Air pollution affects lung cancer survival

Jaime E Hart[1,2]

Lung cancer is one of the most commonly occurring cancers in the USA. The American Cancer Society estimates that a total of 221 200 individuals were newly diagnosed with lung cancer in 2015, representing approximately 13% of all new cancer diagnoses.[1] Worldwide, lung cancer is the most commonly diagnosed malignancy. In their most recent report, WHO estimated that there were 1.8 million new lung cancer cases diagnosed in 2012.[2]

In addition to being one of the most commonly diagnosed cancers, survival from lung cancer is poor, making it the leading cause of cancer death in the USA.[3] The 5-year lung cancer survival rate for cases diagnosed in 2011 was only 17.8%, with wide variations in survival rates by stage at diagnosis and specific histological subtype.[4] The survival rate has only improved modestly in recent decades; the Surveillance, Epidemiology, and End Results (SEER) programme of the National Cancer Institute estimated that overall 5-year survival rates were 12.2% for cases diagnosed in 1975–1977, 13.0% for cases diagnosed in 1987–1989 and 14.6% for cases diagnosed in 1996–1998.[4] Therefore, interventions or other strategies to increase survival are a source of consistent research, with a focus on lifestyle and treatment interventions.[5 6]

Given the large impact of lung cancer and the modest improvement in survival rates, population level prevention and intervention strategies are appealing as a public health tool. In addition to advances in early detection and strategies to reduce exposures from active and passive cigarette smoking, environmental exposures, especially radon and air pollution, have emerged as potential public health targets. The International Agency for Research on Cancer recently declared air pollution generally, and particulate matter (PM) specifically, carcinogenic to humans.[7] This determination was mainly based on the evidence for lung cancer incidence and mortality, where a rapidly growing number of studies have observed positive associations.[7–9] However, to date, there has been no clear evidence of the impact of air pollution after a lung cancer diagnosis. In *Thorax*, Eckel *et al*[10] publish the results of the first study to examine the impacts of air pollution exposures on the risk of subsequent all-cause or lung-cancer mortality among newly diagnosed individuals with lung cancer in California.

The authors used information collected on lung cancer cases diagnosed between 1988 and 2009 that were reported to the California Cancer Registry. Information on four different air pollution measures (PM <10 microns in aerodynamic diameter (PM_{10}), PM <2.5 microns in aerodynamic diameter ($PM_{2.5}$), nitrogen dioxide (NO_2) and ozone (O_3)) were interpolated from regulatory monitoring stations to the residential addresses of each individual at the time of diagnosis. Individuals were excluded if the necessary geographic information to locate their home address was not available, or if their address was further than 25 km from a monitoring location. Using daily exposure information, exposures were calculated from the date of diagnosis to the date of death, or end of study follow-up (21 December 2011). From the registry, information was available at an individual-level on age, race/ethnicity, sex, marital status, tumour characteristics at the time of diagnosis (stage, anatomical site, histology) and treatments occurring within 6 months of diagnosis. For each address, the authors calculated the distance to the nearest primary interstate highway and primary US and state highways to account for exposures to local traffic. For each address, they also obtained area-level information on measures of urbanicity and socioeconomic status from the Census. Information on vital status and cause of death were also available from the registry and were used to identify cases.

In multivariable adjusted models for all lung cancer stages considered together, there were elevations in both all-cause and lung cancer-specific mortality with increases in each of the pollutants examined, ranging from a 2% increased risk on all-cause mortality per IQR increase in O_3 to a 16% increased risk per IQR increase in $PM_{2.5}$. As the authors note, the most interesting findings were those from models stratified by stage at diagnosis and adjusted for histology and those stratified by both stage and histology. Across all pollutants, larger HRs were consistently observed for patients diagnosed at earlier stages and there were suggestions that the effects for PM_{10}, $PM_{2.5}$, and NO_2 were larger for adenocarcinoma cases compared with small-cell cases of the same stage.

This study, along with two other previously published analyses on the impact of air pollution on cancer survival, provide compelling initial evidence that air pollution may be a potential target for future prevention and intervention studies to increase cancer survival.[11 12] With such a large number of cases with detailed stage and histological subtype information, this work has set the bar high for future analyses; however, it is important to note that this study does have limitations. First, with the exception of treatment within 6 months of diagnosis, this study was unable to account for potential confounding by changes in lifestyle habits, subsequent treatments or changes in time-activity patterns. Adjusting for these changes, which may differ by prognosis at diagnosis, would be important to address the potential for confounding.[5 6] Second, although the density of regulatory monitors in California is higher than most other locations in the USA, future studies should improve on the exposure accuracy of the current analysis with the use of residence-level or individual-level predictions. The authors did not have information on changes in residence after diagnosis, which could introduce bias if there are differences in patterns of residential mobility by stage or subtype of cancer at diagnosis. The authors also focused on large-scale differences in pollution exposures in their analyses. Future work should also consider the impact of smaller-scale differences in exposures, as well as the impact of exposure to mixtures of pollutants. In conclusion, this emerging link between cancer survival and air pollution exposures should be seen as evidence of the importance of air pollution regulations, as well as a worthwhile target for interventions focused on increasing lung cancer survival rates.

[1]Channing Division of Network Medicine, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, Massachusetts, USA;
[2]Exposure, Epidemiology, and Risk Program, Department of Environmental Health, Harvard T.H. Chan School of Public Health, Boston, Massachusetts, USA

Correspondence to Dr Jaime E Hart, Channing Division of Network Medicine, Brigham and Women's Hospital and Harvard Medical School, 401 Park Dr, Landmark Center 3rd Floor West, Boston, MA 02215, USA; Jaime.hart@channing.harvard.edu

Competing interests None declared.

Provenance and peer review Commissioned; internally peer reviewed.

To cite Hart JE. *Thorax* 2016;**71**:875–876.

Published Online First 4 August 2016

▸ http://dx.doi.org/10.1136/thoraxjnl-2015-207927

Thorax 2016;**71**:875–876.

doi:10.1136/thoraxjnl-2016-208967

REFERENCES

1 American Cancer Society. *Cancer Facts & Figures 2015*. Atlanta: American Cancer Society, Inc, 2015:1.
2 International Agency for Research on Cancer. *GLOBOCAN 2012: Estimated Cancer Incidence, Mortality and Prevalence Worldwide in 2012. Lung Cancer*. World Health Organization International Agency for Research on Cancer, 2012.
3 Centers for Disease Control and Prevention. *CDC WONDER On-line Database*. National Center for Health Statistics, 2014.
4 Howlader N, Noone AM, Krapcho M, *et al*, eds. SEER Cancer Statistics Review, 1975–2011. Bethesda, MD: National Cancer Institute, 2014. http://seer.cancer.gov/csr/1975_2011/
5 Demark-Wahnefried W, Jones LW. Promoting a healthy lifestyle among cancer survivors. *Hematol Oncol Clin North Am* 2008;22:319–42, viii.
6 Pinto BM, Trunzo JJ. Health behaviors during and after a cancer diagnosis. *Cancer* 2005;104(Suppl 11):2614–23.
7 International Agency for Research on Cancer. *Outdoor air pollution. IARC monographs*. France: World Health Organization International Agency for Research on Cancer, 2015:1–449.
8 Hamra GB, Guha N, Cohen A, *et al*. Outdoor particulate matter exposure and lung cancer: a systematic review and meta-analysis. *Environ Health Perspect* 2014;122:906–11.
9 Chen H, Goldberg MS, Villeneuve PJ. A systematic review of the relation between long-term exposure to ambient air pollution and chronic diseases. *Rev Environ Health* 2008;23:243–97.
10 Eckel S, Cockburn M, Shu Y, *et al*. Air pollution affects lung cancer survival. *Thorax* 2016. doi:10.1136/thoraxjnl-2015-207927
11 Hu H, Dailey AB, Kan H, *et al*. The effect of atmospheric particulate matter on survival of breast cancer among US females. *Breast Cancer Res Treat* 2013;139:217–26.
12 Xu X, Ha S, Kan H, *et al*. Health effects of air pollution on length of respiratory cancer survival. *BMC Public Health* 2013;13:800.