Less clarity as the fog begins to lift

Anoop S V Shah, David E Newby

Epidemiological and clinical evidence accumulated over the last six decades has established a long-standing and close temporal relationship of air pollution with adverse health effects: from the extreme episodes of the Meuse Valley fog in 1930 and the London fog incident in 1952 to recent studies implicating ambient air pollution as a major perpetrator of adverse health effects. Globally, ambient particulate pollution is responsible for an estimated 3.2 million deaths worldwide, primarily driven by cardiovascular events.1

Several recent studies, using time-series and case-crossover study designs, have investigated the association of ambient air pollution and adverse cardiovascular events. Short-term exposure studies are more sensitive to daily fluctuations in outcomes and exposures (in this case pollutants), and allow greater control of potential temporal confounders providing a more accurate insight into the real impact of pollution on adverse health events. However, there still remains considerable variation in overall effect estimates reported in the literature due to various factors including heterogeneity in the underlying population studied, accurate measurement of the pollutants, analytical variation in terms of controlling for confounding and choice of lag (time interval between exposure and outcome) used for each pollutant.

Coronary heart disease, cerebrovascular disease and heart failure are the three most common causes of morbidity or mortality. In this issue of Heart, Milojevic and colleagues present a more contemporary analysis from three nationwide databases in the UK, on the short-term effects of air pollution on cardiovascular disease.2 The Myocardial Ischaemia National Audit Project (MINAP) database was used to identify all acute admissions for myocardial infarction ensuring accurate case definition and limiting classification bias. The authors have used two further large nationwide datasets to acquire hospital admission and mortality data likely to be representative of the general population. The authors report several important findings in these contemporary datasets. First, except for nitrogen dioxide, there was no clear evidence that short-term increases in air pollutants (lag 0–4 days) influenced overall cardiovascular or heart failure admissions. Second, the authors observed no clear association between ambient air pollutants and death or hospital admission with ST-elevation myocardial infarction, stroke or heart failure. Finally, even after stratification by shorter lags (lag 0–1 days), the overall association between air pollutants and cardiovascular morbidity and mortality remained largely unchanged. How do we interpret these new contemporary data in the light of previous work?

There are several important aspects that should be highlighted when evaluating these data. While the overall sizes of the three different datasets are large, some of the results were rather inconsistent and probably reflect the diverse reporting patterns, types of datasets and the mechanisms involved. For example, there was no association between nitrogen dioxide with cardiovascular mortality, but there was a positive association with cardiovascular admissions. Similarly, for fine particulate matter (PM$_{2.5}$), mortality from pulmonary embolism was increased but hospital admissions were reduced. This does seem rather inconsistent although, theoretically, this could in part be due to an increase in prehospital deaths leading to a reduction in hospitalisations. However, these data are at odds with previous analyses suggesting no association between air pollution and venous thromboembolism.3

There were some inconsistencies across the pollutants. While there were positive associations of cardiovascular morbidity with nitrogen dioxide, these were not seen with PM$_{2.5}$. Nitrogen dioxide and PM$_{2.5}$ are generated by similar and common combustion sources, primarily emissions from road traffic vehicles. Previous clinical and epidemiological studies have shown closely correlated and consistent effects of these two pollutants.4 5 This discrepancy may be explained by limitations in the assessment of exposure to particulates given the relatively low numbers of PM$_{2.5}$ monitors in the UK coupled with exposure misclassification, as roadside exposure may not equate to regional background measurements.

The authors argue that thrombotic pathways may be less important given the lack of association of gaseous and particulate pollution with stroke and ST-elevation myocardial infarction. However, they report a positive association with pulmonary embolism and also with non-ST-elevation myocardial infarction: both thrombotic conditions affecting the venous and arterial circulations, respectively. Patients with non-ST-elevation myocardial infarction are generally 10 years older than those suffering from ST-elevation myocardial infarction. The stronger association seen with non-ST-elevation myocardial infarction may therefore reflect prothrombotic effects of ambient air pollution in the elderly: an at-risk and potentially more susceptible population.

The data relating to atrial fibrillation and arrhythmias are challenging. There was a dramatic association between PM$_{2.5}$ and death, but no association with, or perhaps even an apparent trend to a reduction in, hospital admissions. This mirrors the data for pulmonary embolism, but the number of events was much smaller, the findings contrast with those of stroke, and it remains unclear how the association with atrial fibrillation led to death. As the authors discuss, this could be due to competing risks, but this is unlikely to be the sole explanation. Moreover, there were a surprisingly low number of sudden cardiac deaths in the reported datasets.

Experimental evidence suggests that the potential effects of inhaled ambient toxins, including particulates, are acute and immediate. Two large and global pooled analysis have further shown this epidemiologically for incident myocardial infarction, heart failure admissions and mortality (see figure 1).4 6 Furthermore, the strongest effect of gaseous and particulate pollution resulting in heart failure admission or mortality was seen immediately at lag 0 days, with marked attenuation at longer lag periods. Indeed, the authors’ own previous data suggested an association between incident myocardial infarction and ambient pollutant concentrations in the hours prior to the event.6 It may be possible that pollutant concentrations averaged over 48 h (lag 0–1) prior to the event, may be inappropriate in assessing the short-term effects of air pollution, and lacks the necessary temporal resolution. However, the current study demonstrates the challenges of trying to integrate diverse and complex datasets with remote pollution monitoring across national datasets using daily air pollutant averages.

It is important to note that in this study within the UK, the median PM$_{2.5}$ concentration was 10 µg/m$^3$ within a relatively
narrow range (IQR, 7–15 μg/m³). This contrasts with levels that are more than 10–20 times higher in many of the mega-cities across the world. Some have suggested that associations with adverse cardiovascular events persist even at low pollutant concentrations, but as air quality continues to improve, the adverse impact on health will decline. The current lack of consistent associations with contemporary UK data may suggest that as the fog begins to clear, the adverse health effects of air pollution are starting to have less of an impact and are more difficult to delineate.

**Funding** British Heart Foundation (CH/09/002, RG/10/9).

**Competing interests** None.

**Provenance and peer review** Commissioned; internally peer reviewed.

**To cite** Shah ASV, Newby DE. Heart Published Online First: [please include Day Month Year] doi:10.1136/heartjnl-2014-305877

Figure 1 Percentage increase in risk for incident myocardial infarction and heart failure admission or mortality with every 10 μg/m³ increment in particulate matter (PM2.5 and PM10). (Derived from pooled analysis by Mustačić et al4 and Shah et al5).
Less clarity as the fog begins to lift

Anoop S V Shah and David E Newby

Heart published online June 4, 2014
doi: 10.1136/heartjnl-2014-305877

Updated information and services can be found at:
http://heart.bmj.com/content/early/2014/04/29/heartjnl-2014-305877.full.html

These include:

Data Supplement
"Press release"
http://heart.bmj.com/content/suppl/2014/06/05/heartjnl-2014-305877.DC1.html

References
This article cites 5 articles, 1 of which can be accessed free at:
http://heart.bmj.com/content/early/2014/04/29/heartjnl-2014-305877.full.html#ref-list-1

Published online June 4, 2014 in advance of the print journal.

Email alerting service
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Notes

Advance online articles have been peer reviewed, accepted for publication, edited and typeset, but have not yet appeared in the paper journal. Advance online articles are citable and establish publication priority; they are indexed by PubMed from initial publication. Citations to Advance online articles must include the digital object identifier (DOIs) and date of initial publication.

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/