

# Air pollution and respiratory complications after cardiac surgery

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## Introduction

Air pollution is associated with short term morbidity (asthma and ischaemic heart disease), but also with longer term conditions of the respiratory, cardiovascular and the immune response. Air pollution, together with multiple genetic risk factors and modifiable lifestyle factors, including smoking, drinking alcohol, unhealthy diet, and physical inactivity, all interact to increase the risk of chronic respiratory susceptibility<sup>1</sup>. Small particles penetrate deeply into the respiratory system where they cause cytotoxicity, increasing the risk of respiratory infections and the development of reduced lung function and aggravation of existing pulmonary disease. Exposure to nitrogen dioxide has been associated with an increased risk of respiratory tract infections secondary to alterations in the immune system, direct irritation and inflammation<sup>2,3</sup>.

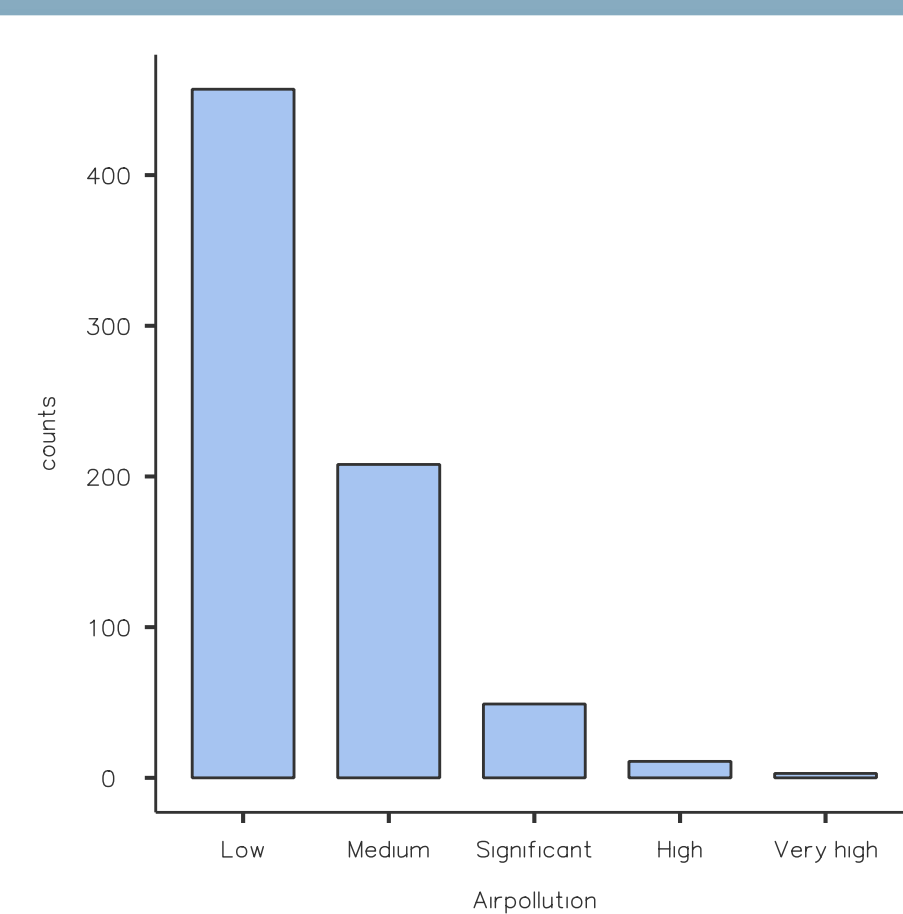


Fig 1. Chronic exposure of our patient cohort by national percentile to environmental pollution.

## Methodology

We investigated whether prior chronic exposure to environmental pollution was linked to short- and medium-term adverse respiratory outcomes after cardiac surgery.

We analysed the environmental exposure to 10 $\mu$ m and 2.5 $\mu$ m particles (PM<sub>10</sub> and PM<sub>2.5</sub>), and to NO<sub>2</sub>, based on the postal code, for 728 patients who had cardiac surgery over a 2-year period in a UK centre in South Wales. We adjusted for smoking history.

A Postoperative Pulmonary Complication (PPC) was considered positive if:  
Postoperative ventilation >48hrs  
Diagnosis of collapse/consolidation  
Escalation of antibiotic cover  
Positive bacteria, or candida in sputum

The primary outcome was compared between groups, either ranked by grade of pollution or absolute exposure to individual pollutants.

## Results

Overall exposure, by national percentile, of our cohort is shown in Fig 1. Only 8.7% of our cohort were considered to have chronic exposure to 'significant', 'high' or 'very high' levels. However, 26% of patients live in areas with concentrations higher than the WHO target for PM<sub>10</sub>, 35% above the target for NO<sub>2</sub>, and almost all (97%) are exposed to levels of PM<sub>2.5</sub> above the WHO target.

## Results..contd

A 'PPC' occurred in 221/728 (30%) of cases, but there was no association with national percentile of pollution (coefficient estimate 0.01 (SE=0.005) p=0.056), and was not different when adjusted for smokers.

PPC is associated with significantly worse survival. Fig 2.

Estimating fixed effects parameters show a significant difference in number of postoperative days requiring level 2 or 3 respiratory support between patients exposed to significant levels and those with low levels (Estimate: [2.8 days], p < 0.001, 95% CI: [1.3 - 4.2]).

Environmental exposure to PM<sub>10</sub> appeared to be correlated with a longer period of postoperative ventilation, an effect that disappears in current or ex-smokers.

Pneumonia was associated with chronic exposure to both PM<sub>10</sub> (RR = 1.09, 95% CI [0.998, 1.2], p = 0.039) and NO<sub>2</sub> (RR = 1.08, 95% CI [0.999, 1.16], p = 0.048) above WHO limits. However, the CIs includes the value 1 so we cannot be confident that the observed increase in risk is not due to random chance.

## Conclusion

Chronic exposure to significant levels of environmental pollution in patients presenting for cardiac surgery increases the duration of advanced respiratory support necessary postoperatively. Further work to identify a cohort of patients that might benefit from targeted respiratory prehabilitation, based on environmental pollution exposure, is necessary to reduce the burden of postoperative pulmonary complications.

## References

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- 2 Darrow LA, Klein M, Flanders WD, Mulholland JA, Tolbert PE, Strickland MJ. Air pollution and acute respiratory infections among children 0-4 years of age: an 18-year time-series study. *Am J Epidemiol* 2014; **180**: 968-77
- 3 Cui Z, Ma Y, Yu Y, et al. Short-term exposure to ambient fine particulate pollution aggravates ventilator-associated pneumonia in pediatric intensive care patients undergoing cardiovascular surgeries. *Environ Health* 2023; **22**: 39

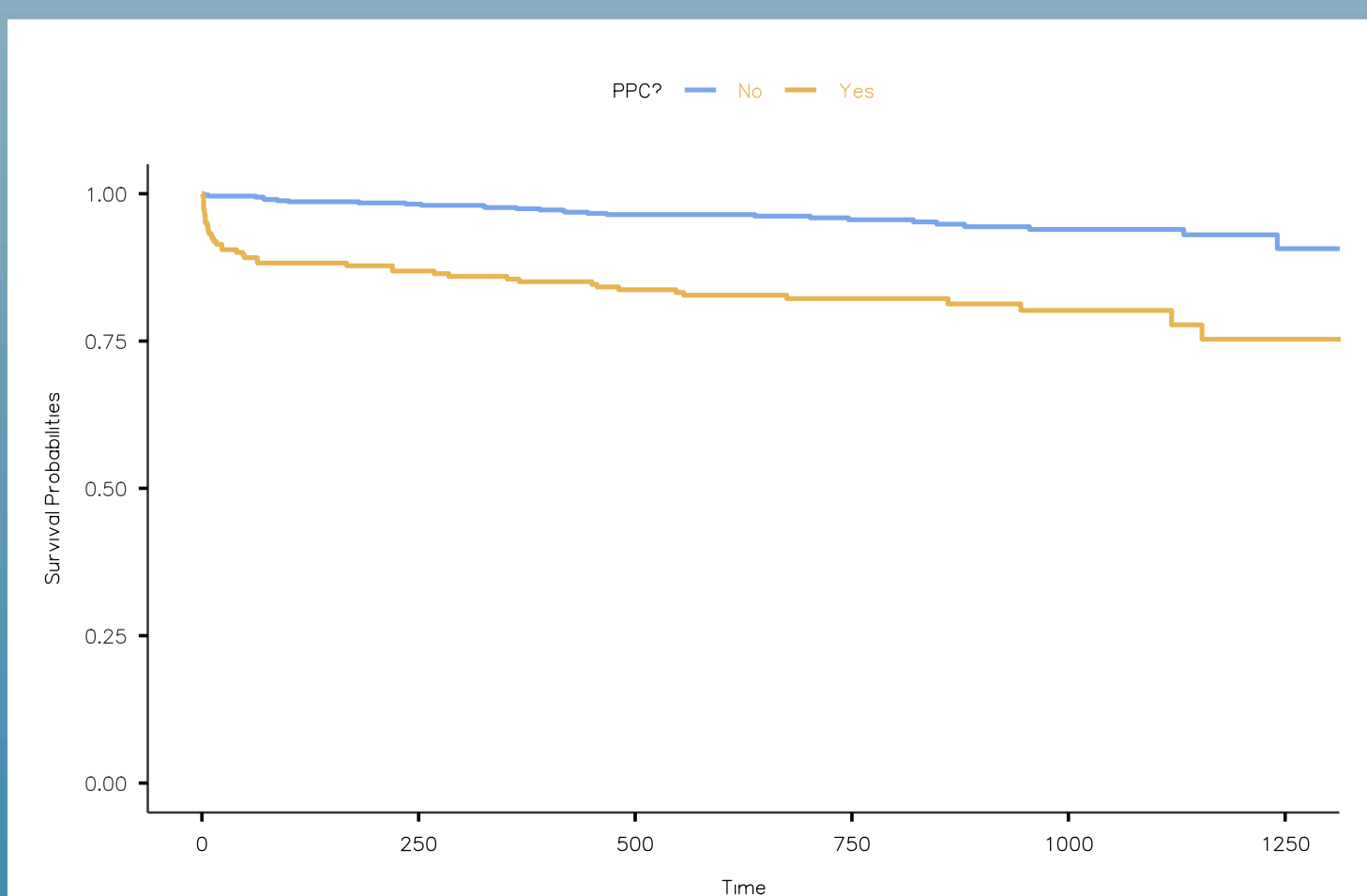


Fig 2. Survival curves, to 1250 days, for patients with, and without a PPC