Published in final edited form as:
Cancer. 2010 October 15; 116(20): 4793–4799. doi:10.1002/cncr.25466.

Health Care Utilization Following Screening for Lung Cancer

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Abstract

Background—To evaluate the benefits of lung cancer screening, all effects of screening need to be considered. We sought to determine whether screening had an effect on health care utilization, specifically whether utilization increased for those with a false positive or indeterminate screening result.

Methods—We recruited 400 individuals participating in a lung cancer screening study at the University of Pittsburgh. We collected self reported outpatient health care utilization for the 6 months prior to screening, and 0–6 months and 6–12 months following screening. The screening outcomes were negative, indeterminate and suspicious. Repeated measures Poisson regressions models were used to examine changes in utilization over time, and how changes over time varied among the screening outcome groups.

Results—58% of participants had a negative screening result, 36% an indeterminate result, and approximately 6% a suspicious result. The percentage of individuals who had any incidence of each type of outpatient use increased following screening, with the greatest increase for those with a suspicious screening result. Adjusted mean utilization significantly increased for almost all types of utilization and for all three screening results categories in the 6 months following screening, but mostly declined to pre-screening levels in the next 6 months.

Conclusions—Outpatient health care utilization increased following screening for all individuals who were screened for lung cancer, regardless of the screening finding. The cost of the lung related visits alone is substantial. Therefore, if lung cancer screening prevalence increases, attendant follow up health care costs are also likely to increase.

Keywords

lung cancer; screening; health care utilization; costs; survey

Introduction

Although many types of screening are effective in reducing mortality, screening may also have unintended negative effects. Evidence from cancer and genetic screening shows that

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There are no financial disclosures from any authors.

not only positive screening results (Lerman et al. 1991a,b, Primic Zakelu 1999, Broadstock et al. 2000, Aktan Collan et al. 2001), but also indeterminate (Wiggins et al. 1992, Ong et al. 1997), false positive (Wardle et al. 1992, Lampic et al. 2001), and even negative (Swanson et al. Grosfel et al. 1996) results can cause adverse psychological effects including worry and anxiety. This has been especially well studied in breast cancer, and numerous studies have shown increases in anxiety following screening (Barton et al. 2001, Jatoi et al. 2006). Another, but much less studied, potential consequence is that screening may increase potentially unnecessary health care utilization that is unrelated to the screening result. Barton et al. (2001) found that women with a false positive screening result for breast cancer had increased ambulatory visits – both breast-related and non-breast-related visits following screening. However, Gram et al. (1990) found no differences in self reported visits to clinicians. Jatoi et al. (2006) report higher rates of visits to mental health professionals in the year following screening by women who had received a false positive finding.

It is important to understand all of the effects of screening. This is particularly true when it is unclear whether screening and subsequent treatment will reduce mortality. Then, it is of critical importance to evaluate the psychological and health care utilization consequences of the screening examination. This is the case for lung cancer screening.

Studies on the effectiveness of spiral CT screening to reduce lung cancer mortality are ongoing (Henscke et al. 1999, 2000, 2006, Ellis et al. 2001, Bach 2007); and there is not a consensus as to whether CT screening reduces lung cancer mortality. Thus, understanding the potential unintended consequences of screening is of great importance. Negative physical consequences of being screened, including resection mortality and complication rates (Romano and Mark 1992, Bach et al. 2001, Ganti and Mulshine 2006), biopsy mortality (Twombly 2007), and effects of repeated CT radiation (Twombly 2007) have been reported in the literature. However, unlike breast cancer, little work has been done on the effect that a false positive screening result will have on psychological well being or on health care utilization.

False positive (initially suspicious but not leading to cancer and indeterminate) finding rates are very high for spiral CT screening; 23–51% of all screened individuals have at least one nodule or abnormality (Patz et al. 2000). Thus, there is a large population who might suffer negative consequences from receiving this screening result. In previous research, we have shown that individuals with a suspicious or an indeterminate screening result have increased anxiety following screening (Byrne et al. 2008). In this report, we address the question of outpatient health care utilization following screening.

Methods

The protocol for this study was approved by the University of Pittsburgh and University of Miami Institutional Review Boards.

Study Population

Participants (n=400) for this study were enrolled in the Pittsburgh Lung Screening Study (PLuSS), which was funded by the National Cancer Institute [PLuSS was not related to the National Lung Screening Trial]. PLuSS investigated the operational characteristics of screening lung CT in a local setting and evaluated the pathologic and molecular characteristics and outcomes of screening lung CT-detected cancer. Individuals were recruited into PLuSS via mass mailing and physician referral. Participants completed background history information and were screened approximately 1–4 weeks following enrollment and at a one year follow up. Demographics information collected at baseline included: gender (female/male), age in years, marital status (married/not married), race

(White, African-American), education level (high school or less, some post-high school education, college graduate or more), and smoking status (current smoker/ex-smoker). Demographic characteristics of the complete PLuSS population are reported in Wilson et al. (2008).

Individuals were approached for enrollment in this study when they completed informed consent for PLuSS. Those agreeing to participate completed informed consent. Eligibility criteria matched those for the PLuSS study which included age 50–79 years old, no personal history of lung cancer, smoking history of at least 25 years, no self-reported screening lung CT within a year, and weight less than 400 pounds.

Study Design

The core of this study was a series of four written surveys completed by participants. Surveys were completed approximately 2–4 weeks prior to initial CT screening, immediately after screening results were given, and at 6 and 12 months follow up. All four surveys contained the same instruments. The first survey was given to the participant following enrollment; and subsequent surveys were mailed to participants. Research assistants followed up with participants who had not returned surveys within 2–3 weeks, and sent duplicate surveys if needed. Participants were mailed $5 as a thank you following receipt of each survey.

Survey Instruments

The following survey instruments were completed by participants.

Self-reported Medical Utilization—Participants reported health care utilization completed either in the previous 6 months (baseline survey) or since the last time they had completed a survey (3 follow up surveys). They indicated the total number of outpatient visits, the type of health care provider (primary care, specialist) for each visit, and whether the visit was lung-related. By combining data from the second and third survey we obtained self-reported health care utilization for 3 time periods of 6 months each: 6 months prior to the first survey (baseline), and 0–6 and 6–12 months following.

Although survey timing is based on date of the first survey, we refer to the utilization periods as being prior to or following screening. We do this a) because the change in utilization is hypothesized to be due to the screening result, and b) because the actual time difference is small. Because individuals do not know their screening result until a few weeks into the 0–6 month period, our results for the effect of screening on health care utilization may be slightly conservative.

Perceived Health and Anxiety—We collected information on perceived health via the Health Perceptions Questionnaire (HPQ; Ware 1976) and a visual analog scale measurement of perceived health. The HPQ contains 33 items, of which we used 22 to calculate the General Health Rating Index (alpha = 0.89; McDowell and Newell 1996). Since anxiety has been shown to be related to health care utilization, we measured both state and trait anxiety (20 items each; alpha = 0.85 and 0.79 respectively; Stanley et al. 1996) using the State Trait Anxiety Inventory (Spielberger 1983).

Screening Results

Participants were categorized into four screening outcome classes following screening. The objective risk of lung cancer assigned to each of the categories by PLuSS investigators is given in parentheses.

- Negative: no diagnostic follow-up or physician referral recommended (<1%)
- Definitely or probably benign: physician referral for clinically significant non-lung cancer radiological finding (<1%)
- Indeterminate: advise periodic follow-up CT for one or more indeterminate non-calcified lung nodule (1–5%)
- Suspicious: strong physician referral for lung cancer suspicion on screening CT (15–20%)

Participants with a screening result of “definitely or probably benign” (4 individuals) and those who were diagnosed with lung cancer at any point during the 12 months of the study (3 individuals) were excluded from the analysis. Benign findings may entail increased lung related follow up, but these are not lung cancer related; participants diagnosed with lung cancer will have substantially different health care utilization following screening than other participants.

Statistical Analyses

Statistical analyses were carried out using SAS v9.2 for Windows (Cary, NC). We hypothesized that individuals with an indeterminate or suspicious screening result would have higher levels of all types of health care utilization following screening, but that these effects would diminish over time.

We first calculated descriptive demographic characteristics by screening result for the 393 participants. Summary statistics were calculated for each of 4 types of health care utilization for each time period: total visits, lung related visits, primary care visits and specialty care visits. Lung related visits are not mutually exclusive to primary care or specialty visits. [Visits to psychologists and “other” providers are not included here.] We also calculated the percentage of individuals who had at least one incidence of each type of visit during a period.

For the multivariate analyses, the outcome variables were number of health care visits each period for each type of visit. The primary explanatory variables were screening result and time period. Control variables were age in years, race (White/African-American), gender, marital status, education level (high school or less, some post-high school, college graduate or more), smoking status, perceived health (range 5–110), general health rating (range 0–100), and state and trait anxiety scores (range 20–80).

We used multivariate repeated measures Poisson regression models (Molenberghs and Verbeke 2005) to calculate adjusted utilization rates. Poisson model are appropriate when the dependent variable is a count, such as the number of “events” observed over a given period of time. Since the count outcome is repeatedly measured over time in our study, the correlation among repeated measurements must also be taken into account in the models by incorporating an appropriate variance-covariance structure.

As multivariate repeated measures Poisson regression models are not a full likelihood-modeling approach, Akaike Information Criterion (AIC) cannot be used for model selection. Therefore, we computed the quasi-likelihood based information criterion (QICu) developed by Pan (Pan 2001) to assess the appropriateness of the fitted models. When using QICu to compare models, the model which yields the smaller statistic is preferred. Using this criterion, a compound symmetry structure was chosen as the variance-covariance structure since it provided the smallest statistic on the QICu.

The multivariate repeated measures Poisson regression models, both with a fixed set of primary explanatory variables and with compound symmetry variance-covariance structure, were used to estimate the adjusted mean number of visits for each type of health care utilization by screening result over time. These models yield Adjusted Incidence Rate Ratios (AIRRs) for each outcome; and the AIRRs were used to calculate adjusted mean number of visits (i.e., predicted means over time) that take into account the values of a set of primary explanatory and control variables along with their associated AIRRs.

Changes in health care utilization from baseline (6 month prior to screening) to the 0–6 months and 6–12 months periods by screening result were also calculated and graphically displayed. Again, the AIRRs were used to calculate the change in number of visits (of each type) that a "typical" individual with each screening result would have during the two follow up time periods.

Power calculations—Statistical power analyses for longitudinal studies are generally calculated using assumptions of a between-patient study with no repeated measures (Brown and Prescott 1999). Not taking into account the correlation among repeated measures leads to an estimate of the necessary sample size that is larger (and power lower) than otherwise, and thus our estimate of the power of our analysis is conservative. We based our statistical power analysis on detecting a 50% increase in utilization (an incidence rate ratio of 1.50), with a significance level of 0.05. We chose a 50% increase based on a 1998 study which showed that health care costs for workers reporting high levels of stress, as might be experienced by individuals with a false positive screening result, were almost 50% higher than for workers not reporting stress (Goetzel et al. 1998). We calculated that a sample size of 380 provides 82% power for detecting a significant difference and a sample size of 400 provides 84% power (Signorini 1991). Therefore, with our sample size, we have power of over 80% to detect an increase of 50% in utilization.

Results

Study Participants

Four hundred individuals were enrolled in the study. Of those approached, approximately 2% declined to participate. Seven out of the 400 participants were excluded from the analysis for several reasons (n=4 with clinically significant non-lung cancer radiological finding and n=3 with lung cancer). Therefore, 393 were retained in our analyses and completed at least one survey. Of the 393 participants included, 341 (87%) completed all 4 surveys. There were no significant differences in any measures at baseline, or in screening result, between those who did and did not complete all surveys (Byrne et al. 2008).

Table 1 shows the demographic characteristics of participants by screening result. Overall, the average age was 60 years old, and average years smoked was 41. Half were female, and the large majority (94%) was White. 58% participants had a negative screening result, 36% had an indeterminate result, and less than 6% had a suspicious result. There was a significantly higher percentage of females with an indeterminate result than other results, and a higher percentage of married individuals in the negative and indeterminate classes than in the suspicious category. In addition, there were significant differences among categories in education level and years smoked.

The percentage of individuals, who had any incidence of each type of health care utilization in each period, by screening result, is shown in Figure 1. Although there were increases in the percentage of people utilizing all types of outpatient care, the relative increase was greatest for lung related visits. This is particularly true for those individuals with a suspicious screening result. However, one third of those with a suspicious screening result did not report any lung related visits following receipt of the results. In the 6–12 month period, the percentage of individuals utilizing care fell for all screening results and types of visits.

Figure 2 shows the unadjusted and adjusted means for utilization for each 6 months time period, by screening result. Baseline rates of utilization for each type of visit did not vary significantly among individuals with different screening results. Unadjusted baseline utilization rates were: 1.92 visits total, 0.08 lung-related visits, 0.94 visits to primary care providers, and 0.71 visits to specialists.

In general, for each type of health care visit, utilization increased in the 0–6 month period following screening (second period) and then declined in the 6–12 month period (third period). The following is a summary of the statistical analysis of the adjusted changes in utilization for each of the screening results groups. Because our primary interest was in determining the effect of time period on utilization in each screening results group, we only present the significance of associations between time and our dependent variables.

1. Negative group: The number of visits in the second period was significantly higher than baseline ($p<0.0001$), and the number of visits significantly lower in the third period then in the second period ($p<0.009$).
2. Indeterminate group: The number of visits in the second period was significantly higher than baseline for all types of visits ($p<0.0001$) except for specialty visits ($p=0.09$). The number of visits in the third period was significantly lower than in the second for all types of visits ($p<0.0001$) except for lung related visits ($p=0.1021$).
3. Suspicious group: The number of visits in the second period was significantly higher than baseline for both lung related and specialty visits ($p<0.05$) but not for total ($p=0.0531$) or primary care visits ($p=0.4277$). The number of visits in the third period was lower than in the second period for all types of visits, but no differences were statistically significant.

Figure 3 shows the changes in the adjusted mean number of visits in the second and third period relative to baseline. After adjusting for all covariates, we found that all types of utilization, for all screening result categories, had increases in the 6 months following screening. Individuals with suspicious screening results had slightly more than one additional visit to any outpatient care provider which is an increase of approximately 56%. These individuals had a 10 fold increase in lung related visits. Surprisingly, individuals with a negative screening result also had an increase in total visits of almost 0.9 visits in the 6 months following screening, which is a 47% increase; and a 2 fold increase in lung related visits. These are not large changes in absolute terms, but most changes are at least a 50% increase over baseline levels of use. This level of increase has been cited in previous literature as being an important change in utilization (Goetzl et al. 1999). For all categories, utilization fell during the 6–12 month period.

Discussion

Much previous research has looked at the psychological consequences of receiving a “non-normal” or false-positive screening result, particularly in breast cancer. Less research has looked at the effects on health care utilization of these false-positive results. Barton et al. (2001) found that both breast related and non-breast related patient initiated visits occurred following screening. Jatoi et al. (2006) found that women over the age of 50 who had an abnormal mammogram were significantly more likely to report seeing a mental health professional in the 12 months following screening than did those with a normal mammogram. Despite the very high number of abnormal findings in screening for lung cancer, this is the first study that we know of that explores the effect of lung cancer screening result on health care utilization.

In our study, 36% of participants received an “indeterminate” screening result, and about 6% received a “suspicious” result which after follow-up proved not to be cancer. Therefore, 42% received an “abnormal” finding. We hypothesized, based on previous literature, that both lung and non-lung related health care utilization would increase following screening for individuals with an indeterminate or suspicious result. We did not expect a similar increase in utilization for those who had received a negative screening result.

However, we found that outpatient visits as a total, to primary care providers and to specialists, did increase following screening. This was true for all of the screening categories, even individuals with negative screening results. This was unexpected, and may be due to several causes. First, it might be that individuals who were screened became more anxious about their health overall and so have an increased number of health care visits. Alternatively, they may have been given information about their health during their participation in screening that encouraged them to seek additional visits. Finally, the individuals participating in the screening study might have decided to do a number of health care visits around the same time, and thus the increase in visits is nothing more than the individuals “getting all of their health care out of the way”.

In contrast to the additional health care utilization seen on average, we also found that a third of individuals with a suspicious screening result reported no lung related visits in the 6 months following screening although these individuals were counseled by personnel in the parent PLuSS study to get follow up care. This type of non-adherence with follow up has been shown previously in a number of cancer screening recall studies (Antill et al. 2006, Paskett et al. 1990, Melnikow et al. 1999).

The main limitations of our study include: that our utilization data come from patient self-report. Patients may not have been able to remember all utilization that they had had in the 6 months prior to being enrolled in our study, whereas they might have been more cognizant of utilization once they were enrolled. This would potentially bias utilization in the baseline period downward and falsely inflate the increase in utilization that we found. Therefore, the increases may be less than we report here. However, third period utilization was quite similar to that of the baseline period, providing some support for an unbiased recall. The absolute size of the increase in utilization was not large for some types of visits, and we cannot definitively state that they are of practical significance. Nevertheless, the relative increases were quite large for lung-related visits (2–10 fold increases), and such increases seem likely to have an impact on the healthcare system. In addition, our results may not be generalizable to all populations, only 7% of our study participants were minorities.

In summary, we found that outpatient health care utilization increased following screening for all individuals who were screened for lung cancer, regardless of the screening finding. This was somewhat surprising, although it may be attributable to testing-associated anxiety. The increase in lung-related visits alone is substantial and likely to increase costs. Therefore, if lung cancer screening increases, attendant follow up health care costs may also increase.

Acknowledgments

Funding for this study was provided through a National Cancer Institute career development award to Dr. Byrne (K07 CA10181). We express our deep gratitude for invaluable research assistance from Cleve Heller and Lisa Schiller. In addition, we thank the University of Pittsburgh’s Department of Internal Medicine for providing space and resources throughout this project.

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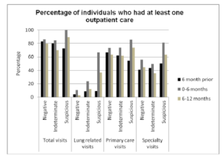

Figure 1.
Percentage of individuals who had any incidence of each type of outpatient care, by screening results category.

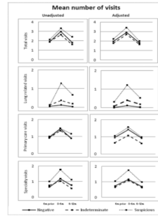

Figure 2.

Unadjusted and adjusted mean number of visits for each type of health care utilization over time, by screening result. Adjusted means were calculated based on multivariate Poisson regression model results.

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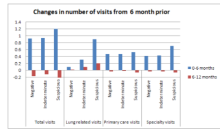

Figure 3.

Changes in adjusted mean number of visits from 6 months worth of utilization prior to screening for each type of health care utilization by screening result.

Table1

Demographic characteristics of participants by screening results category

Characteristics	Negative	Indeterminate	Suspicious	Total
	n (%)	n (%)	n (%)	n (%)
Total participants	228 (100.0)	141 (100.0)	24 (100.0)	393 (100.0)
Age**	59.8 (6.8)	60.4 (6.8)	61.2 (6.9)	60.1 (6.8)
Female*	101 (44.3)	83 (58.9)	10 (41.7)	194 (49.4)
White	211 (92.5)	136 (96.5)	24 (100.0)	371 (94.4)
Married*	149 (65.4)	84 (59.6)	9 (37.5)	242 (61.6)
Education*				
High school or less	56 (24.6)	44 (31.2)	10 (41.7)	110 (28.0)
More than high school	90 (39.5)	59 (41.8)	10 (41.7)	159 (40.5)
College graduate or more	82 (36.0)	38 (27.0)	4 (16.7)	124 (31.6)
Current smoker	137 (60.1)	80 (56.7)	15 (62.5)	232 (59.0)
Years smoked**	40.5 (7.3)	40.9 (7.4)	42.8 (8.1)	40.8 (7.4)

*Significant differences between the categories p<0.05, Chi-square test

**Mean (standard deviation), significant differences between the categories p<0.05, ANOVA