Arsenic in urban air: sources, health risk and mitigation

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Abstract

Over recent years, several studies have suggested that high concentrations of arsenic may occur in outdoor air in urban areas of New Zealand on some winter nights. These spikes in arsenic concentrations are presumed to be caused by some householders burning copper-chrome-arsenate (CCA)-treated wood as a fuel for domestic home heating, but detailed examination of the issue has been lacking. The aims of this work are to examine the concentrations and source(s) of arsenic in ambient air in a representative New Zealand wood-burning community, identify and quantify potential health risks linked to both arsenic in air and the activity of burning CCA-treated wood, and undertake an initial exploration of social factors that may contribute to the issue. The town of Wainuiomata in the Wellington region was selected as the representative community.

Concentrations of total arsenic in Wainuiomata outdoor air were measured over two years, along with a number of other relevant variables useful for source characterisation, including two size fractions of particulate matter (PM_{10} and $PM_{2.5}$), black carbon and other trace elements. Over both years, concentrations of arsenic in Wainuiomata air were indistinguishable from the national ambient air quality guideline of 5.5 ng/m^3 expressed as an annual average. Arsenic levels were strongly seasonal and peaked during the winter months, but with significant variability from night to night. The highest 24-hour concentration recorded during winter was 79 ng/m^3. Results of correlation analysis and source attribution provide strong support for the idea that the principal source of elevated arsenic in outdoor air is the domestic burning of wood treated with CCA preservative.

A detailed exposure model was developed and applied to estimate and contextualise potential arsenic exposures that may be experienced by adults and children living in the community, and quantify relative health risks. Potential community health impacts are estimated not to be significant where exposure is limited to outdoor arsenic, including that which infiltrates into the indoor environment, where “not significant” is defined as an additional lifetime cancer risk of less than 1 in 100,000 and a hazard quotient less than 1. Annual average arsenic in outdoor air would need to be around

15 times higher than the guideline value to increase an individual's attributable lifetime cancer risk to 1 in 10,000.

Of more potential concern are health risks arising from indoor exposure for residents who use CCA-treated timber as supplementary firewood where this may lead to fugitive emissions of arsenic from the firebox into indoor air. Not only does the predicted excess lifetime cancer risk approach 7 in 100,000, but there are also non-cancer health risks to children due to short-term exposure to the relatively higher levels of arsenic during the winter months. Hazard quotients above 1 were found to potentially exist for a small number of children (4%) based on the likelihood of living in a home where CCA-treated timber might be burnt combined with the presence of at least one adult smoker. However, overall greatest potential for acute health risk for children was found to be posed by accidental or incidental ingestion of CCA-wood ash, which contains very high concentrations of arsenic.

Results of focus group sessions and community surveying provided useful contextual information about the source activity and identification of some potentially modifiable social factors, along with some understanding about why prohibition of the activity of burning CCA-treated wood may be ineffective. Findings included an upper estimate of the proportion of households that may burn CCA-treated timber (approximately 16%), and identification of the problem that most residents are not able to distinguish treated from untreated wood.

A number of recommendations are made. Despite the preliminary nature of the findings due to uncertainties in the modelling and toxicity reference values, it is recommended that efforts should be made to discourage the practice of CCA-wood burning as a precautionary measure to protect against inhalation exposure to indoor sources of arsenic and ingestion of contaminated ash by children. Community education initiatives would need to be developed from the perspective of local residents, most of whom cannot identify CCA-treated wood. It would be ideal if this were complemented with a high-level review of the policy and regulatory framework which permits the manufacture, use and disposal of CCA-treated wood in New Zealand, to determine where risks might be best managed.

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