Principles for setting air quality guidelines to protect human health in Australia

The current mechanism for setting air quality thresholds in Australia does not adequately protect community health

The current air quality framework to mitigate against the health effects of exposure to air pollution within Australia relies on national environmental protection standards — set out under the National Environmental Protection (Ambient Air Quality) Measure (the ambient air quality NEPM) — and the jurisdictional requirements for monitoring and reporting exceedances. The ambient air quality NEPM sets reportable limits for key criteria air pollutants. Criteria air pollutants are those that are legislated internationally as measures of air quality and include particulate matter (PM), nitrogen dioxide (NO₂), carbon monoxide, ozone, sulfur dioxide (SO₂) and lead (Box). Air toxics are non-criteria air pollutants that are considered to pose a hazard to human health. Air toxics are legislated under a separate NEPM which has the goal of generating baseline data for later development of standards for five compounds: benzene, benzo(a)pyrene, formaldehyde, toluene and xylenes. The air toxics standards, based on the gathered baseline data, were due to be set in 2012 but are yet to be reviewed.

In 2011, the National Environment Protection Council published guidelines for setting air quality standards. These guidelines outline a method that balances risk assessment (health effects based on the exposure–response relationship) with the costs of abatement strategies to achieve the required targets. The process for updating the ambient air quality NEPM based on new evidence about the health effects of criteria air pollutants is slow. Since the publication of these guidelines, there has only been one formal change to the NEPM, which was approved in 2016. This variation focused on modifications to the measures related to PM₁₀ and PM₂.₅ (PM ≤ 10 μm and ≤ 2.5 μm in aerodynamic diameter, respectively), as it was thought that the potential benefits to human health, and the available abatement strategies, were greater than those for other criteria pollutants.

The variation included, among other measures, the introduction of an annual average for PM₁₀ and progress towards the introduction of a PM₂.₅ standard. The national standards for gaseous pollutants are currently under review. Moreover, the catastrophic 2019–20 bushfires have highlighted the importance of air quality for many Australians. It is therefore timely to consider the current ambient air quality standards and whether they are fit for purpose. We focus on the criteria air pollutants as these are the only air pollutants currently covered by legislation that attempts to enforce maximum exposure limits.

Criteria air pollutants — are there safe limits?

Particulate pollutants

Air pollution is composed of a complex mixture of solid, liquid and gaseous molecules. Airborne PM is comprised of solid and liquid particles suspended in the air that vary in size and chemical composition. PM is generated from a range of sources including combustion, plant materials, sea salt and earth-derived inorganic compounds.

PM₁₀ is small enough to bypass the upper airways and lodge in the conducting airways, but is usually too large to reach the alveoli. Acute exposure to PM₁₀ is associated with hospitalisations and mortality for cardiorespiratory conditions, while long term exposure is linked to chronic cardiorespiratory conditions and metabolic disorders. No safe threshold for PM₁₀ exposure has been identified. PM₂.₅ can penetrate deeper into the lungs and is one of the leading causes of global mortality and morbidity. PM₂.₅ has been linked to cardiovascular disease, respiratory disease, pre-term birth, metabolic disorders and neurological health problems. Like PM₁₀, there is no evidence for a safe threshold for PM₂.₅ exposure. This has been highlighted in Australian studies, where PM₂.₅ is typically low, showing associations between exposure to PM₂.₅ and mortality. Consistent with this, there is evidence that the exposure–response relationship is steeper at lower PM₂.₅ concentrations.

Gaseous pollutants

Of the gaseous air pollutants, data are most extensive for NO₂, a combustion by-product. Studies on the health effects of low concentrations of NO₂ have shown associations between NO₂ and childhood pneumonia and otitis media and impaired lung function. While data on the exposure–response relationship suggest that there is an effect threshold, it is three to five times lower than the current NO₂ standard (Box). Data on the magnitude of the health effects of SO₂, a combustion product primarily related to sulfur-containing fuels, are less extensive. While there is an established relationship between exposure to SO₂ and cardiorespiratory mortality, data are not robust enough to determine whether there is a health effect threshold. Similarly, while carbon monoxide has a range of physiological effects on the body, the co-existence of carbon monoxide with other criteria pollutants makes it difficult to disentangle the contribution of this pollutant to the health effects of pollution in general.
Acute exposure to ozone, a by-product of interactions between combustion emissions and sunlight, is strongly linked to respiratory hospitalisations; however, consensus regarding a threshold for these health effects is contentious.18

Lead pollutants
The teratogenic and neurological health effects of lead are well established and there is no safe level of exposure.4 While overall community exposure to lead has decreased with the elimination of tetraethyl lead from fuels, there are still some communities in Australia exposed to anthropogenic sources of lead.

Summary
Collectively, there is sufficient evidence to conclude that there is no safe threshold for exposure to PM10, PM2.5 or lead. For NO2, there is a threshold, but the current NEPM standard is well above this level.1 On this basis, the current standards are not sufficient to adequately protect the health of the Australian community (Box).

Principles for setting air quality guidelines in Australia
In Australia, the background concentrations of air pollution in most areas are relatively low compared with other countries around the world.19 To a certain extent, it is likely that this observation influences current policies regarding ambient air quality standard setting, which aim to identify a threshold concentration where the health risks are balanced against the feasibility of achieving these thresholds. Unfortunately, this puts regulators in a position of balancing the costs of expanding infrastructure against the benefits to human health, as the existing monitoring network, which assesses adherence to the standards, does not have sufficient coverage to generate data with enough accuracy to monitor exceedances.20

The adverse health effects of the NEPM criteria pollutants are well established. For many (eg, PM2.5), there is sufficient evidence, both from our review and expert consensus, that it is not possible to set a threshold as health effects can be detected even at low exposure doses, whereas for others, the threshold is well below the current NEPM standard (eg, NO2). The current approach to regulation of air pollution implies a causal model that is inconsistent with the available evidence. It provides no incentive for reducing exposure and allows increases in exposure to harmful pollutants, as long as the levels remain below the thresholds. This provides only partial health protection and adversely impacts community perceptions by implying that the current standards represent a “safe” level of exposure. It also relies on an accurate and comprehensive network for monitoring exceedances, which is lacking in many Australian jurisdictions, and appropriate mechanisms to ensure implementation of the measures, including appropriate penalties if standards are not met.

We believe this approach must be replaced by regulation focused on harm minimisation using the principle of continual improvement; similar to the approach recently adopted by the European Union where targets for PM2.5 are set for percentage reductions in levels within a given time frame.21 This would drive better practice in air quality management and encourage implementation of strategies that improve ambient air quality and health for all Australians by reducing existing levels of exposure and discouraging new increases in exposure, regardless of the current levels.

The concept of “no safe limit” was raised in independent commissioned reports20.22 provided
before the most recent NEPM variation to guide the decision-making process. The concept of an exposure reduction framework was also raised at that time and included in the impact statement prepared for the National Environment Protection Council outlining the case for the NEPM variation. It was argued that the introduction of an exposure reduction framework was necessary because there was no evidence for a threshold for the health effects of exposure to PM and, in contrast to the existing NEPM approach, it would maximise the community level health benefits.

Unfortunately, it seems that this approach was dismissed because of concerns regarding the ability to monitor overall reductions in PM, due to inadequate monitoring infrastructure across the country, and whether reductions could actually be achieved. This seems to ignore the intent of such a framework — it is not about setting targets, it is about driving behaviour and promoting best practice.

Reassuringly, the most recent impact statement prepared for the National Environment Protection Council for the revision of the standards for gaseous pollutants recommends changing the NEPM to make reference to minimising the health effects of exposures and “incorporation of exposure–reduction targets”. We endorse this approach. However, the recommended measures for gaseous pollutants still seem to rely on specifying a standard in the future, albeit a lower one, as part of an exposure–reduction framework, rather than proposing goals for continual reduction. In the absence of a mechanism to promote continual improvement and best practice by regulators and industry, we are failing to adequately protect the Australian community from the health impacts of air pollution.

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