant noted that advances like LDCT screening should be offered to rural communities to support healthcare equity. Others felt it was unfair to offer screening to patients who couldn’t afford follow-up care. One participant felt it was unfair to nonsmokers to have to pay for the “free” screening of smokers. A few participants felt it would be more advantageous to focus screening on younger patients who would be more likely to change their behavior than
<table>
<thead>
<tr>
<th>Implications</th>
<th>This study illustrates the need for further education of primary care providers in regard to lung cancer screening guidelines, follow-up, and counseling. This study reveals the desire among providers for further research into improve the risk-benefit ratio of LDCT screening (i.e. decreasing false-positive results). This study suggests that screening may not be feasible in communities without the proper infrastructure for high-quality screening or in communities with socioeconomically disadvantaged patients who may not understand the implications of screening or be able to afford it.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strengths and Weaknesses</td>
<td>Strengths of the study include the use of an interview guide to streamline interviews, attainment of thematic saturation, and thorough data analysis involving the consensus of multiple researchers. Weaknesses include the use of a very specific and unique sample. These results are likely only transferrable to other US healthcare systems serving minority and low socioeconomic status populations without access to public transportation and large medical centers. Also, the results may be influenced by the fact that all the participants were from the RIOS network of New Mexico. This network may attract providers with different attitudes and beliefs than those who don’t involve themselves with the network. It is not mentioned whether the interviews were conducted by a sole researcher or multiple researcher. This may have influenced participant responses.</td>
</tr>
</tbody>
</table>
Jessica Luciano

Literature Matrix #10

Topic: Current Perception and Practice of Lung Cancer Screening

| Purpose | The purpose of this study was to evaluate the knowledge and practice of lung cancer screening in general practitioners (GPs), thoracic oncologists (TOs), and pulmonologists (PUs). |
| Number of Subjects | Subjects included 242 doctors. |
| Sample Characteristics | The sample included 155 GPs, 37 thoracic oncologists, and 52 pulmonologists who attended continuing medical education meetings and other professional meetings in the Rhône-Alpes region of France. |
| Year of Data Collection | Data was collected between October and November of 2012. |
| Study Design | This is a descriptive, cross-sectional quantitative study. |
| Data Collection Method | Questionnaires were distributed along with the welcome packets at continuing education meetings (for GPs), the Regional Respiratory Medicine Society meeting (for PUs), and the Regional Cancer Network guideline update meeting (for TOs). Questionnaires were collected before the lung cancer screening session of each meeting (when applicable). Thirty-five percent of GPs (n=155), 43% of PUs (n=52), and 71% of TOs (n=37) returned completed questionnaires. The questionnaires were created by a multidisciplinary team. The questionnaires addressed physicians’ certifications, practice types, and histories. Other questions addressed desired cancer screening program outcomes and lung cancer screening techniques. Physicians were also asked about their current lung cancer screening practices and their opinion on tobacco-cessation programs in conjunction with lung cancer screening practices. |
| Data Analysis Method | The chi square test and 2-sided exact Fisher test were used to compare qualitative variables. Variance analysis was used to compare numeric results. Results with p-values < 0.05 were deemed statistically significant. |
| Results | There were significant differences among the three groups in terms of type of certification and years of practice. There was not a significant difference among the three groups in regards to the end goal of a cancer screening program. However, when PUs and TOs were pooled, they were significantly more likely than GPs to |
answer that “decreased overall or lung cancer mortality” was the end goal. Another statistically significant result was that TOs were much more likely to answer that LDCTS is efficient in lung cancer screening (which is the correct response) than PUs or GPs (who were more likely to answer that another methodology or no methodology had been demonstrated to efficiently screen for lung cancer). GPs reported proposing lung cancer screening to patients in daily practice the least and this was also significant. When pooled, PUs and TOs were more likely to consider lung cancer screening for heavy smokers (rather than all smokers regardless of pack-year history); this was a significant difference. GPs were significantly more likely to offer screening every three to five years (rather than yearly). GPs were significantly more likely to answer that smoking cessation programs absolutely did not or did not necessarily have to be incorporated with cancer screening programs.

<table>
<thead>
<tr>
<th>Implications</th>
<th>This study demonstrated that GPs have a knowledge deficit in regards to the purpose of a lung cancer screening program and are unaware of an efficient test to screen for lung cancer. This study also shows that lung cancer screening is beginning to be implemented in everyday medical practice. These findings reveal a need for further education of providers responsible for implementing lung cancer screening. The findings are also reflective of the time lapse between publication of evidence and dissemination of knowledge (the NLST results had just been released in 2011 and this study was conducted in 2012).</th>
</tr>
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</table>

| Strengths and Weaknesses | Strengths of the study include the anonymity of the surveys and the ease and convenience of completion for the participants. A large amount of information was collected all at once. Weaknesses include a selection bias because the doctors that chose to answer the questionnaire were likely to be those most interested in lung cancer screening. Also, the groups being compared were not equally distributed. The cross-sectional design does not produce a particularly strong level of evidence. The sample size is also small. No power analysis is mentioned. Cronbach’s alpha was not reported for the questionnaire so it is difficult to determine whether the questionnaire measured what it was supposed to measure. The results of the study may not be generalizable beyond France. |
Jessica Luciano

Literature Matrix #11

Topic: Current Perception and Practice of Lung Cancer Screening

| Purpose | The purpose of this study was to evaluate pulmonologists’ tendencies to offer lung cancer screening in relation to their attitudes towards LDCT screening and their foreseen barriers to LDCT screening programs. |
| Number of Subjects | Subjects included 286 pulmonologists. |
| Sample Characteristics | All invited participants were pulmonary attending physicians who practiced at Veterans Health Administration pulmonary clinics in the US or Puerto Rico. Pulmonologists practicing at community-based sites were excluded as those sites were unlikely to have the necessary infrastructure to implement a LDCT screening program. The respondents were from all over the US and Puerto Rico and had a wide range of experience (< 5 years to > 20 years of practice). |
| Year of Data Collection | Data was collected between July 2013 and February 2014. |
| Study Design | This is a descriptive, cross-sectional quantitative study. |
| Data Collection Method | Eligible participants were identified through the Specialty Care Services section of the VA Office of Patient Care Services, the VA central office human resources department, and VA facility staff physician listings. Eligible participants received up to three invitations to each of their e-mail addresses. A web-based survey with 33 questions was administered to consenting VA pulmonologists. The questions were based on the Promoting Action on Research in Implementation of Health Services implementation science framework which includes: acknowledging available evidence, willingness and responsiveness of the research consumer, and obstacles and helps in the application of the research. The survey was approved for reliability and validity by four VA pulmonologists, one VA oncologist, one VA primary care provider, and three survey researchers. Questions addressed understanding of LDCT screening guidelines as well as acquaintance with the NLST study. The tendency to offer screening was measured with pulmonologists’ responses to three clinical vignettes in which lung cancer screening would either be advised, ill-advised, or marginally-advised according to LDCT screening guidelines. Questions also addressed the degree to which certain factors affected their propensity to offer screening as well as which factors |
| Data Analysis Method | Based on their responses to the two clinical vignettes describing a LDCT screening guideline-eligible and guideline-ineligible patient, participants were classified as over-screeners, guideline-concordant screeners, and under-screeners. Via chi-square tests, associations between the tendency to be an over-, under-, or guideline-concordant screener and one other variable (demographics, guideline familiarity, factors affecting choice to screen, or foreseen barriers to LDCT screening program implementation) were assessed. A multinomial logistic regression model was used to assess the associations of the aforementioned variables with over- or under-screening in comparison to guideline-concordant screening. The multinomial logistic regression model only included associations from the chi-square tests with a p-value < 0.1 (modest association). Based on a factor analysis, two subsets of factors affecting tendency to screen were identified and the subsets were used to form two scales (“evidence and guidelines” and “downsides of screening”). The two scales were determined to have “good internally consistency” based on their alpha of > 0.6. They were also determined not to be “substantially correlated” based on their rho of 0.23. |
| Results | Respondents categorized as guideline-concordant or over-screeners were statistically significantly more likely to offer screening the guideline-marginal patient in the third vignette. Under-screeners were significantly more likely to be male, have more years in practice, have less familiarity with LDCT screening guidelines, believe that evidence for LDCT screening is not strong, and believe that LDCT screening is not likely to be effective in the VA. Over-screeners and guideline-concordant screeners were significantly more likely to make screening decisions influenced by mortality reduction with screening, clinical trial evidence, and LDCT screening guidelines. Under-screeners were significantly more likely to make screening decisions influenced by high false-positive rates in clinical trials, incidental findings in clinical trials, radiation exposure, and poor cost-benefit ratios of screening. Under-screeners were significantly less likely to be influenced by clinical trial evidence and guidelines and had significantly more years in practice than guideline-concordant screeners according to the multinomial regression analysis. No significant differences were found between over-screeners and guideline-concordant screeners in the multinomial regression analysis. Over- and guideline-concordant screeners were significantly more likely to believe that a LDCT screening program would succeed at their institution. Under-screeners were significantly more likely to site lack of |
| Implications | This study illustrates that more experienced providers are less likely to be influenced by LDCT screening clinical trials and guidelines and are therefore more likely to take a cautious, conservative approach to LDCT screening. This study also demonstrated little difference between the characteristics of guideline-concordant and over-screeners which may indicate a problem with the clinical vignettes presented or a need for decision tools and best practice advisories (in order to prevent over-screening). It is likely that a provider’s perceptions of guidelines and screenings will be transmitted to their patients while making the shared decision of whether to use LDCT screening or not. Providers with positive perceptions of screening may offer screening to lower-risk individuals and providers with negative perceptions of screening may withhold screening from guideline-eligible patients. This makes it especially important for patients at any risk for lung cancer to receive unbiased information and data about LDCT screening in addition to discussion with their provider in order to make the best decision. This study also demonstrates that providers of all perceptions foresee infrastructure and costs as the biggest barriers to LDCT screening. These items need to be considered before healthcare systems implement screening programs to ensure that high-quality screening is feasible at that institution. |
| Strengths and Weaknesses | Strengths of the study include that participants were from all over the US and Puerto Rico and had a wide range of familiarity with the LDCT screening guidelines and the NLST study. This makes for a representative sample. Weaknesses of the study include the use of only VA pulmonologists who serve a very specific population and have a different reimbursement system than the typical healthcare system. This makes the results less generalizable. Responses to the clinical vignettes may not exactly match each respondent’s everyday practice and it is difficult to assess a provider’s practice habits based solely on three clinical vignettes. Therefore the associations found may not be entirely accurate or as strong as they were presented to be. Also, the cross-sectional design does not return the highest level of evidence due to lack of randomization and control. |
Jessica Luciano

Literature Matrix #12

**Topic: Current Perception and Practice of Lung Cancer Screening**

| Purpose | The purpose of this study was to assess the knowledge, attitudes, and practices of PCPs in regard to lung cancer screening. |
| Number of Subjects | Subjects included 212 PCPs. |
| Sample Characteristics | Participants included PCPs (physicians, NPs, and PAs) practicing internal medicine, family medicine, or obstetrics and gynecology at an academic medical center which participated in the NLST study. Participants had to have provided primary care services to adults ≥ 40 years old within the last 12 months. First year interns were excluded. The under-representation of attending physicians in the sample was found to be statistically significant. |
| Year of Data Collection | Data was collected between November and December 2013. |
| Study Design | This is a descriptive, cross-sectional quantitative study. |
| Data Collection Method | Eligible subjects received up to four e-mail invitations to complete an online questionnaire. The questionnaire was tested on three PCPs outside the academic medical center. Questions addressed the PCPs' reported screening of asymptomatic patients for lung cancer over the last 12 months and which tests they used. Other questions assessed the PCPs' knowledge of current lung cancer screening guidelines. Participants were asked if Medicare covers LDCT screening to assess which guidelines they're influenced by. Questions also addressed perceived obstacles to LDCT screening at the provider, patient, and organization level. Other questions addressed perceptions of the efficacy of different cancer screening tests in comparison to the efficacy of lung cancer screening. Participants were also asked if they'd be interested in a continuing education program about lung cancer screening. |
| Data Analysis Method | Descriptive statistics were used to evaluate provider and practice attributes, screening practices, perceptions of screening effectiveness, familiarity with guidelines, and perceived barriers to screening. Logistic regression was used to determine the strongest predictors of LDCT use, CXR use, and effectiveness of screening believed to be moderately or very effective. The predictors were evaluated individually and if their p-value was < 0.25, they were included in a multivariable logistic regression model. Perceived effectiveness of LDCT in comparison to Pap smear, colonoscopy, |
PSA, and mammography was compared with the McNemar test. The association between LDCT, CXR, or sputum cytology use and knowledge of three or more guidelines was assessed with the Fisher exact test. P-values < 0.05 were considered statistically significant.

**Results**

Mammography, colonoscopy, and Pap smear were significantly more likely to be perceived as moderately or very effective compared to LDCT. PSA had a significantly lower rate of perceived effectiveness. Participants who knew three or more guideline components were significantly more likely to screen with LDCT and CXR but not sputum cytology. Guideline knowledge was the only significant predictor of LDCT screening use.

**Implications**

LDCT screening guidelines had been published two years before the data for this study was collected. However, few PCPs reported ordering lung cancer screening and 21% ordered the incorrect screening test (CXR). Most participants did not perceived LDCT screening to be effective and did not have sufficient knowledge of the current guidelines. These results demonstrate a great need for further education regarding lung cancer screening recommendations, facts, and figures.

**Strengths and Weaknesses**

Strengths of the study include the anonymity of the survey. Also, many of the survey questions were based on questions posed on pre-existing surveys from other professional organizations. This likely bolters the reliability and validity of this study’s survey. Weaknesses of the study include the use of participants from only one medical center who were mainly young with shorter ranges of experience. The results may not be generalizable to other medical centers or to older and more experienced PCPs. The researcher also noted that the sample was not completely representative of the sample frame because attending physicians were underrepresented. This is a threat to internal validity. Also, participants had to self-report their behaviors so answers to some of the questions may be the result of social desirability or inaccurate recall. Cross-sectional studies lack randomization and control groups and therefore their results are more likely to be the result of extraneous variables than RCTs.