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Eliminating Childhood Lead Toxicity in Australia: A Little is Still Too Much. Macquarie University Lead Forum 5th July 2012.

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Background

The experience of people in the modern world with lead is one of poorly considered impacts, extensive and poorly controlled exposures, and poorly characterised environmental and human impacts.[i,ii,iii]

Over one hundred years ago, in 1904, the Scottish born Australian physician J Lockhart Gibson was among the first English-language authors to directly link lead-based paint to childhood lead poisoning, specifically noting the dangers to children from painted walls and verandas of houses in Queensland.[iv]

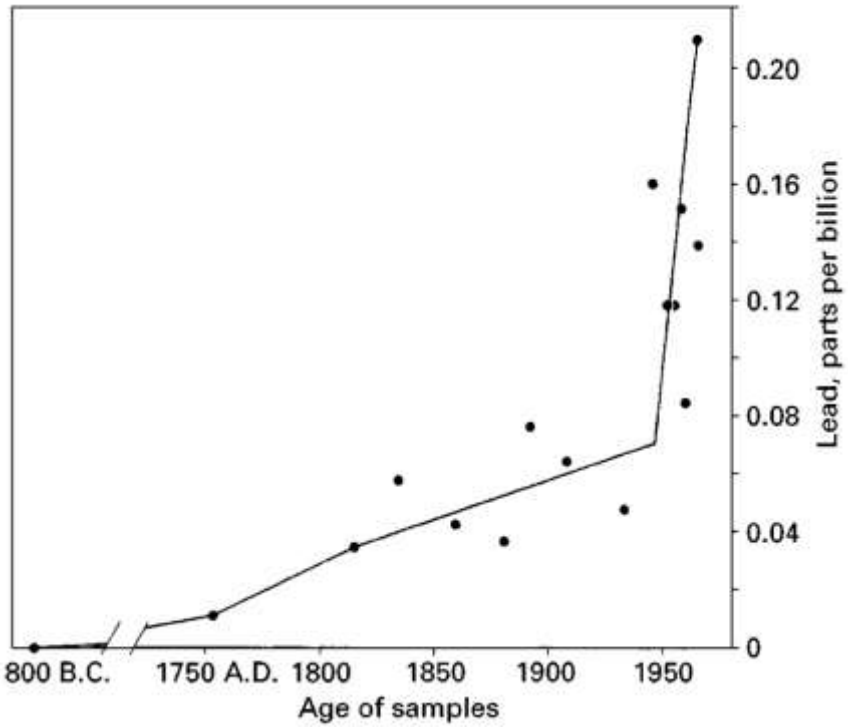
In 1909, another physician working in Australia, Dr Alfred Jefferis Turner, was the first to suggest that preventive approaches that identify, and then remove exposures to lead offered the most effective way to protect children from the effects of lead.[v]

Environmental Accumulation of Lead

Throughout the twentieth Century, exposures increased, but the views of public health and environmental professionals (including Gibson and Turner) that lead was damaging the health of adults, but more particularly children, were largely ignored.

In 1969, work by Clare Patterson and colleagues suggested that environmental lead levels had increased since Roman times, increasing gradually from the start of the industrial revolution, and increasing exponentially since the introduction of lead in petrol (until at least the 1970s). Figure 1 shows data from analysis of snow cores from Greenland.

Figure 1: Lead Contamination of Greenland Snow Cores

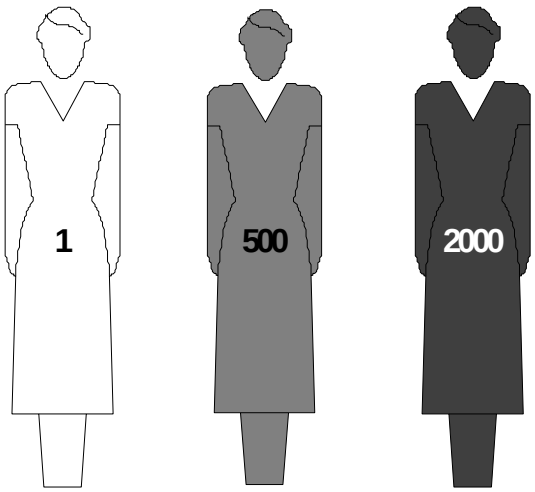


Reproduced from: Murozumi et al, 1969[vi]

From this, Patterson suggested current lead loads in humans, while not necessarily dangerous, were in fact orders of magnitude higher than our prehistoric ancestors.[vi]

Figure 2, presents the view that modern day human lead burdens were already sufficiently high to suggest the margin of safety from "normal" to toxic levels was very small.

Figure 2: Comparison of Relative Amounts of Lead in People



Modified from: Ericson et al, 1979[vii]

The amount of lead found in prehistoric Peruvians is shown in the first figure, represented as 1.

The amount of lead found in Americans at the end of the twentieth century is shown in the second figure, represented as 500.

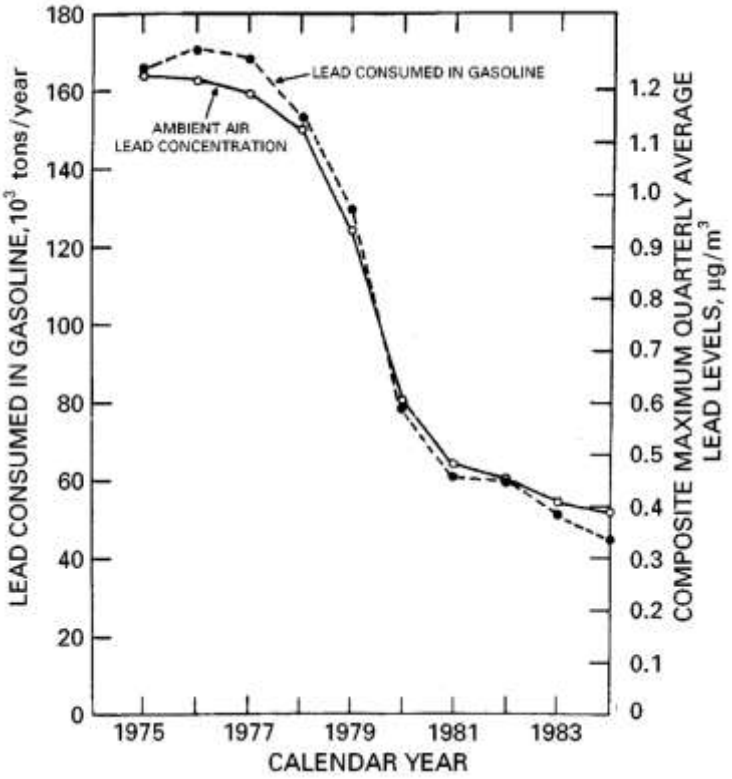
The amount of lead that represents the minimum amount of lead that will cause classical lead poisoning in a significant amount is a group of people is shown in the third figure, represented as 2000.

The margin of safety between the second and the third figure is not large, in conventional toxicological terms.

Modern humans had body lead loads hundreds of times higher than their forebears, perhaps showing subclinical toxic effects across an entire population.

The USA moved to remove lead from petrol in 1972. Lead levels in air fell from 1.2 µg/m^3 in 1975 to 0.4 µg/m^3 in 1984, following closely the fall in consumption of lead in petrol (see Figure 3 below).

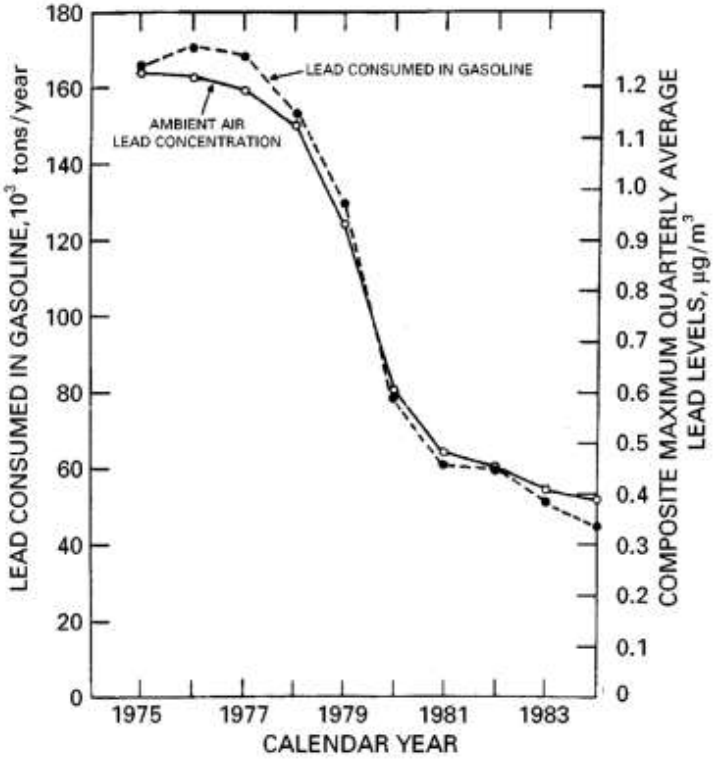
Figure 3: Relationship between Lead in Petrol Consumption and Lead in Air



Reproduced from: US EPA, 1986[i]

Further, the decrease was mirrored by a decline in population blood leads from about 16 µg/dL in 1976, to below 10 µg/dL in 1980 (see Figure 4 below).

Figure 4: Relationship between Lead in Petrol Consumption and Lead in Blood



Reproduced from: US EPA, 1986[i]

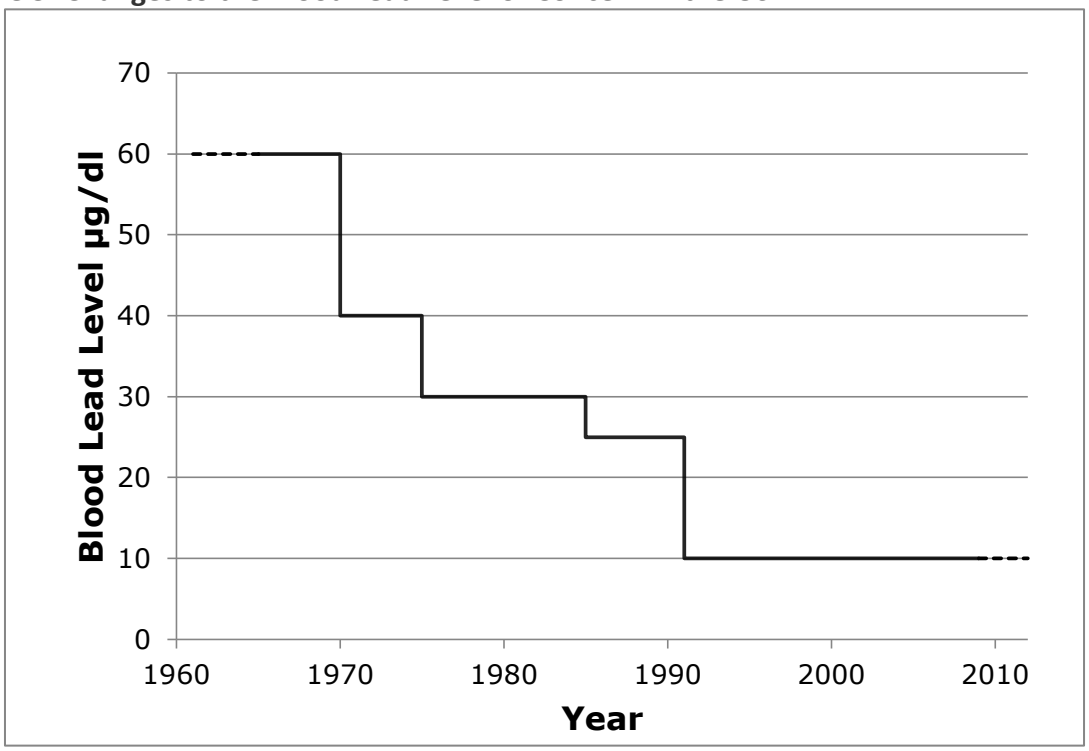
Population blood levels continued to fall in the USA. By 1990, median US population blood levels were down to 2.8 µg/dL.[viii]

Leaded petrol marketed by the Commonwealth Oil Refineries was being sold in Australia from at least August 1932.[ix] In 1985, changes to Australian Design Rules for catalytic converters to be included in motor vehicles were introduced. Lead free petrol was available from then, but the availability of leaded petrol continued to 2002.

Development of the Pediatric "Level of Concern"

As evidence increased from multiple studies showing loss of mental capacity in children, even when no pathology was observed, the concept of a "level of concern" for lead exposure in poisoned children emerged. This level was one that pediatricians could use for establishing priorities and interventions for the lead poisoned child. In about 1960, Health agencies in Europe and the USA set, and then lowered, this level of concern from 60 µg/dL, to 40 µg/dL (in 1971), to 30 µg/dL in 1985, and lastly, to 10 µg/dL in 1991 (see Figure 5).[x,xi,xii]

Figure 5: Changes to the Blood Lead Level of Concern in the USA



In 1979, a breakthrough study by Herb Needleman and colleagues related lead in children's teeth to diminished mental capacity.[xiii] Epidemiological evidence demonstrating adverse effects of lead on children's neurodevelopment, including reduced IQ scores and learning difficulties, at lower and lower exposures accumulated throughout the 1970s, 1980s and 1990s.

In 1992, at an International Conference held in Melbourne, discussions around the nature of the level of concern and its move from a blood lead number that related to a pediatric emergency, to considerations emerged that a means of managing a public health risk was needed.[xiv] At the time, one of the reasons that 10 µg/dL was retained as a criterion for lead exposure, was not because it was a safe level, or even because it was the upper limit of normal, but because it was recognised that the psychological tools available at the time were too crude to measure functional neuropsychological deficits in young children with any degree of accuracy.

Notwithstanding these difficulties, agencies such as the US CDC[xv] and the NHMRC[xvi] continued to issue guidance to health professionals about what should be done when confronted with a child with elevated lead exposure. These agencies suggested that a blood level of 10 µg/dL should be used as a level above which levels are regarded as elevated, and that investigation or intervention is recommended.

What should now be done?

That was over twenty years ago. Since then, more and more studies have shown that blood lead levels below 10 µg/dL harm children.[xvii] Furthermore, these affects are not just seen in intelligence, but also cardiovascular, immunological and endocrine effects. Additionally, at least some of these impacts are irreversible. It also appears that such effects do not appear to be confined to children of lower socioeconomic status.

What perhaps is less well known is that evidence is also emerging to indicate that lead may also be affecting the cardiovascular, renal, reproductive health and cognitive function of adults at levels lower than previously considered, and in some cases below 10 µg/dl.[xviii] Some of these findings support the possible persistence of lead induced effects in childhood into adulthood.[xix,xx]

So, the idea of a "level of concern" is becoming obsolete, except for action in clinical cases.

In 2010, the German Federal Environment Agency moved to the term "reference value" and set its value based on the 95th percentile of blood lead levels from national blood lead surveys as their new trigger levels for action,[xxi] arriving at:

- 3.5 µg/dL for children;
- 7 µg/dL for women;
- 9 µg/dL for men.

In the US, in November 2011, the National Toxicology Program published a draft monograph on Health Effects of Low Level Lead,[xxii] which reported that "there is sufficient evidence for adverse health effects in children and adults at blood Pb [lead] levels below 10 µg/dL [micrograms per deciliter] and below 5 µg/dL as well." These health effects included adverse associations for cardiovascular, renal and immune health outcomes.

In January 2012, a report of the CDC Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP), made a recommendation (subsequently accepted by the US CDC), that the term "level of concern" be eliminated.[xvii] The ACCLPP also recommended that a reference value of 5 µg/dL be used to identify children who have an elevated blood lead level, based on the 97.5 percentile for children aged 1-5.[xvii] This level should trigger lead education, parental advice on nutrition, environmental investigations, and if warranted, additional health surveillance. In Australia, the NHMRC are investigating this issue.

The focus now should be on identifying sources, assessing risks and eliminating exposures, with the fundamental aim of primary prevention as now noted by such agencies as the World Health Organisation (WHO) and US CDC.[xvii,xxiii]

The history of advances in the understanding of the toxic effects of lead over the past thirty years is an outstanding example of how knowledge learned from research can impact in public health. Measures that have had the greatest impact on reducing exposure to lead have been reduction of lead from petrol, elimination of lead solder from canned food, removal of lead from paint, and abatement of housing containing degrading lead-based paint.[xxiv,xxv] Those countries where these initiatives have been implemented have seen exposures and body burdens of lead decrease.[i]

In order to continue to sustain national and international efforts to manage the health risks of lead to children, a lead risk management approach should be taken to:

Consult and communicate

1. Community groups where lead risks exist should be informed and engaged so that they are part of the risk management solution, otherwise lead risk management is unlikely to be successfully implemented.

2. Wherever possible, such lead risk reduction activities should be part of an international coordinated effort that fosters networks for information exchange and development of consistent, harmonised policies and programs that will continue the effort to alleviate the effects of lead in childhood and throughout life.

Identify the lead risk

3. The usefulness of a level of concern for lead risk management is obsolete, and it should be phased out as a measure of lead risk, except for action in clinical cases of lead intoxication.
4. Government health agencies should:
    - review new data that shows health problems in children occurring at lower blood leads than before;
    - consider assessing lead levels in children through a national survey that will provide representative data that will better establish the blood lead distribution in Australia;
    - use such a review and survey to develop a new reference level or blood lead index for action in lead risk management.

5. Government environment agencies should review new data on environmental impacts with a view to reducing standards and protocol for measuring lead in the environment.

6. Government occupational health agencies should review new data that shows health problems in adults occurring at lower blood leads than before, with a view to a revision of lead exposure limits in the workplace.

7. Evidence based models for lead reduction, coupled to economic modelling to determine the costs/benefits of intervention, should be conducted, so that any benefits of lead measurement activities can be contextualised. Otherwise improvements to standards may be difficult to implement. This should be conducted in Australia under Australian conditions of costs, structures and so on.

Assess the lead risk

8. Where existing sources of lead pollution exist:
    - Governments need to fill any void created by re-location or loss of industry where necessary;
    - The usefulness of interventions, such as information dissemination, education programs on lead abatement, nutrition and so forth, should be properly evaluated.

9. Where new potential sources of lead pollution are proposed there needs to be sufficient geographic separation, unlike the co-location of many existing mining and smelting industries and communities in the past.

10. Where existing mines or industries using lead exist:
    - standards for control of lead exposure or for lead emissions should be reviewed;
    - better technology improvements at source are required.

Control the lead risk

11. Wherever possible, all industrial and commercial uses of lead should be eliminated.

12. Where elimination of lead risks is not possible, these uses and the exposures they generate, must be controlled to a level as low as reasonably practicable.

13. The term "level of concern" should be eliminated or restricted for use in emergency cases of lead poisoning.

14. A need still exists for a reference level or blood lead index for action.

15. A reference value of 5 µg/dL should be adopted within Australia to identify children and adults who have an elevated blood lead level or who have a lead risk.

16. This level should trigger medical, paediatric, public health, environmental, and other agencies to better manage the lead risk through a national blood lead survey of all ages, lead education and awareness-raising on lead risks and lead abatement, parental advice on nutrition, environmental investigations, and additional health surveillance.

17. Doctors and allied health professionals should be educated about the effects of lower levels lead exposure on children.

18. Where they are reviewed and revised, all relevant standards should be consistent with each other in such a way that efforts to reduce lead exposure are consistent.

It remains generally acknowledged that there is no safe level of exposure to lead. Therefore, the lower the level, the better it will be for everyone.

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[xxii] **NTP Monograph on Health Effects of Low-level Lead (June 2012 prepublication copy)**

- NTP Monograph on Health Effects of Low-level Lead (2.1 MB) (without appendices)
- Appendices A – E: Human Studies Considered in Developing Conclusions (4 MB) (single file with all appendices)

Individual Appendix files

- Appendix A: Human Studies of Neurological Effects of Lead Considered in Developing Conclusions (1.6 MB)
- Appendix B: Human Studies of Immune Effects of Lead Considered in Developing Conclusions (618KB)
- Appendix C: Human Studies of Cardiovascular Effects of Lead Considered in Developing Conclusions (827 KB)
- Appendix D: Human Studies of Renal Effects of Lead Considered in Developing Conclusions (397 KB)
- Appendix E: Human Studies of Reproductive and Developmental Effects of Lead Considered in Developing Conclusions (1.5 MB)

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