Research Article

Cancer Epidemiology, Biomarkers & Prevention

Lower Risk of Lung Cancer after Multiple Pneumonia Diagnoses

Jill Koshiol[1], Melissa Rotunno[1], Dario Consonni[2], Angela Cecilia Pesatori[2], Sara De Matteis[2], Alisa M. Goldstein[1], Anil K. Chaturvedi[1], Sholom Wacholder[1], Maria Teresa Landi[1], Jay H. Lubin[1], and Neil E. Caporaso[1]

Abstract

Background: Although pneumonia has been suggested as a risk factor for lung cancer, previous studies have not evaluated the influence of number of pneumonia diagnoses in relation to lung cancer risk.

Methods: The Environment And Genetics in Lung cancer Etiology (EAGLE) population-based study of 2,100 cases and 2,120 controls collected information on pneumonia more than 1 year before enrollment from 1,890 cases and 2,078 controls.

Results: After adjusting for study design variables, smoking, and chronic bronchitis, pneumonia was associated with decreased risk of lung cancer [odds ratio (OR), 0.79; 95% confidence interval (CI), 0.64-0.97], especially among individuals with three or more diagnoses versus none (OR, 0.35; 95% CI, 0.16-0.75). Adjustment for chronic bronchitis contributed to this inverse association. In comparison, pulmonary tuberculosis was not associated with lung cancer (OR, 0.96; 95% CI, 0.62-1.48).

Conclusions: The apparent protective effect of pneumonia among individuals with multiple pneumonia diagnoses may reflect an underlying difference in immune response and requires further investigation and confirmation. Therefore, careful evaluation of the number of pneumonia episodes may shed light on lung cancer etiology. *Cancer Epidemiol Biomarkers Prev; 19(3); 716–21. ©2010 AACR.*

Introduction

Pulmonary infections have been proposed as risk factors for lung cancer (1). Respiratory tract infections may contribute to lung carcinogenesis by promoting airway remodeling (2) and causing inflammation, which could generate reactive oxygen or nitrogen species, increase cellular proliferation, upregulate antiapoptotic pathways, and stimulate angiogenesis (1). Both self-reported pneumonia and *Chlamydia pneumoniae* have been associated with increased lung cancer risk (1, 3). Although previous studies have evaluated any diagnosis of pneumonia and lung cancer, to our knowledge, no previous study has analyzed the number of pneumonia diagnoses.

The Environment And Genetics in Lung cancer Etiology (EAGLE) population-based case control study collected information on the number of self-reported pneumonia diagnoses, as well as tuberculosis diagnosis.

Materials and Methods

As previously described (4), EAGLE enrolled 2,100 consecutive incident lung cancer cases from 13 hospitals in the Lombardy region of northern Italy, which accounted for ~80% of all lung cancer cases in the municipalities selected for the study, and 2,120 population-based controls randomly sampled from the Regional Health Service database and frequency-matched to cases by age, sex, and area of residence. Of all eligible subjects, 86.6% of cases and 72.4% of controls agreed to participate and provided informed consent approved by the institutional review boards of each participating hospital and university in Italy and the National Cancer Institute. All enrolled subjects were Caucasian.

Information on the history of pneumonia and tuberculosis, including ages at diagnoses, were collected from cases and controls using a computer-assisted personal interview. Data were collected for age at first, second, and third diagnosis of pneumonia, allowing evaluation of latency as the difference between study age (age at first diagnosis of lung cancer for cases or age at interview for controls) and age at first diagnosis. Seven cases and seven controls whose date of first pneumonia diagnosis was <1 y before study entry were

Authors' Affiliations: [1]Division of Cancer Epidemiology and Genetics, National Cancer Institute, NIH, Department of Health and Human Services, Bethesda, Maryland and [2]EPOCA Research Center, Department of Occupational and Environmental Health, Università degli Studi di Milano and Epidemiology Unit, Fondazione IRCCS Ca' Granda-Ospedale Maggiore Policlinico, Milan, Italy

Corresponding Author: Jill Koshiol, National Cancer Institute, 6120 Executive Boulevard, MSC 7248, Bethesda, MD 20892-7248. Phone: 301-402-9508; Fax: 301-402-0817. E-mail: koshiolj@mail.nih.gov

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Table 1. Descriptive characteristics of cases and controls providing data on pneumonia at least 1 y prior to entry into the EAGLE case-control study

Characteristic	Cases (*n* = 1,890)	Controls (*n* = 2,078)	*p*
Median age (range)	67 (35-80)	66 (35-80)	0.02
% male	79.2	76.4	0.04
Study area, *n* (%)			0.9
Brescia	238 (12.6)	242 (11.6)	
Milano	1,242 (65.7)	1,417 (68.2)	
Monza	129 (6.8)	116 (5.6)	
Pavia	125 (6.6)	126 (6.1)	
Varese	156 (8.3)	177 (8.5)	
% ever smokers	93.0	67.8	<0.0001
Median smoking intensity (average packs/d)	1.0	0.75	<0.0001
Median duration of smoking (y)	44	33	<0.0001
Education, *n* (%)*			<0.0001
None	107 (5.7)	90 (4.3)	
Elementary	734 (38.9)	557 (26.8)	
Middle school	541 (28.6)	601 (28.9)	
High school	411 (21.8)	568 (27.3)	
University	96 (5.1)	262 (12.6)	
% Married/cohabitating	77.0	82.8	<0.0001

*Does not sum to total due to missing values.

excluded, leaving 2,094 cases and 2,113 controls. Of these, 1,890 (90.3%) cases and 2,078 (98.3%) controls provided data on pneumonia. These percentages are similar to the overall computer-assisted personal interview completion rates (cases, 92.6%; controls, 99.8%).

Lung cancer was confirmed from surgery, biopsy, or cytology samples in ~95% of cases, with confirmation through clinical history and imaging for the remainder (4). Main analyses included all primary lung cancer cases regardless of histologic type, whereas histology-specific

Table 2. ORs and 95% CIs for associations of lung cancer with pneumonia and tuberculosis diagnosed at least 1 y prior to entry into the EAGLE case-control study, both overall and stratified by smoking status

	Overall			Smoking status		
				Never		
	Cases *n* = 1,846 (%)	Controls *n* = 2,054 (%)	OR (95% CI)*	Cases *n* = 131 (%)	Controls *n* = 666 (%)	OR (95% CI)*
Pneumonia†						
No	1,555 (84.2)	1,746 (85.0)	1	118 (90.1)	586 (88.0)	1
Yes	291 (15.8)	308 (15.0)	0.79 (0.64-0.97)	13 (9.9)	80 (12.0)	0.72 (0.37-1.41)
One diagnosis	240 (13.0)	253 (12.3)	0.81 (0.65-1.02)	11 (8.4)	61 (9.2)	0.89 (0.44-1.83)
Two diagnoses	35 (1.9)	33 (1.6)	0.97 (0.55-1.71)	2 (1.5)	12 (1.8)	0.59 (0.12-2.95)
Three or more diagnoses	16 (0.9)	22 (1.1)	0.35 (0.16-0.75)	0 (0.0)	7 (1.1)	0
P trend			0.008			0.1
Tuberculosis†						
No	1,777 (96.7)	1,985 (97.0)	1	128 (98.5)	643 (96.8)	1
Yes	60 (3.3)	61 (3.0)	0.96 (0.62-1.48)	2 (1.5)	21 (3.2)	0.40 (0.09-1.89)

*Adjusted for study age, sex, region, and chronic bronchitis for never smokers as well as pack-years and smoking intensity (average packs/d) for smokers and overall.
†Overall number does not sum to total due to subjects missing data on other variables included in the multivariate model.

analyses included only adenocarcinoma, squamous cell carcinoma, large cell carcinoma, and small cell carcinoma, as defined by the WHO Histological Typing of Lung and Pleural Tumors (1999).

Odds ratios (OR) and 95% confidence intervals (CI) for associations with lung cancer were calculated through unconditional binary logistic regression for main analyses and polytomous logistic regression for analyses by histologic type. All models included the design variables (study age, gender, and region) on which controls were frequency-matched to cases. After backwards modeling to evaluate smoking [e.g., smoking intensity (average packs per day), time between last smoking quit attempt, and study entry], demographic/socioeconomic variables (e.g., education, marital status), chronic bronchitis, emphysema, asthma, tuberculosis, family history of lung cancer in first-degree relatives, and other factors as potential confounders, only the removal of chronic bronchitis changed the β coefficient for pneumonia by >10%. However, in accord with several recent studies of adjustment for smoking (5-7), continuous pack-years and smoking intensity were included with history of chronic bronchitis in the final models. Additional smoking variables [time since quitting smoking, age at initiation of cigarette smoking, environmental tobacco smoke in childhood or adulthood (at work or home), and other tobacco smoking] had little effect on the ORs for pneumonia or tuberculosis and were not included in the final models. Similarly, additional adjustment for other self-reported previous lung diseases (emphysema, asthma, and tuberculosis in the pneumonia models) did not substantively change the results.

Effect modification by smoking and latency was evaluated using likelihood ratio tests for interaction. Differences in ORs for separate histologic types were evaluated with the Wald test for homogeneity.

Results

The distribution of cases and controls is described in Table 1. Sixteen percent of cases (296 of 1,890) and 15% of controls (318 of 2,078) reported one or more pneumonia diagnoses (χ^2 $P = 0.8$). Three percent of both cases (61 of 1,881) and controls (62 of 2,070) reported tuberculosis ($P = 0.3$). The mean age at first diagnosis among cases and controls was 32.6 (median, 29; range, 0-78) for pneumonia and 24.9 (median, 22; range, 2-73) for tuberculosis. Over 90% of tuberculosis diagnoses were reported as occurring more than 20 years prior to study enrollment, compared with ~65% of initial pneumonia diagnoses. Pneumonia and tuberculosis were not associated: <1% of cases ($n = 16$) or controls ($n = 17$) had both.

The median time between diagnoses was 10 years (range, 1-71) among 87 people who reported age at first and second pneumonia diagnoses, and 3 years (range, 1-33) among 23 people who reported age at second and third pneumonia diagnoses, suggesting separate episodes rather than unresolved infection. The median time between diagnoses was similar for cases and controls.

After adjustment, pneumonia reduced the risk of lung cancer (Table 2). This association did not vary by smoking status (likelihood ratio test, $P = 0.6$). The protective effect was strongest for patients with three or more diagnoses versus patients with no pneumonia diagnoses (OR, 0.35; 95% CI, 0.16-0.75). This pattern was similar for never, former, and current smokers, and the OR for pneumonia overall was similar if additionally adjusted for smoking status (OR, 0.78; 95% CI, 0.63-0.96). Among subjects reporting pneumonia, the OR for three

Table 2. ORs and 95% CIs for associations of lung cancer with pneumonia and tuberculosis diagnosed at least 1 y prior to entry into the EAGLE case-control study, both overall and stratified by smoking status (Cont'd)

Smoking status					
Former			Current		
Cases *n* = 791 (%)	Controls *n* = 879 (%)	OR (95% CI)*	Cases *n* = 924 (%)	Controls *n* = 509 (%)	OR (95% CI)*
647 (81.8)	727 (82.7)	1	790 (85.5)	433 (85.1)	1
144 (18.2)	152 (17.3)	0.83 (0.62-1.12)	134 (14.5)	76 (14.9)	0.75 (0.54-1.06)
113 (14.3)	128 (14.6)	0.83 (0.60-1.12)	116 (12.6)	64 (12.6)	0.78 (0.54-1.12)
22 (2.8)	14 (1.6)	1.25 (0.58-2.71)	11 (1.2)	7 (1.4)	0.78 (0.28-2.20)
9 (1.1)	10 (1.1)	0.49 (0.17-1.42)	7 (0.8)	5 (1.0)	0.38 (0.22)-1.30
		0.2			0.06
764 (96.8)	843 (96.2)	1	885 (96.4)	499 (98.6)	1
25 (3.2)	33 (3.8)	0.87 (0.48-1.58)	33 (3.6)	7 (1.4)	1.73 (0.72-4.14)

or more versus one or two diagnoses was 0.44 (95% CI, 0.20-0.97). Removal of chronic bronchitis from the model raised the fully adjusted OR for pneumonia from 0.79 (95% CI, 0.64-0.97) to 0.88 (95% CI, 0.72-1.08). Although removing pack-years and smoking intensity had little effect (OR, 0.81; 95% CI, 0.67-0.98), removal of chronic bronchitis in addition to the smoking variables brought the OR to 0.99 (0.83-1.18). In contrast to pneumonia, tuberculosis was not associated with lung cancer (Table 2). Although risk of lung cancer increased somewhat across smoking status (likelihood ratio test, $P = 0.02$), numbers were quite small.

We evaluated the joint effects of pneumonia and chronic bronchitis (Table 3). The OR for pneumonia and lung cancer in individuals without chronic bronchitis was 0.83 (0.65-1.05), whereas chronic bronchitis was associated with increased risk of lung cancer regardless of pneumonia status. Even among individuals with chronic bronchitis, however, pneumonia had a protective effect (1.63 divided by 2.45 = 0.66; 95% CI, 0.43-1.04).

Pneumonia was not associated with attempting to quit smoking (OR, 1.05; 95% CI, 0.83-1.33) or number of quit attempts (P trend = 1.0). The number of pneumonia diagnoses was similarly not associated with quitting smoking (data not shown). Among cases, neither pneumonia nor number of pneumonia diagnoses was associated with tumor stage (data not shown).

In addition to tumor stage, the associations for pneumonia and for tuberculosis did not vary by histology (Wald $P = 0.8$ and 0.7, respectively), although numbers were small for some histology categories. Histologic results were similar when stratified by smoking status (data not shown). Likewise, associations of pneumonia and tuberculosis with lung cancer did not vary by quartiles of latency (likelihood ratio test, $P = 0.7$). ORs were inverse for individuals with three or more pneumonia diagnoses with no clear pattern by latency, whereas individuals with one or two diagnoses had inconsistent patterns tending to cluster around 1.0 (Table 4). Results were similar using latency calculated with the last known pneumonia diagnosis instead of the first.

Table 3. Distribution of pneumonia among individuals with and without history of chronic bronchitis in the EAGLE case-control study and ORs and 95% CIs for the risk of lung cancer among individuals with pneumonia only, chronic bronchitis only, or both pneumonia and chronic bronchitis compared with individuals without chronic bronchitis (referent)

History of pneumonia*	History of chronic bronchitis	
	No	Yes
No		
n cases	1,266	289
n controls	1,659	87
OR (95% CI)†	Referent	2.45 (1.85-3.25)
Yes		
n cases	172	119
n controls	253	55
OR (95% CI)†	0.83 (0.65-1.05)	1.63 (1.12-2.36)

*Numbers do not sum to total due to subjects missing data on other variables included in the multivariate model.
†Adjusted for study age, gender, region, pack-years, and smoking intensity (average packs/d).

Discussion

To our knowledge, this study is the first to evaluate the number of reported pneumonia diagnoses and lung cancer. Previous pneumonia was associated with decreased risk of lung cancer, especially among individuals reporting three or more pneumonia diagnoses, whereas previous tuberculosis exhibited no association. Additional adjustment for smoking beyond pack-years and smoking intensity did not materially change these results, and there were no clear patterns by latency.

Although previous studies generally have found positive associations between self-reported pneumonia and lung cancer (8-17), only one (15) controlled for chronic bronchitis. Because chronic bronchitis is clearly associated with increased risk of lung cancer (18) regardless of pneumonia status, chronic bronchitis may mask the true effect of pneumonia if chronic bronchitis is not taken into account. The etiologic factors for chronic bronchitis include smoking, genetics, and occupational and environmental exposures (19). Pneumonia is not thought to be important in etiology because studies such as Framingham establish that infectious exacerbations do not influence the underlying progression in decline of FEV1 (forced expiratory volume in 1 second) characteristic of chronic obstructive pulmonary disease (19). Because this evidence suggests that chronic bronchitis is not a key intermediate on the pathway from pneumonia to lung cancer, adjustment for chronic bronchitis was considered appropriate. Although longitudinal data are needed to clarify the relation between chronic bronchitis and pneumonia further, pneumonia reduced lung cancer risk even among subjects reporting no chronic bronchitis (OR, 0.83; 95% CI, 0.65-1.05). Adjusting for other lung diseases associated with lung cancer (18), such as emphysema, did not affect the association between pneumonia and lung cancer.

In our study, the inverse association seemed to be driven largely by the number of pneumonia diagnoses, although it is important to note that few individuals had three or more diagnoses. Previous studies have not addressed this issue. It is possible that having multiple bouts of pneumonia reflects some difference in immune function resulting in repeated pneumonia and an attenuated inflammatory response leading to slower progression to malignancy. Such an effect could be genetically mediated as family history of pneumonia also

Table 4. ORs and 95% CIs for the association of lung cancer with pneumonia latency (time from first or last known pneumonia diagnosis to lung cancer or interview) using tertiles in controls (based on time from first pneumonia diagnosis), stratified by number of pneumonia diagnoses

Pneumonia latency		Based on first pneumonia diagnosis			Based on last known pneumonia diagnosis		
n diagnoses	Tertile (y)	*n* cases*	*n* controls*	OR (95% CI)†	*n* cases*	*n* controls*	OR (95% CI)†
0	Not applicable	1,555	1,746	1.0	1,555	1,746	1.0
1	First (1-<23)	111	84	0.99 (0.70-1.40)	111	84	0.99 (0.70-1.40)
1	Second (23-<53)	51	76	0.64 (0.41-0.98)	51	76	0.64 (0.41-0.98)
1	Third (≥53)	64	72	0.87 (0.59-1.30)	64	72	0.87 (0.59-1.30)
2	First (1 to <23)	5	3	1.83 (0.35-9.55)	22	14	1.50 (0.69-3.24)
2	Second (23 to <53)	13	9	1.63 (0.63-4.23)	8	11	0.72 (0.25-2.09)
2	Third (≥53)	14	16	0.92 (0.41-2.07)	4	4	1.15 (0.25-5.24)
≥3	First (1 to <23)	2	3	0.43 (0.06-3.31)	9	8	0.62 (0.21-1.83)
≥3	Second (23 to <53)	5	7	0.33 (0.09-1.23)	2	6	0.07 (0.01-0.39)
≥3	Third (≥53)	7	6	0.61 (0.15-2.39)	3	5	0.32 (0.05-2.00)

*Numbers do not sum to total due to subjects missing data on other variables included in the multivariate model or subjects who answered "Don't know" for one or more age at diagnosis of pneumonia variable.
†Referent is no report of pneumonia. Adjusted for study age, gender, region, pack-years, smoking intensity (average packs/d), and chronic bronchitis.

seems to decrease the risk of lung cancer, especially among older individuals (20). Alternatively, antibiotic treatment for pneumonia may eliminate infectious agents reported to increase lung cancer risk, such as *C. pneumoniae* (3). Thus, repeated treatment courses for multiple bouts of pneumonia might decrease the risk of lung cancer. Although people with pneumonia might, in theory, be more likely to reduce or quit smoking or avoid other environmental risk factors for lung cancer, adjusting for smoking and other factors only strengthened the inverse association in our study. Finally, the "immunesurveillance hypothesis" proposed for asthma may be relevant in this case: multiple bouts of pneumonia may stimulate the immune system such that it is better able to detect and destroy cancer cells (21). Although we are unsure why we see inverse associations, our findings warrant further investigation in other studies with data on multiple pneumonia diagnoses.

Tuberculosis and lung cancer exhibited no association in our data. Reported associations between tuberculosis and lung cancer have been inconsistent (8-12, 15-17, 22-25) and often weaker with longer latency (9, 16, 22, 25). In our study, the median age at tuberculosis diagnosis was 22, and diagnosis occurred more than 20 years prior to interview in >90% of subjects. Thus, it may not be surprising that we found no association because the association between tuberculosis and lung cancer weakens with longer latency (22). Individuals diagnosed with tuberculosis at a young age may tend to avoid risk factors like smoking, thus reducing their risk for lung cancer.

These results must be interpreted with caution given the potential for misclassification through self-report and the small number of subjects with three or more pneumonia diagnoses. Although recall bias is of concern as in all case-control studies, the same persons did not report both pneumonia and tuberculosis, suggesting that there was not consistent differential error in reporting in cases or controls. Although it is theoretically possible that lung cancer may be diagnosed earlier in exposed individuals due to increased medical investigations like chest X-rays, pneumonia was not associated with tumor stage. In addition, such surveillance bias would increase the OR and thus cannot account for the inverse association we observed between pneumonia and lung cancer, but could lead to a bias towards a weaker estimate of effect.

EAGLE is an excellent setting in which to evaluate pneumonia and lung cancer given its large size, population-based design, detailed questionnaires including number of pneumonia diagnoses, and high participation rate. Interviewers were centrally trained to ensure accurate and complete data collection. Data collection and transfer were further protected through extensive quality control procedures (4).

In one of the largest studies of previous pneumonia and lung cancer to date and the first to our knowledge to report on number of pneumonia diagnoses, we found a novel inverse association between pneumonia and lung cancer. Given that this result was largely limited to people with three or more pneumonia diagnoses, we speculate that some immune perturbation or effect of treatment accounts for the decreased risk of lung cancer in these individuals. Future studies focused on these individuals, perhaps with specific attention to genetic polymorphisms, may help elucidate the underlying mechanisms involved in lung carcinogenesis.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

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References

1. Engels EA. Inflammation in the development of lung cancer: epidemiological evidence. Expert Rev Anticancer Ther 2008;8:605–15.
2. Holtzman MJ, Tyner JW, Kim EY, et al. Acute and chronic airway responses to viral infection: implications for asthma and chronic obstructive pulmonary disease. Proc Am Thorac Soc 2005;2:132–40.
3. Littman AJ, Jackson LA, Vaughan TL. *Chlamydia pneumoniae* and lung cancer: epidemiologic evidence. Cancer Epidemiol Biomarkers Prev 2005;14:773–8.
4. Landi MT, Consonni D, Rotunno M, et al. Environment And Genetics in Lung cancer Etiology (EAGLE) study: an integrative population-based case-control study of lung cancer. BMC Public Health 2008; 8:203–13.
5. Lubin JH, Caporaso NE. Cigarette smoking and lung cancer: modeling total exposure and intensity. Cancer Epidemiol Biomarkers Prev 2006;15:517–23.
6. Lubin JH, Kogevinas M, Silverman D, et al. Evidence for an intensity-dependent interaction of NAT2 acetylation genotype and cigarette smoking in the Spanish Bladder Cancer Study. Int J Epidemiol 2007;36:236–41.
7. Lubin JH, Virtamo J, Weinstein SJ, Albanes D. Cigarette smoking and cancer: intensity patterns in the α-tocopherol, β-carotene cancer prevention study in Finnish men. Am J Epidemiol 2008;167:970–5.
8. Alavanja MC, Brownson RC, Boice JD, Jr., Hock E. Preexisting lung disease and lung cancer among nonsmoking women. Am J Epidemiol 1992;136:623–32.
9. Brenner AV, Wang Z, Kleinerman RA, et al. Previous pulmonary diseases and risk of lung cancer in Gansu Province, China. Int J Epidemiol 2001;30:118–24.
10. Brownson RC, Alavanja MC. Previous lung disease and lung cancer risk among women (United States). Cancer Causes Control 2000;11: 853–8.
11. Mayne ST, Buenconsejo J, Janerich DT. Previous lung disease and risk of lung cancer among men and women nonsmokers. Am J Epidemiol 1999;149:13–20.
12. Osann KE, Lowery JT, Schell MJ. Small cell lung cancer in women: risk associated with smoking, prior respiratory disease, and occupation. Lung Cancer 2000;28:1–10.
13. Schabath MB, Delclos GL, Martynowicz MM, et al. Opposing effects of emphysema, hay fever, and select genetic variants on lung cancer risk. Am J Epidemiol 2005;161:412–22.
14. Wang XR, Yu IT, Chiu YL, et al. Previous pulmonary disease and family cancer history increase the risk of lung cancer among Hong Kong women. Cancer Causes Control 2009;20:757–63.
15. Wu AH, Fontham ET, Reynolds P, et al. Previous lung disease and risk of lung cancer among lifetime nonsmoking women in the United States. Am J Epidemiol 1995;141:1023–32.
16. Wu AH, Yu MC, Thomas DC, Pike MD, Henderson BE. Personal and family history of lung disease as risk factors for adenocarcinoma of the lung. Cancer Res 1988;48:7279–84.
17. Wu-Williams AH, Dai XD, Blot W, et al. Lung cancer among women in north-east China. Br J Cancer 1990;62:982–7.
18. Koshiol J, Rotunno M, Consonni D, et al. Chronic obstructive pulmonary disease and altered risk of lung cancer in a population-based case-control study. PLoS ONE 2009;4:e7380.
19. Anthonisen NR, Manfeda J. Epidemiology of chronic obstructive pulmonary disease. In: Crapo JD, Glassroth JL, Karlinsky JB, King TE, editors. Braum's textbook of pulmonary diseases. Philadelphia: Lippincott Williams & Wilkins; 2004, p. 203–22.
20. Gao Y, Goldstein AM, Consonni D, et al. Family history of cancer and nonmalignant lung diseases as risk factors for lung cancer. Int J Cancer 2009;125:146–52.
21. Schabath MB, Gorlova OY, Spitz MR. Re: "Cancer mortality among US men and women with asthma and hay fever". Am J Epidemiol 2006;163:394–5, author reply 5–6. Epub 2005 Dec 21.
22. Engels EA, Shen M, Chapman RS, et al. Tuberculosis and subsequent risk of lung cancer in Xuanwei, China. Int J Cancer 2009; 124:1183–7.
23. Samet JM, Humble CG, Pathak DR. Personal and family history of respiratory disease and lung cancer risk. Am Rev Respir Dis 1986; 134:466–70.
24. Wang SY, Hu YL, Wu YL, et al. A comparative study of the risk factors for lung cancer in Guangdong, China. Lung Cancer 1996;14 Suppl 1:S99–105.
25. Zheng W, Blot WJ, Liao ML, et al. Lung cancer and prior tuberculosis infection in Shanghai. Br J Cancer 1987;56:501–4.
26. http://eagle.cancer.gov/