The Lead Education and Abatement Design Group
Working to eliminate lead poisoning globally and to protect the environment from lead in all its uses: past, current and new uses
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Background to the Model Australian Public Health Policy on Lead

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This document provides the weight of evidence to support The LEAD Group's proposed policy for adoption by the National Health and Medical Research Council (NHMRC). It contains background material to support proposals in the Model Policy. DATE: 3rd December 2010.

Introduction

The Model Australian Public Health Policy on Lead, was written for the Health Ministers of Australia's National Government and State and Territory Governments, by The LEAD Group Inc, an Australian Health Promotion Charity.

The proposals for policy are numbered and in bold type.

1. Adopt Germany's approach (world's best practice) to setting individual action levels within sub-populations, for blood lead.

The German policy paper by Wilhelm et al (2010), "Reassessment of critical lead effects by the German Human Biomonitoring Commission results in suspension of the human biomonitoring values (HBM I and HBM II) for lead in blood of children and adults", written on behalf of the Human Biomonitoring Commission of the German Federal Environment Agency, replaces their 1996 health-based blood lead levels of concern / "goals" with individual action levels (called "reference values" in Germany) which differ for each sub-population, and are based on the 95th percentile blood lead result in a blood lead survey for that sub-population. Wilhelm et al state that:

> *Based on the results of the German Environmental Survey for Children 2003/2006 (GerES IV), the HBM Commission has updated the reference values for blood lead levels for the group of children (Schulz et al 2009):*
>
> *Children (3–14 years of age): 35 µg Pb/l blood [equivalent to 3.5 µg/dL].*
>
> *The reference values for adults (Schulz et al 2007), which are based on data from the German Environmental Survey of 1998, are:*
>
> *Men: 90 µg Pb/l blood [9.0 µg/dL].*
>
> *Women: 70 µg Pb/l blood [7.0 µg/dL].*

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According to Schulz et al (2009):

> *Reference values are statistically derived values that indicate the upper margin of background exposure to a given pollutant in a given population at a given time. They can be used as criteria to classify the measured values of individuals or population groups as being "elevated" or "not elevated".*

In addition to the reference values obtained from blood lead surveys, the Germans had set human biomonitoring (HBM) values for lead in 1996 and reviewed and retained them in 2002: the HBM is the concentration of a substance or its metabolites corresponding to tolerable intake doses:

> *Two levels are defined: HBM I and HBM II. In 1996, the Commission set a HBM I of 100 µg/l [10 µg/dL] for lead in blood of children ≤12 years and females of a reproductive age and a HBM I of 150 µg/l [15 µg/dL] for the other persons* (Wilhelm et al 2010).

At the HBM I level, the action previously recommended was to re-test to confirm the blood lead level, then search for sources and eliminate or minimise lead exposure from those sources. (Umweltbundesamt, 2009)

> *The HBM II value represents the concentration of a substance in human biological material above which – according to the knowledge and judgement of the commission and with regard to the substance under consideration – there is an increased risk for adverse health effects and, consequently, an urgent need to reduce exposure and to provide individual biomedical care (advice).* (Schulz et al 2007)

In 2002 the HBM II of 150 µg/l [15 µg/dL] for lead in blood of children ≤12 years and females of a reproductive age and a HBM II of 250 µg/l [25 µg/dL] for the other persons were confirmed by the Commission (Schulz et al 2009).

In April 2010, the German public health policy changed, such that, instead of recommending action at the previous HBM blood lead levels, they make practical recommendations for when an individual exceeds their sub-population's reference value, which include:

> *Levels above the background level (greater than reference values) must be assumed to come from a specific source. For reasons of anticipatory health protection, such elevated exposure is undesirable.*

The Commission recommends using the relevant population reference value as concentration above which there is a need for action (in line with "level of concern" of the US Centers for Disease Control and Prevention, 2009). These values should be understood as precautionary action values above which exposure abatement measures as demanded by the minimisation principle are appropriate and effective, taking into account their proportionality.

> *The following measures are recommended:*

- *repeat analysis (to validate the result),*

- *informing about the exceedance and anamnestic* [defined below] *search for its source (hobbies, lead containing paints, ceramics with prohibited lead glaze, e.g. in imported products),*
- *inspecting the drinking water distribution system and exchanging lead pipes if necessary,*
- *informing the persons affected about 'simple' minimisation measures within their immediate environment,*
- *repeat analysis after some time (after >3 months to monitor effectiveness of exposure abatement measures, trend analysis).*

The urgency with which measures should be performed depends on the blood lead concentration.

According to Wikipedia (2010a), "the **medical history** or **anamnesis**[1][2] (abbr. *Hx*) of a patient is information gained by a physician by asking specific questions, either of the patient or of other people who know the person and can give suitable information (in this case, it is sometimes called **heteroanamnesis**), with the aim of obtaining information useful in formulating a diagnosis and providing medical care to the patient. The medically relevant complaints reported by the patient or others familiar with the patient are referred to as symptoms, in contrast with clinical signs, which are ascertained by direct examination on the part of medical personnel."

2. Develop and implement a national blood lead survey of all ages, to definitively establish who is at risk and what are the most common and most concerning sources and pathways of lead exposure in Australia. Base a review of the National Health and Medical Research Council's (NHMRC) 2009 goal on the survey results.

Developing a national lead survey must involve a study of the entire population, covering all ages and sub-populations most at risk of exposure and adverse health effects. The NHMRC 'Blood Lead Levels for Australians Information Paper for Practitioners and Policy Makers 2009' still states 10 micrograms per decilitre (µg/dL) of blood as their recommendation for the Australian blood lead level (NHMRC, 2009). The NHMRC originally set this target in 1993 and it has not been reviewed since, nor tested under any national survey of blood lead levels of all ages. The last national blood lead survey was the 'National Survey of Lead in Children' by the NHMRC in 1995 (Donovan, 1996). This survey only tested children 1-4 years old, as the major concern at this time was focused at new research into the adverse health risks on children and their development.

The LEAD Group Inc. strongly believes that the current recommendation of 10 µg/dL for Australia's blood lead level is too high and a National Survey would result in accurate blood lead action levels which would form the basis for setting new targets for each sub-population, to achieve which would require reducing lead poisoning. A review of lead action levels is important because Australia is the global leader and largest exporter of lead (Geoscience Australia, 2010).

3. Plan and carry out a National All-Ages Survey to test lead in the Blood of representative samples* of all Australian adult and child sub-populations. The following identified high-risk sub-group's within the sub-populations require

over-sampling to allow for statistically significant findings: Aboriginals and Torres Strait Islanders, people living in older housing, people undergoing renovations on housing built pre 1970, people dependent on rainwater for drinking water, lead mining and smelting community residents, smokers, passive smokers, ex-smokers, alcoholics, people taking Ayurvedic medicines or Chinese herbal medicines, people suffering from hypertension, osteoporosis, learning difficulties, developmental delay, autism, pica (eating non-food items such as soil or plastics), cataracts or Alzheimers, hobbyists such as backyard car-repairers, renovators, jewellery-makers, fishing sinker or ammunition casters, ceramicists, artist painters, lead workers and ex-lead-workers, etc.

* A representative sample is a small number (big enough to obtain statistically significant results) of the targeted sub-population, as listed above whose characteristics represent (as accurately as possible) the entire population.

High-risk sub-group's within each of the sub-populations are the groups of people within the Australian population who present an increased risk to lead exposure.

Housing built in Australia before 1970 is likely to contain paint with a high level of lead. There are over 3.5 million homes in Australia built before 1970. The recommended amount of lead in domestic paint has declined from 50% before 1965, to 1% in 1970. In 1992, it was reduced to 0.25%, and in 1997 it was further reduced to 0.1% (Department of the Environment, Water, Heritage and the Arts 2009).

This evidence, therefore, places people living in housing built before 1970 and building contractors and occupants associated with housing undergoing renovations or demolition as a significant sub-group for blood lead testing as they have an elevated risk of lead exposure (Calvert, 2010).

Lead mining and smelting community residents are the most obvious sub-group at risk of increased blood lead levels, as their residential and occupational proximity to large sources of lead is increased. A recent survey in Mount Isa by Queensland Health (2008) found that 11% of children surveyed had blood lead concentrations in excess of 10 μg/dL. This level is above the current NHMRC recommendation of 10 μg/dL, which indicates that priority must be given to children and communities within present and former lead mining towns. This study only noted children's blood lead levels, but an adult working in these conditions is likely to have increased or high blood lead levels as well. Occupational exposure increases the contact with lead, as well as being a resident in a mining community. The National Survey should involve an over-sampling of the population within this group, as they are exposed to higher ambient levels: to lead within water supplies, in soil and in dust from the emissions.

The older populations within Australia exhibit health conditions, which have resulted from exposure to lead in their lifetime. This is especially due to the longer exposure to lead- based paints and leaded petrol. Elevated blood lead levels and ageing are linked with the emergence and exacerbation of health conditions. Contrasting with the ageing population is the importance of surveying blood lead levels in young children. The link between children and elevated blood lead levels contributes to intellectual deficits, school failure and behavioral problems such as delinquency and attention hyperactivity deficit disorder (Dayton, 2009).

Within Australia a keen interest in using Chinese herbal medicines and Ayurvedic medicines has emerged as a result of a diverse and multicultural population. The concern of this sub-group is the high lead levels sometimes found in imported herbal preparations. Current Australian policy does not require testing on imported Ayruvedic medicines or Chinese medicines, only on exported products. Recently this sub-group has gained recognition as potentially having elevated blood lead levels, after a media report from New South Wales (NSW) Health regarding the poisoning of a user (NSW Health, 2010). As Ayurvedic medicine and Chinese medicines are easily obtainable over the internet or by asking contacts overseas to purchase them and post them, and the potential for contamination is high, this sub-group must be included in over-sampling within the National Blood Lead Level Survey.

4. Based on the results of the survey, identify individuals and groups with elevated blood lead levels (i.e. above the 95th percentile), and implement relevant legislative changes and education programs for doctors and the public within those sub-populations and sub-groups, and fund ongoing monitoring programs consisting of regular follow up surveys to determine the success of the interventions. In each repeat of the national blood lead survey of all ages, use isotopic fingerprinting* to identify the sources of lead exposure in the 5% of the study population with the highest blood lead levels.

* Isotopic fingerprinting is an expensive technique used to identify the original mine source and pathways of lead found in the blood.

Identifying individuals and groups with elevated blood lead levels from the results of the survey will be guided by calculation of the 95th percentile within each sub-population as outlined in policy point 3. Geographic location, age, sex, occupation and medical history will allow relevant intervention and education for people identified with elevated blood lead levels. These elevated blood lead levels will be established after setting an action level based on the 95th percentile of the population. The results will document sub-groups in which blood lead levels are likely to be elevated and allows further research into the conditions in which increased exposure has occurred. Education directed at individuals or groups experiencing lead exposure will empower people to discover the sources of lead, test surfaces and change behaviours towards decreasing the blood lead level. Education for doctors is beneficial as they can pass on their knowledge to their patients and also inquire about risk-factors and recognise symptoms and behavioural outcomes when a patient presents to them. Education on the prevention of lead poisoning and absorption in everyday life is one step better than the current initiative to promote practices such as washing children's hands frequently.

Isotopic fingerprinting should be adopted as an alternative technique to environmental databases and human subjects to identify lead sources. Its success has been noted in China where they are undertaking rapid industrial change in urban areas (Cheng and Hu 2010). Sources of lead from the contaminated site can be identified by mapping the isotopic composition of the soil and comparing it to the isotopic fingerprinting for resemblance (Torres et al 2004). It is a costly process but one which must be used on a needs basis.

5. Set new National Health and Medical Research Council (NHMRC) national blood lead targets* and action levels according to the 95th percentile (the blood lead level that 95% of the population is already below) for the survey results within each sub-population: Foetal (via the umbilical cord), pre-crawling babies and 4-8 month old children in lead mining and smelting towns; 9 month to 5

year olds; 6-17 year olds; men and women born after the peak in the use of lead in petrol (1985); men and women born before the peak in the use of lead in petrol in Australia; post-menopausal women, retired men.

* A target blood lead level to be achieved by the entire sub-population by a certain date. An action level is the blood lead level at which the government recommends action should be taken to assist that individual to identify the lead sources and pathways and eliminate their exposure. The target and the action level can be the same level within the sub-population, but each sub-population (or lead-exposure occupation) will have a different target/action level.

Elizabeth O'Brien of The LEAD Group Inc. believes that Germany's approach to lead prevention (The Federal Environmental Agency, 2009) and blood lead levels are the best policy on which to base Australian blood lead action levels for both the general public and lead workers.

The blood lead levels set by Germany are based on calculating blood lead levels of the 95th percentile. This means it is an accurate assessment of the overwhelming majority's blood lead level. It allows the level set to be manageable and acceptable for that community. A blood lead action level must be set on what is achievable for a certain population. The issue with the procedure and testing by Germany is that the ages and time intervals, which were tested, were large and varied. As outlined by the LEAD Group Inc., testing should be no longer than every 5-7 years and at a smaller age brackets, with specific attention to children and their development. Age brackets must be reconsidered for ages born before and after the introduction of unleaded petrol and the phase out of leaded petrol.

The sub-populations for blood lead testing as outlined in policy point 3 are essential, as they have different risk factors and cover the entire population. Each of the sub-populations has historically had different exposure to lead and at different concentrations, so determining an appropriate nationwide blood lead level must take into account actual levels presented by the population.

6. To successfully achieve the continual reduction of the targets, National Blood Lead Surveys should be conducted every 5 to 7 years in order to achieve an intermediate goal* for all Australians to have a blood lead level less than 5 micrograms per deciliter, and a long term goal of less than 2 micrograms per decilitre, with the ultimate goal being zero blood lead level.

* A goal is the result or achievement toward which an effort is directed - it has no timeframe for success, but it drives policy.

7. Review the recommended timing and frequency of Occupational blood lead testing and recommended action levels for workers exposed to lead and other heavy metals according to Occupational Health and Safety Regulations.

8. Lead workers eventually change industry or retire, and their lead bone store from occupational exposure then becomes a public health issue, rather than one of Occupational Health and Safety. (This is because the 'acceptable' blood lead level is much lower for non-lead industry workers.) Blood lead surveys for individuals in all lead-related occupations should be carried out and the results

used to set new blood lead targets for workers under 18 years, and workers over 18 years, according to the 95th percentile for each lead-risk occupation.

This policy would effectively apply the German public health blood lead action level setting process also to occupational health – there being no justifiable difference in health protection afforded to workers and other humans. Why continue to allow workers to be exposed to blood lead levels which are known to cause unacceptable health effects later in life, including early death?

Among adults, over 95% of the total body stores of lead are found in bone. For children, about 70% of lead is stored in bone (Cal-Lead, 1991). The cumulative nature of lead over time does not allow it to readily move out of the body. Lead in the bones has a half-life of 5-15 years. As we age, and through pregnancy, the demineralisation of our bones will cause lead to return to the blood stream and flow around the body. Kim (2004) states that the mean residence time of lead in cortical bone* is 30 years. When a worker within the mining sector retires they are still carrying 30 years' worth of lead burden in their bones, this could be the rest of their life. As will be explored later, lead exacerbates health issues connected with ageing. Employers must provide medical examinations and regular biological monitoring for workers in lead-risk jobs and keep records of these for 30 years.

***cortical bone** : the compact bone of the shaft of a bone that surrounds the marrow cavity. (The Free Dictionary 2010)

Lead-risk jobs are defined as jobs involving a lead process in which the blood level of the worker is reasonably likely to exceed 30 µg/dL or 10 µg/dL for female employees of reproductive capacity, and must be notified to the Work Cover Authority (2000) in writing.

Currently, NSW policy on the time and frequency of blood lead testing for workers as of September 1st 2001 (NSW Government, 2001) is:

- Before they commence lead-risk work
- Within 1 month of commencement of lead-risk work
- After 2 months of commencement of lead-risk work
- After 6 months of commencement of lead-risk work.

Biological monitoring (blood lead testing) is required (Work Cover NSW, 2008) for;

- Females of reproductive capacity:
- Within 3 months of last biological monitoring if the result of last monitoring shows level less than 10 µg/dL
- Within 6 weeks of last biological monitoring if the result of last monitoring shows level more than 10 µg/dL.

- Females not of reproductive capacity, and males:
- Within 6 months of last biological monitoring if the result of last monitoring shows a level of less than 30 µg/dL.

- Within 3 months of last biological monitoring if the result of last monitoring shows a level above 30 µg/dL and below 40 µg/dL.
- Within 6 weeks of last biological monitoring if the result of last monitoring shows a level above 40 µg/dL.

Work Safe Victoria (2007) lists workers at risk of lead exposure:

- Radiator repair industry
- Lead smelting and refining
- Lead-acid battery industry, including recycling
- Glass and ceramic industries
- Printing, publishing and allied industries
- Cable makers
- Vinyl manufacture
- Leadlighting
- Painting
- Petroleum industry
- Assaying (for gold)
- Ammunition and explosives

Work Cover NSW (2008) and the Victorian Government (2004) removal levels of worker from lead risk work include:

A worker must cease to carry out lead risk work if it is considered that the worker has received an excessive exposure to lead in the workplace, and the results of biological monitoring on the worker confirm the blood lead level of the worker as:

- 15 µg/dL or more for females who are pregnant or breast feeding, or
- 20 µg/dL or more for other females of reproductive capacity, or
- 50 µg/dL or more for females not of reproductive capacity, and males.

Work Cover NSW (2008) return to lead risk work levels:

The worker cannot return to lead risk work until their blood lead levels are below:

• 10 µg/dL for females of reproductive capacity, or

• 40 µg/dL for females not of reproductive capacity, and males, and the worker is certified as fit to return to the lead risk work by an authorised medical practitioner.

For the United States of America (USA), under Occupational Health and Safety Administration guidelines, an occupational blood lead level is considered excessive at or above 40 µg/dL, while medical monitoring intervenes at or above 30 µg/dL and medical removal from work at 50 µg/dL. Once removed from the work place, an employee cannot return until their blood lead level is at or below 40 µg/dL.

These levels are too high, considering that recent studies show that having a blood lead level below 10 µg/dL can cause adverse health effects (Roberts, O'Brien, Taylor 2009, Taylor 2010a, Taylor 2010b). Occupational levels should be revised by Safe Work Australia, as the current acceptable levels cause lead poisoning which research shows is resulting in health effects which are no longer acceptable.

9. According to the recommendations made by the Australian Institute of Occupational Hygienists Inc (AIOH), immediately establish a reduced industry standard on the medical-removal and return-to-work lead levels. Following the blood lead survey, new targets can be set by occupation to establish the medical removal benchmark, whereby the worker is removed from the lead risk job (and provided with non-lead risk work) if blood lead levels exceed the target. Establish a separate and significantly-reduced blood lead level by occupation for workers returning after medical removal.

The following table states an example of current international occupational exposure limits according to blood lead level (AIOH, 2009: 15)

Country	**Occupational Exposure Limits (µg/dL)**
Argentina	30
Australia	50
Chile	50
Denmark	20
Germany	40
Ireland	70
Japan	40
New Zealand	67
Spain	70

The AIOH (2009) provided detailed and appropriate occupational recommendations that should be in place in Australia for all lead-exposure occupations until the specific 95th percentile action level can be determined from blood lead surveys within each lead-exposure occupation. The current national standard for the control of inorganic lead at work does not offer an acceptable level of protection for the majority of workers, especially females of reproductive capacity.

AIOH recommendations:

- At or below 20 µg/dL for all males and females not of reproductive age

- At or below10 μg/dL for females of reproductive age
- At or below 30 μg/dL as the transfer level* for males
- At or below 10 μg/dL as the transfer level for reproductive females.

  *A transfer level is the blood lead level at which the AIOH recommends that the person be transferred to a non lead risk job.

Other general recommendations include;

- Frequency of monitoring should increase as lead approaches transfer level.
- Contractors and new workers: a blood test is required and must be at or below
- 20 μg/dL for males and females of reproductive age
- 10 μg/dL for females of reproductive age before permitted to work in a lead free job.

This AIOH position paper was written in 2009 and provides up-to-date information. The AIOH sets lower benchmark targets than the previous 50 μg/dL for exposure in a lead risk job. These recommendations are appropriate and should be phased in with recommendations to employers on how to reduce exposure to lead in a lead risk environment. These can include on-site laundering, clean-rooms, PPE, nutrition packages, assistance in quitting smoking, etc.

Primary Prevention: preventing lead poisoning occurring in the first place

10. Blood lead testing and collation and analysis of the results is the most useful tool in setting a baseline for individuals and sub-populations, and for ongoing monitoring to determine whether lead poisoning primary prevention policies are working.

11. Develop a questionnaire, regarding patients' symptoms and behaviours, to trigger a blood lead test, either by the doctor ordering a blood lead test or the patient requesting one.

Questionnaires can be used to identify an individual's risk factors to lead. This, followed by a venous blood test, is the best way to confirm exposure to lead. The LEAD Group website provides two examples of childhood lead poisoning risk factor questionnaires which can be used on children aged 9 months to 48 months (Balzer 1998, The LEAD Group Inc. 2006b) and a questionnaire for adults (Massachusetts Division of Occupational Safety and O'Brien 2010). Questions relate to housing, hobbies and work of people living in the home, eating of non food items, behavioural problems and nutritional deficiencies. This preliminary questionnaire is used to identify pathways of lead exposure and direct further action, based on answers to the questionnaire.

12. Make this questionnaire publicly accessible – e.g. on NHMRC's website, and on display in doctors' waiting rooms. Educate doctors on the range of symptoms and behaviours which may be caused by exposure to lead, but which also may have another cause. Encourage doctors to automatically order a blood test for lead when such symptoms or behaviours manifest themselves.

13. Through provision of advice to doctors, and publicly-accessible information – e.g. on NHMRC website, pamphlets in doctors' waiting rooms - aim to increase by at least ten-fold over the next two years, the number of blood lead tests carried out each year in Australia, and add all results to a national register with details of postcode, gender, age, any known lead exposure and the reason for testing. It is only by pre-testing and post-testing blood lead levels at times when the blood lead level could reasonably be expected to change (e.g. before and after an infant begins crawling in an old home; when moving children into an old home or a family to a smelter or mining town; when planning to renovate an old home or to conceive; when an older person is forced into inactivity and bed-rest due to bone break/s, etc); that cases of elevated blood lead levels can be found at the time of exposure, rather than missed altogether.

14. Promote lead to be included in opportunistic testing* of blood within a medical setting, especially when a patient is being investigated for iron deficiency anaemia, pica, developmental delay, hypertension, Alzheimers disease or osteoporosis.

* Opportunistic testing occurs when an additional test is offered to an individual when they present to a health care practitioner for a medical enquiry which would normally entail a blood test. For example, a woman of reproductive age who presents to the doctor for a blood test to confirm pregnancy could also be tested for lead (and iron and other nutrients).

The benefit of opportunistic blood lead testing is that it will be done in association with other blood testing unrelated to blood lead testing. Lead will be added to a testing registry. This allows administration costs to be lower as the test does not need to be established as a separate test. Opportunistic blood lead screening should occur whenever a child is having blood taken for any other purpose. Universal questionnaire screening of children when having a blood lead test will occur by having every parent fill in a questionnaire on the child's potential lead risk (Ealorga, Tabei, Brandle, Burke & Herman, 2004).

Mount Isa in Queensland had a successful opportunistic testing scheme in place in 1992. It was a Government initiative as Mount Isa is a mining town, so blood lead levels are generally higher than other populations and the health risks associated with this elevation are a concern. Mount Isa Mines (MIM) organized a voluntary blood lead sampling program focusing on young children. It was designed to measure blood lead levels in children when they needed blood tests for other purposes. For the period of 1992-1994 the results indicated that 1 in 4 children were tested and the mean blood lead level was 10.9 μg/dL, with a range of 2-29 μg/dL. 15.6% of children had a level exceeding 15 μg/dL and 36.7% had levels exceeding 10 μg/dL. The purpose of the opportunistic testing initiative was aimed at reducing the impact of lead contamination and provides effective lead education for the community. A final report was filed in the late 1990s. A similar testing scheme should again be implemented as it increases the awareness of the issue of lead poisoning (Moore, 2008).

15. Provide input to veterinary associations recommending the publication and dissemination via veterinary clinics of a factsheet about pets as sentinels for human lead poisoning, stating that vets recommend blood lead testing to family members (especially young children or renovators) whenever a pet is diagnosed with elevated blood lead levels, if the lead source is not known or is known to be a source which humans may also be exposed to.

Vets are in a unique position to refer humans for blood lead tests because some parents are more likely to request that their pets be blood lead tested than their children be tested. Some pets, such as dogs, show symptoms at lower blood lead levels than humans and are thus more likely to be lead tested than a human. Also, well-equipped vets have spot testing equipment for immediate blood lead results, making blood lead testing of pets probably more common than blood lead testing of humans in Australia. Pets make good sentinels for human lead exposure, especially in children, because pets have similar sources and pathways of lead uptake to children, as well as to renovators and adult residents of mining or smelting towns if the lead is made airborne. (Berny et al 1995, Bischoff et al 2010)

16. Recommend to the states and territories that they promote and support the Australian Government's "National Waste Policy"; in particular, the Product Stewardship Scheme, which will recycle televisions, computers and electrical appliances, and should be operational by 2011. Promote the expansion of E-waste recycling services in Australia and encourage involvement from all levels of government.

E-waste does not have a uniform definition. In its simplest form it refers to any form of electric and electronic equipment, such as computers, mobile telephones, fax machines, printers and entertainment electronics that have expired and have no further value to it the owner (Widmer et al 2005).

Televisions and computers contain elements including tin, nickel, zinc and copper, and hazardous materials including lead and mercury. For example, lead is used in the funnel glass of cathode ray tubes of computer monitors, which contain between 1.5-2 kg of lead and television tubes to prevent harmful radiation penetrating the user(s). (Australian Government for the United Nations Environment Programme, 2005). In Australia during 2007-2008, a total of 16.8 million televisions and computers reached their end of life and 84% of the waste ended up in landfill (Pratt, 2009).

The proper management of expired E-waste is an important issue for Australia because electric and electronic equipment contains hazardous and toxic materials, which, when disposed into a landfill, can be dispersed into the human environment. The management of E-waste will become more important following the recent Labor government's implementation of the National Broadband Scheme, which can be expected to indefinitely increase the number of computers, televisions and mobile telephones (all of which can be connected to the broadband service) that will be used and eventually be disposed of by people in Australia, thereby increasing the amount of E-waste produced. (The National Broadband Scheme will also potentially expose more telecommunications workers to lead as they set about digging up all the lead-sheathed copper cabling in order to lay new cabling for the Scheme. Telecommunications workers are not automatically blood lead tested in Australia. (Tulloch 2010))

Support for the 'National Waste Policy Implementation Plan' (Environment Protection and Heritage Council, 2009) developed by the Australian Government is an important framework to plan for the future of Australia's waste management and resource recovery protocol. The policy ensures the safe recycling of E-waste and involvement from all levels of government. Local councils should be involved in creating awareness of the importance of E-waste recycling, and provide an outlet for the public to deposit their expired equipment for

recycling. The Council of the City of Sydney (2010) provides quarterly services to collect ratepayers' and residents' expired, broken and unwanted electronic equipment.

On an international scale, Europe is leading the way in constructing and implementing policies to manage E-waste. As an example, Switzerland's E-waste management schemes have shown many successful outcomes and provide useful insights into how E-waste management systems can be constructed and implemented (Khetriwal et al 2007). The Swiss Federal Office for the Environment implemented an E-waste management strategy in 1998 on 'The Return, the Taking Back and the Disposal of Electrical and Electronic Equipment (ORDEE)' by means of Producer Responsibility, whereby traders and manufacturers are responsible for taking back electric and electronic equipment when it has expired or is unwanted by the consumer. They also stipulate an assigned fee onto the purchase of all electric and electronic equipment to cover the products eventual recycling costs. Countries such as Sweden, Norway, Belgium, Netherlands and Japan have already implemented producer responsibility based E-waste policies. Switzerland's Product Responsibility scheme provides a successful framework that Australia can further develop. It is also important that Australia continue to encourage the development of environmentally friendly products.

17. In accordance with Australia's commitment to fulfilling the objectives of the Basel Convention, the NHMRC recommends that the Department of Sustainability, Environment, Water, Population & Communities (DSEWPaC) license smelters to recycle wastes containing heavy metals. This will dispose of hazardous matter close to the source of production and reduce its movement.

The Basel Convention is an international agreement, signed by Australia in 1992, which provides guidelines, assistance, training and regulations on the safe disposal of hazardous waste. One of the key objectives of the Convention is to regulate the movement and disposal of hazardous wastes in developing countries by developed nations (United Nations Environment Programme, 2010). As a result, the Convention supports an environmentally sound management approach to protect human and environmental health.

In accordance with Australia's *Hazardous Waste (Regulation of Import and Exports) Act 1989* and Australia's commitment to the Basel Convention, all smelters should be licensed to recycle heavy metals. This would have many positive outcomes. It would prohibit the movement of hazardous wastes interstate and internationally, ensure that the heavy metal recycling process is completed closer to production facilities, promote the development of adequate heavy metal recycling facilities in Australia and assign responsibility for the management of heavy metals to smelting companies, which are the main producers of lead, zinc, copper and silver which are components of many products and materials.

18. In accordance with Australia's commitment to the OECD Declaration on Risk Reduction for Lead 1996), recommend that Customs be alert to new uses of lead in imported items, and, if found, regulate to limit such new uses of lead. Encourage research into finding substitute materials for lead products such as fishing sinkers and jigs, motor vehicle wheel weights, leaded petrol, shot and bullets.

Due to the success of lead free solder (96.5% tin, 3% silver and 0.5% copper) and unleaded petrol there is potential for other lead based products to be substituted and be more environmentally sound.

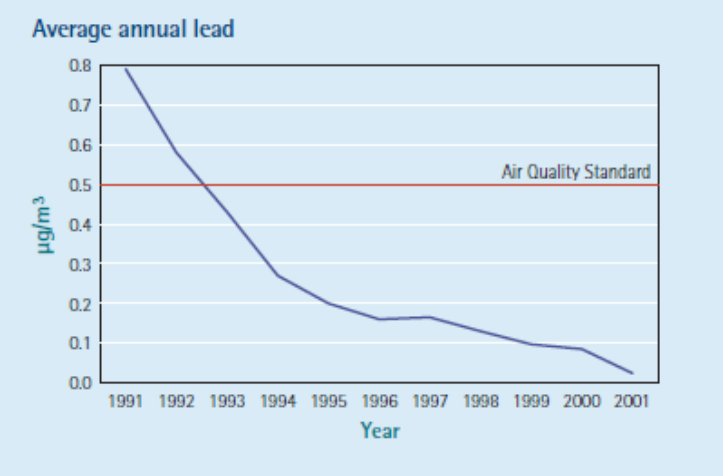
The success of phasing out of unleaded petrol is motivation to discover substitutes for lead products and their manufacture. A complete phase out of unleaded petrol was reached in 2002 in Australia, which instantly reduced lead emissions. The transition to unleaded petrol has been relatively smooth in most countries. Substitutes for lead in all products which are currently produced containing it, need to be researched, and replacements made where a feasible alternative to the lead can be developed, or the product can be made to perform its function without the need to contain lead.

> Australia has produced many lead-free products. Kumar (2009) notes International POPs Elimination Network's (IPEN)* involvement in discovering an alternative for lead in shielding products. Lead has been used in the shielding used to prevent radiation from X-rays in a medical setting. Kumar (2009) notes that tungsten, steel and concrete could all be used as alternative shielding materials. For an alternative material to work, it needs to possess the same or similar properties to lead. Kumar (2009) also reports that coating lead with a metal or polymer decreases its toxicity. Such products for coating can be stainless steel cladding and aluminum.
>
> *The **International POPs Elimination Network** (IPEN) is a global network of NGOs dedicated to the common aim of eliminating persistent organic pollutants. (Wikipedia 2009)

The most common lead substitutes are the alloys SAC305, SAC387 and SN100c. The majority of these alloys are used as alternatives to leaded solder and solder products. The chemical make up of these substitutes is similar to lead, so this would be a good basis for development of a wider range of lead free substitutes. Alloy SAC305 comprises of 96.5% tin, 0.5% copper and 3 % silver, alloy 387 comprises of 95.5% tin, 3.8% silver and 0.7% copper, and alloy SN1000c is comprised of tin, copper and a small amount of nickel. Each of these solders contains the same and similar compounds and is used as an alternative to lead. This chemical basis should be developed on, but not limited to, when researching more alternatives for lead (Northern Smelters Pty Ltd, 2010.Bastow & Jenson, 2009. AIM Products Australia Pty Ltd, 2005 and Maxim Integrated Products, 2010).

19. Ensure that aviation gasoline (AvGas), and fuel for motor racing boats and vehicles which still use the additive Tetraethyl lead (TEL) are phased out, while also ensuring that unleaded fuels maintain the requirements for effective functioning and safety of the racing vehicles and aircraft.

Air quality was significantly improved over the past decade with the phase out of leaded petrol for on-road motor vehicles. The graph below (Department of the Environment and Heritage, 2004) shows the average annual air lead levels in Australian cities have dramatically been reduced and have been below the air quality standard, of 0.5 micrograms per cubic metre of lead in air averaged over a year, since 1993. TEL is added to AvGas as an octane enhancer and to prevent 'pinging' noises and knocks. AvGas is used in most piston-engine aircrafts as well as cars, motorcycles and boats used in motor and water sports and vintage cars. AvGas is used as a motor racing fuel and is regulated by the *Fuel Quality Standard Act 2000,* and the Australian Government must grant approval for its use under this Act.



Most AvGas used in Australia is manufactured in Australia. AvGas can be purchased in Australia from a number of aviation distributors, airfields and few motor vehicle racing organisations (Department of the Environment, Water, Heritage and the Arts, 2009).

In the year ended 1 February 2005, 250 tonnes of TEL was imported for use in the production of AvGas. The concentration of TEL used in AvGas ranges from 0.55 - 2.08 grams per litre (Department of Health and Ageing NICNAS 2005). In the same year, about 18 tonnes of Australian -manufactured AvGas was exported to Papua New Guinea, Taiwan, Japan, New Zealand, Philippines, Malaysia, Guam, Tahiti, Noumea, New Caledonia, Fiji, Micronesia and Norfolk Island (Department of Health and Ageing NICNAS 2005). Therefore, Australia is not only a primary manufacturer of AvGas, but also an international exporter.

International environmental and human health concerns about the use of the additive TEL in AvGas requires a lead-free or synthetic substitute to be developed and used. In the USA AvGas is a main contributor to environmental lead pollution, emitting about 565,000 kg of lead into the air during 2002 (Windom et al 2010).

The USA has made significant contributions to the development of a substitute aviation fuel. The US EPA (Environmental Protection Agency) temporarily exempts the aviation community from complying with legislation that prohibits the use of lead in petrol in accordance with the *Clean Air Act*. Therefore, it is likely that leaded fuel will also be prohibited in the aviation community once an alternative is found because AvGas is a major contributor to airborne lead in the USA. There are a large number of companies and programs, such as 'The Unleaded Gasoline Program,' working on the development of an unleaded aviation fuel and testing the primary problems associated with lead replacement, such as achieving a high octane level, knocking and endurance performance (Office of Aviation Research 1999).

Over a period of many years, the US Federal Aviation Administration (FAA) has developed a large body of research on substitute fuels, tested fuel properties, components and engines and has reviewed the safety and health concerns of the switch to an unleaded fuel (Ferrara et al 1994). However, issues have arisen about the decreased performance of unleaded fuel in aircrafts that contains the same octane as standard leaded AvGas.

The main aviation fuel standards company in the USA is ASTM International and they have also actively been working on setting new standard specifications for unleaded AvGas which is currently being developed and tested (Orr, 2009). Once a suitable substitute for AvGas is found, the phasing out of leaded aviation fuel can occur.

20. Keep a watching brief on the U.S. Environmental Protection Agency (EPA) which is in the process of reviewing the extent to which aviation lead emissions cause or contribute to air pollution, and in turn impact upon health. The results

will be used to review the emission engine standards and the transition of piston engine aircraft to use unleaded fuel. Adopt similar policy in Australia.

The EPA web-published a media release on 21 April, 2010 which was an advanced notice of proposed rulemaking, asking the public to comment on the actions under review by the EPA, which includes the extent to which aviation lead emissions are related to air pollution (Milbourn, 2010). By USA law, any positive associations would require the EPA and FAA to amend the current standards.

21. Recommend that the Federal Government develop a Foreign National Policy on the importation, exportation and safe disposal of lead.

22. Recommend that the Federal Government establish legislation to ban the international export of lead ores or concentrates to smelting companies that are on-selling or using Australian lead for the production of leaded petrol, lead-based paints or inks, leaded pesticides or other dispersive uses of lead for which alternatives exist.

Globally, there has been a general prohibition of leaded petrol. The lead additive used in petrol is referred to as Tetraethyl lead (TEL) which has been reported since it was first added to gasoline in the 1920s in the United States to be harmful to health (Landrigan, 2002). Countries which have phased out leaded petrol (leaded gasoline) have seen a noticeable reduction in blood lead levels. As of May 2010, 11 countries with a total population of 280,583,921 people have still not eliminated leaded petrol (Taylor 2010e). As a result, companies are still manufacturing leaded petrol, and Australia, being one of the world's main exporters of lead, is currently facilitating the manufacture of the TEL additive for leaded petrol in the United Kingdom (UK). Australia's involvement in this trade is hindering the global eradication of leaded petrol.

As mentioned in The LEAD Group's LEAD Action News of August 2008, the trade of lead ores from Australia to the UK ends up supplying the TEL additive to the countries which have not phased out leaded petrol (O'Brien 2008). The Mount Isa Xstrata smelting company mines lead ores that are sent to the UK company Britannia, where they smelt the lead ores into lead metal and on-sell it to Innospec, another organisation in the UK which convert the lead metal into TEL to be used in the production of leaded petrol. The leaded petrol is then exported to countries which still use leaded petrol including Burma, Egypt and North Korea. Countries which have already phased out lead in petrol, such as Australia, should be assisting these remaining lead-petrol countries because this will have positive local and global health impacts, such as reduced blood lead levels in adults and children where leaded petrol is still being used and an improvement in Australia's green credentials overseas, through reduction in the amount of lead ores exported from Australia for the purpose of making TEL.

A Lead Stewardship Policy would discontinue Australia's involvement in the exportation of lead to the UK for the manufacture of the lead additive for leaded petrol for road vehicles. As a major contributor to the manufacture of leaded petrol, Australia's actions would hopefully encourage the countries that still use leaded petrol to undergo the transition.

23. The Foreign National Policy will prohibit the exportation of leaded ores, concentrates or refined lead metal to countries which have not established adequate facilities to smelt, manufacture lead products, or recycle them safely.

Lead corporations to provide assistance to non-Organization of Economic Co-operation and Development (OECD) countries to develop large scale lead acid battery and e-waste recycling plants.

Thirty-three countries are members of the OECD, including Australia, and work on a number of global issues, including the environment and sustainable development. OECD countries have made significant steps that have resulted in the phase-out of leaded petrol, with the establishment of the 'Ministerial Declaration.' The Declaration recognises the importance of sharing information on environmentally-sound management and technologies that can be used to reduce lead exposure to non-member countries. It is important that the OECD countries assist non-OECD countries to establish adequate facilities to produce and smelt all forms of lead and heavy metals to recycle them safely.

24. Recommend that the Federal Government establish an OECD countries' Lead Licensing Scheme to enforce safety standards on the exportation by OECD countries of lead ores, concentrates and refined lead metal to non-OECD countries.

E-Waste is one form in which lead is exported by the OECD countries and imported by non-OECD countries. Countries in the OECD produce the majority of E-waste. As part of the Basel Convention, OECD countries have highly regulated the international movement of E-waste due to the high toxicity of substances found in electric and electronic products, including lead, iron, copper, aluminum, arsenic, selenium, cadmium and mercury. These metals comprise about 60 % of the materials present in E-waste (Widmer et al 2005). However, due to the profitable nature of recovering these metals from retired electric and electronic equipment, E-waste has become a global trade. Some Asian countries (Terazono et al 2006) are involved in the illegal importation of E-waste for business opportunities and to meet the population demand for cheap electronic equipment. This has significant impacts on the health of the population, the adequacy of the management procedures to cope with large quantities of waste and the country's sustainability. These regulations need to be further enforced to ensure that non-OECD countries are not able to use OECD countries waste, especially if they do not have the facilities to recycle it safely.

25. Recommend that the Federal Government enforce stricter heavy metal standards on ALL food imports into Australia. Current Australian food manufacturing regulations, according to Food Standards Code 1.4.1, limit the content of lead in food, if it is the only chemical present, to 0.01 mg/kg. If other metals or chemicals are present, the limit of lead varies according to different food groups.

Imported food can be a significant source of exposure to lead, especially if a person favours eating a lot of a particular lead-contaminated food eg turmeric or tinned tomatoes – foods that can be added to a lot of dishes. Lead can either be contained in food or the food could be contaminated during manufacturing, handling, packaging or storage. For example, selling food or drinks packaged in lead soldered cans is not banned in Australia. There is no requirement that lead glazed ceramics or leaded crystal carry a warning label against using the item to store acidic or alcoholic foods or beverages.

Lead is a heavy metal with no nutritional benefits. Lead at high levels can have toxic effects on the body. Prolonged exposure to low levels of lead can result in damage to the reproductive,

cardiovascular, immune, hematopoietic*, nervous and gastrointestinal systems (Food and Agriculture Organisation and the World Health Organisation 2004).

*hematopoietic: pertaining to the formation of blood or blood cells (The Free Dictionary 2010).

Food Standards Australia New Zealand's (FSANZ's) Food Standards Code established a limit of reporting of metals present in food. The representative contaminant level for lead in food is 0.01 mg/kg (FSANZ, 2002). However, some categories of food, and mixed food products (foods containing more than one class of food) have varying maximum limits of lead which have either been set in accordance with levels of lead found in these food categories in market basket surveys, or have been calculated according to a complex mathematical formula. The following table shows the maximum level of lead allowable in various categories of food (FSANZ 2010a):

Food category	**Maximum limit of lead in food (mg/kg)**
Brassicas	0.3
Cereals, Pulses and Legumes	0.2
Edible offal of cattle, sheep, pig and poultry	0.5
Fish	0.5
Fruit	0.1
Infant formulae	0.02
Meat of cattle, sheep, pig and poultry (excluding offal)	0.1
Molluscs	2
Vegetables (except brassicas)	0. 1

FSANZ have developed these food standards for Australia and New Zealand's primary food producers and the food manufacturing industry. Food imported into Australia is regulated by the Australian Quarantine Inspection Service (AQIS), which must inspect imported food, to be sold in Australia, to ensure it meets the Australia New Zealand Food Standards Code. Looking for imported pests in foodstuffs being imported, so that they can be quarantined, is not the same as analyzing imported foods for their lead content. The Food Standards Code for lead in imported products needs to be universally applied to all food products in Australia, particularly those imported into Australia for both personal and commercial use.

Occasionally, when Australian foods are exported, they are tested for lead in the destination country and then recalled in Australia and overseas. In March 2010, a range of Darrell Lea and Ricci Yoghurt Coated Raspberry and Mango Liquorice, which was distributed throughout

Australia and to the UK and the USA, was recalled for containing levels of lead above the Australian standard (FSANZ, 2010b).

Furthermore, in July 2004 there was a voluntary recall of Goodman Fielder's White Wings Corn Flour because it contained unusually high levels of lead. The corn flour was imported into Australia from New Zealand, where they previously imported it from China (FSANZ, 2004).

A study in the USA has shown that elevated blood lead levels are associated with long-term consumption of imported Indian spices and cultural powders (Lin et al 2010). In one study, analysis of the lead content in 86 imported Indian spices and 71 imported cultural powders purchased in the Boston area of the USA, found that the majority of products contained more than 1 microgram of lead per gram of food. As a result, products containing lead require closer inspection and testing as well as tighter enforceable restrictions on their importation and sale.

26. Recommend that the Federal Government enact regulations to prohibit the importation of products painted with lead-containing paints and inks and glazes.

As of 1st January 2010, paints and inks with added lead were banned from being imported, manufactured, supplied and sold in Australia (Department of Health and Ageing NICNAS 2008). However, the prohibition on adding lead to paints and inks does not apply to those paints or inks that are applied to painted or printed items overseas, and then imported into Australia. Items such as pre-painted building components, children's playground equipment, mirror-backings, printed plastic tablecloths and shower curtains can thus be imported with any amount of lead in the paint or ink.

The Australian Customs Service regulates the importation of certain products which contain excess lead or other heavy metals. Their restrictions help to protect the Australian public from lead exposure, via consumption and its associated health risks. The *Customs (Prohibited Imports) Regulations 1956*, set maximum limits to the amount of lead found in certain imported products and any product that contains lead concentrations above the limit are prohibited (Australasian Legal Information Institute, 2010).

Toys, pencils, paintbrushes, moneyboxes and erasers that contain more than 90 mg/kg of leachable lead are prohibited into Australia. Cosmetics containing more than 250 mg/kg of lead or lead compounds and all candlewicks and candles with wicks containing 0.06% of lead by weight are prohibited in Australia (Australasian Legal Information Institute, 2010). Australia was the first country in the world to prohibit lead in candlewicks due to research done by Mike Van Alphen – a member of The LEAD Group's Technical Advisory Board. Lead wicks were shown to be able to emit about 500 to 1000 micrograms of lead per hour into the air, and burning candles on a regular basis in an enclosed space could result in elevated blood lead levels and lead poisoning (Australian Government for the United Nations Environment Programme, 2005).

Glazed ceramic ware's lead content limit is dependent on the volume of the container and the varying limits are set out in the table below (Australasian Legal Information Institute, 2010):

	Amount of leachable lead, per volume of solution (milligrams per litre)
1. Cup, mug, jug, jar, bowl, teapot, coffee pot or other article of tableware (other than an article referred to in Item 3) having a liquid capacity of less than 1100 millilitres.	7.0
2. Cup, mug, jug, jar, bowl, teapot, coffee pot or other article of tableware (other than an article referred to in Item 3) having a liquid capacity equal to or in excess of 1100 millilitres	2.0
3. Plate (including soup plate or dessert plate), saucer, or similar article of tableware	20.0
4. Any article of cooking ware	7.0

These regulations allow for small quantities of lead in products to be imported into Australia to be used by the public, thus exposing them to lead. More stringent regulations are needed to further reduce lead exposure by limiting the amount of lead in such products to zero.

27. The Therapeutic Goods Administration, which is responsible for the regulation of quality and safe therapeutic goods in Australia, to set a limit for lead in all imported traditional medicines, such as traditional Ayurvedic medicines. Customs regulations to require lead testing of all imported traditional medicines which are known to be potentially lead-contaminated from medical cases.

Traditional medicines are most popular in developing countries but are increasingly being used in the West. Research has indicated the overwhelming presence of a number of heavy metals found in traditional Ayurvedic medicines, including lead, mercury and arsenic, which have caused increases in blood level toxicity (Saper et al 2004, Saper et al 2008).

The lead content in traditional medicines is absorbed by the gastrointestinal system which absorbs approximately 15% of ingested lead. The rate of absorption is even higher for children, pregnant women and individuals with iron, calcium or zinc deficiencies (Karri et al 2008).

Lead is a substance eligible for use in medicines, when used as a component with an approved substance, listed on the Australia Register of Therapeutic Goods for supply to Australia. The

concentration of lead allowed in medicines is 0.001% (Department of Health and Ageing Therapeutic Goods Administration, 2007). According to the Therapeutic Goods Administration, "medicines such as Ayurvedic and traditional Chinese medicines are classified as 'complementary medicines', and are generally required to meet the same standards of quality and safety as other medicines" (Department of Health and Ageing Therapeutic Goods Administration, 2005). Complementary medicines should be required to meet the same quality and safety standards of all other medicines in Australia. In particular, those complementary medicines manufactured overseas need to be tested when imported into Australia because the quality and content of the product is often unknown.

28. The Australian Competition and Consumer Commission, Product Safety Australia, to require labels on heat guns, electric sanders, grinders, grinding discs, flame torches, sand paper and sanding sponges, and scrapers, warning purchasers of the danger of producing hazardous lead dust or fumes when the tools or materials are used dry, to remove leaded paint.

Secondary Prevention: preventing further exposure to lead in individuals.

29. A National Surveillance Program requiring ALL blood lead results to be notified to the Register set up for the purpose, along with ANY information about likely sources of lead for results above 2 micrograms per decilitre. Quarterly collation and analysis by the health departments and reporting on trends and sources for elevated blood lead levels. Quarterly summary of results and warnings about identified lead sources to alert doctors, health staff and the public.

According to Australia's last National Blood Lead Survey, the 'National Survey of Lead in Children,' the Australia Institute of Health and Welfare (AIHW) was the primary register to which the results of blood analyses were sent. The AIHW was also responsible for notifying parents and/or the family physician of the child's blood lead levels and, with parental consent, would notify the State or Territory Health Department if a child's blood lead level was equal to or exceeded 15 μg/dL (Donovan, 1996).

Internationally, the Oregon Department of Human Services has developed an integral system of lead poisoning reporting and surveillance (Oregon Department of Human Services, 2009). They require all blood lead tests to be notified to the Department of Human Services within 7 days. They acknowledge an elevated blood lead level at or greater than 10 μg/dL. At this level, medical management involves onsite investigation and testing of the individual's residence to determine lead hazards, nutritional and risk reduction education, monitoring of developmental problems and follow-up blood testing.

A National Surveillance Program, as part of a new Australian policy on lead would ensure all blood lead results above 2 μg/dL, provided by the National Blood Lead Survey, are notifiable to the Register. This will provide the Register with regular quantitative data on Australia's current blood lead levels, identify groups at risk and locations that have a high risk of lead exposure.

30. The NHMRC recommends to pathology laboratories that they add to their blood lead testing reports that an elevated level which is above the 95th

percentile target for the particular sub-population of which the patient is a member, should be followed up with further testing of specific nutrients, such as iron, calcium, zinc, copper, and any other deficiencies known to increase absorption of lead. State health departments are recommended to do follow-up home lead assessments and state occupational health agencies are recommended to carry out follow-up occupational lead assessments in response to these elevated blood lead levels. The environmental assessment results will also be used to write the quarterly summary of results and warnings about identified lead sources in each state and territory with particular emphasis on clusters of results above the 95th percentile (the current target for a particular sub-population), in a particular area health or population health area.

Investigating an elevated blood lead level must involve the testing of other nutrients in the body and levels at which these are present. The presence of other nutrients in the body influences the absorption of lead. The deficiency or elevated presence of certain nutrients determines the level of lead in the body and not just the ingesting of lead itself (Peraza et al 1998). A study at the University of Arizona outlines the influence of nutrition and its effects on lead. Insufficient calcium and iron levels intensify the manifestations of lead. Calcium decreases lead absorption as both lead and calcium compete for similar binding sites on intestinal proteins; the more calcium present, the less binding sites for lead.

Lead is much more easily absorbed into than excreted from the body. Children absorb 50% of ingested lead, whereas adults absorb 10%. As sub-populations such as young children with the most elevated blood lead levels are identified, diets consisting of lead-fighting nutrients can be implemented to young children to further decrease their lead absorption. Dietary zinc, selenium, calcium, iron and vitamin C all help to reduce lead absorption (Taylor, 2010b). The provision of this information to patients via doctors provides an important intervention to accompany the removal of lead sources, or the person from the source of lead.

Common dietary nutrients documented regarding their influence on lead in the body include (Taylor 2010c, Taylor 2010d):

- When present at appropriate levels vitamin C, calcium, iron, zinc and phosphorous reduce absorption of lead in the body.
- Selenium combines with lead to reduce absorption and toxicity.
- When intakes of lead are high, copper deficiency is increased.
- The presence of zinc lessens the impact of lead on the liver, kidneys, testes and especially the brain.
- Calcium, zinc and vitamin D decrease the amount of lead deposited in the bones, thus decreasing the impact of demineralisation effects in older age.
- When iron is present, lead absorption decreases. Iron is beneficial, especially as an offset to lead absorption because it is the most common deficiency in pre-menopausal women, and children, and targets the brain and blood cells.
- Vitamins B1 and B9 aid lead excretion, especially from the brain.

- Vitamin D and folate both increase lead absorption, but also have their benefits. Vitamin D decreases the quantity of lead stored in bone while folate increases excretion of lead more than it aids the absorption.

In addition to nutrient testing in the population with elevated blood lead levels, State Health Departments will conduct in-home assessments which will involve the testing of garden soil, first-flush water, ceiling dust, ambient air quality and indoor and outdoor paint. It will also involve the testing of ceramic or crystal glassware used in the home and jewellery or toys present in the domestic environment. The State Health Department will write assessments on individual cases to present in a report to maintain records of contamination, sources and present removal strategies of the lead contaminant. These archives will be education tools to establish procedures for doctors and the public to empower independent and preventative testing and removal of known or suspected lead sources.

31. The NHMRC recommends that State and Territory governments legislate for Local Councils to assume responsibility for establishing records of land use involving likely sources of lead contamination.

Each local council will maintain an organised and comprehensive record system of known sources or sites of lead within their local council area. This information will be gathered in correspondence with testing that is carried out in:

- Policy point 4: Isotopic fingerprinting findings will be recorded in correlation with identifying groups at risk based on the 95th percentile.
- Policy point 30: Initial and follow up home and environmental lead assessments as well as other specified nutrients once a group or individual has been diagnosed with an elevated blood lead level.
- Policy point 32: The State Government will oversee the provision of mandatory soil testing before the establishment of a community council or grounds for produce. The local council will be influential in conducting the tests and it is their discretion and within state guidelines to approve or disprove the proposed development. The information collected on the components of the soil will contribute to the content within reports archived in local council areas.
- Policy point 36: local council gathered information on home and property owners who must have lead testing on their homes and surrounding soil before a house or property is sold. This will include local waterways surrounding the property.
- Policy point 38: The lead warning statement in the contract for buying and renting property should identify and locate traces of lead.

The EPA (2008) noted a Federal Register Environmental Documents: Lead, Renovation, Repair and Painting Program in the USA. A similar approach must be made by the Australian Government to maintain files of residential contamination. This Register maintains records to reported lead contamination sites and case studies involving lead contamination.

32. State and Territory Governments are recommended to write guidelines on the safe development of private food production gardens, chicken runs and community food production gardens. Potential community garden locations to be tested for lead and pH and for arsenic in areas known to have been orchards or market gardens previously (where lead arsenate pesticide may have been

used). The results of the test to be recorded and acidity/alkalinity to be neutralized by soil treatment then retested for pH until it is within recommended levels to gain council approval.

Community gardens allow people to maintain gardens to bring people within the community together. They usually produce fruits and vegetables for participants to enjoy or to sell at markets, where the money raised returns back into the garden. The Environmental Code of Practice for Poultry Farms in Western Australia states 'a description of land farm, soil types and contours and groundwater depth, quality and flow direction' are required to submit a Poultry Farm Proposal.

The Health Based Soil Investigation Levels (Imray & Langley, 2001) proposed health based soil guidelines for individual substances. This includes;

- Lead: 300mg/kg
- Cadmium: 20mg/kg
- Copper: 1000mg/kg
- Zinc: 7000mg/kg

There are also other ways of lead entering areas where food or community gardens are featured, including air, food and drinking water. Washington State University (2006) conducted a study on the effect of catalyzed hydrogen peroxide (H2O2) propagations on metal release in soil. A soil pH of 6.5 gains the least lead release. At pH3 there was an increased concentration and at pH7 there was a slight decrease in concentration compared to pH3.

The NSW Food Authority (2010) states in their food safety law that 'a small egg farm [producing less than 20 dozen eggs per week] does not need to implement a food safety program, but needs to maintain some sort of records.' In NSW, if your egg farm produces more than 20 dozen eggs a week then you need to apply for a license and comply with the *Food Act 2003* (Food Authority, 2010).

There are currently 13 community gardens across the Sydney Local Government Area (LGA). Site selection criteria must comply when choosing a new community garden on council-owned land. High levels of soil contamination need to be evaluated by an expert or professional. There must also be a city assessment of the application and a council meeting for final approval.

Gray Environmental Inc. (2005) recommends that lead levels exceeding 100 parts per million (ppm) in soil should not be used for gardening where children will be exposed to bare soil. If soil exposure to children is not a concern then lead soil levels up to 300ppm for leafy and root type vegetables and 500pp for fruits and vegetables. The NSW soil action level for further investigation is 300 ppm and in the United States of America (USA) this is 400ppm.

City community gardens, places where soil has been imported from an unknown source, areas around smelters and incinerators, land lying within 10-20 metres of heavily travelled road and land near gutter downpipes or near buildings painted prior to 1970 should all require soil contamination testing before a community garden can be established.

Regulations must require council approval for all community gardens and chicken runs to be certain that soil and water sources are adequate and within approved guidelines.

33. State and Territory Governments are recommended to ensure specialized training and licensing for professionals on the safe testing and abatement of lead in paint, dust and soil contamination.

An international practice that has successfully been implemented to ensure the safety and certification of contractors involved in the testing and removal of lead contaminated hazards is in Oregon, USA. The Oregon Department of Human Services along with the EPA specifically designed a 'Lead-Paint Program' requiring all lead contractors to be trained, certified and licensed (The Western Regional Lead Training Center at Oregon State University, 2004). These regulations apply to inspectors, risk assessors, supervisors, workers and project designers involved in lead paint testing and abatement.

As of mid 2010, this program was followed by the 'Renovation, Repair and Painting (RRP) Program' (Oregon State, 2010), whereby contractors working on the renovation of houses, child care facilities and school buildings built prior to 1978, a date only relevant to infrastructure built in the USA, must have a certified Lead Based Paint Renovation Contractor License. This license entails that the contractors attend an 8 hour training course offered by a training provider accredited by the EPA (which is valid for 5 years) and that they follow safety protocol for the prevention of lead hazards. The Oregon legislation for trained and certified lead professionals is a successful program that could be used to base Australia's national training programs, licensing scheme and accreditation procedures for lead contractors.

34. Only qualified ceiling dust removalists to conduct ceiling dust abatement in homes to be renovated, maintained or demolished. NHMRC recommends this be completed before demolition or partial demolition and replacement (ceilings and cavity walls). Ceiling dust removal prior to demolition or partial demolition is to be *enforced*, when the building is government property.

The Australian public should be aware of home maintenance, renovation and demolition activities that can disturb settled lead contaminated dust in ceilings and wall cavities. Lead can contaminate the dust found in the roof and wall cavities of older homes as a result of past leaded petrol emissions and houses built near major roads and industrial sites. The contaminated dust can be dispersed throughout the house during activities such as demolishing ceilings, adding second storey extensions, putting in new electrical wiring, installing a sky light or any work in the ceiling cavity. Therefore it is beneficial for public health and safety that these tasks be performed by trained and licensed ceiling dust removalists. Contractors hired to clean, maintain or demolish ceilings should be first inspected by accredited professionals to identify sources of contamination and provide guidance on the safe management of the hazard.

These tasks can also be conducted by an individual; however it is essential that the individual has a good understanding of the risks, hazards, management procedures and safe abatement protocol. This includes following correct safety precautions and utilising professional services that can provide valuable assistance and guidance, such as the Australian Dust Removalists Association (A.D.R.A) Incorporated (www.adra.com.au/).

There are a number of safe work procedures that should be more forcibly implemented in industrial and domestic settings when dealing with the removal of ceiling dust. This includes sealing off any openings between living areas of the house and the ceiling before abatement

commences, using Personal Protective Equipment (PPE) including eye protection, respirators and disposable coveralls, decontamination procedures and an emphasis on personal hygiene.

35. NHMRC recommends testing to determine lead content and safe removal of lead-contaminated accessible under-floor soil for the safety of family and pets. Leachate-protected landfill disposal or controlled re-use as non-accessible fill, of lead-contaminated soil.

Home maintenance, renovation or demolition can also reveal lead contaminated under floor soil that exposes lead to family and pets living in the residence. A certified inspector or risk assessor should perform the testing of soil where possible, as advised by the EPA. Therefore, Australian regulations should also incorporate training and certification procedures for soil lead inspectors and risk assessors.

When testing soil, the top half inch of soil should be sampled from bare soil areas (where there is no grass or other matter), such as the under floor and play areas (United States Environmental Protection Agency, 2000). The samples are then sent to an approved laboratory to conduct soil analysis and establish a reading expressed as the weight of lead per unit weight of soil, in ppm.

36. Regulations requiring homebuyers and renters be informed prior to renting, buying and renovating older houses of the likelihood of lead in paint, dust and soils and any known history of lead-related activity on the land and to receive results from Local Council of any previous testing of lead concentrations in soil, waterways, paint, and cavity and ceiling dust on the residential property.

With the establishment of Local Council Records regarding known soil nutrient results on properties, potential homebuyers and renters of a property are eligible to view these test results when determining whether they choose to live there. As a renter, under the *Residential Tenancies Act* (Tenants Union of Australia, 2008), the landlord must provide premises which are clean and fit for habitation and maintain the premises in a reasonable state of repair. Mixing the Residential Tenancies Act with the Queensland Government's (2008) *Contaminated Land Management Amendment Act* creates an understanding of providing a safe and hygienic home environment with an emphasis on lead contamination especially in soil.

If the house was built prior to the 1970s then proof or results of a paint and ceiling dust lead test must be given, while a soil lead contamination test can be requested if initial paint and dust levels come back with concerning results or potential resident is concerned, has young children or plans to use soil for produce purposes. Under legal framework relating to soil and groundwater contamination in Belgium Regions as outlined by the Public Waste Agency of Flanders (OVAM, 2008), a Flemish region example covers the ownership of the contaminated site and subsequently the clean up of this.

Regulations outlined in 1995 demonstrate that the owner of the land where the contamination has occurred is required to carry out the clean up unless the owner can prove that another party has actually control of the land. A landowner must apply for a soil certificate from the Public Waste Agency of Flanders before the transaction of land occurs. This certificate must be cited in transfer deeds. Belgium regulation of soil and groundwater outlines responsibilities when in the process of transferring land. The owner must carry out a soil survey by a

recognized expert and if no communication is received from the Public Waste Agency of Flanders regarding this survey within 60 days then contamination does not exceed soil clean up values.

The LEAD Group Inc. (2006a) believes that preventative measures are the most effective in eliminating lead exposure. This comprehensive framework in Germany protects a potential resident or owner for health and environmental damages. The Belgium study is a good example of protection laws. The results of the surveys will be recorded by the council in land history documents.

37. Renting and buying individuals should be given all known information on lead-based hazards in and around the specific house and general government publications, by the real estate agent, before the sale or lease of property built prior to 1970's.

The successful implementation of legislation in the USA requires the acknowledgement of lead based hazards for individuals prior to buying, renting and/or renovating. The USA implemented the *Residential Lead-Based Paint Hazard Reduction Act of 1992*, also referred to as 'Title X,' which states that all lead based paint hazards must be made known to the intended home owner or renter in housing built prior to 1978 (US Department of Housing and Urban Development, 2008). The Act aims to protect families from exposure to lead contaminated paint, soil and dust.

The need for State regulations in Australia stems from the fact that lead based paint was used in houses prior to the 1970s. The amount of lead in paint has been consistently reduced (Department of the Environment, Water, Heritage and the Arts, 2009). For the 3.5 million houses in Australia built prior to the 1970s there is a probable risk that they contain lead based paint and are exposing the residents to unsafe levels of lead (The LEAD Group, Inc., 2010).

Children are particularly susceptible to exposure from lead based paint as a result of their natural hand to mouth actions and a condition known as pica, whereby a child consumes non-food products, such as paint chips. Elevated blood lead levels as a result of nutritional deficiencies including iron have been shown to have significant implications on childhood development, behaviour and cognition (Kordas, 2010). Another significant body of research suggests that childhood blood lead levels below 10 μg/dL can cause a significant reduction in IQ scores. Schwartz's (1994 cited in Fewtrell et al 2003) meta-analysis showed that an increase in blood lead from 10 μg/dL to 20 μg/dL was linked to a mean reduction of 2.6 IQ points. Canfield's et al. (2003) USA study was able to show that blood lead concentrations below 10 μg/dL are inversely linked with reduced IQ scores among 3 and 5 years of age. Further research has found that blood lead levels below 7.5 μg/dL are associated with intellectual deficits (Lanphear et al 2005), blood lead levels below 10 μg/dL can reduce intellectual functioning (Jusko et al 2008, Lanphear 2005) and are related to compromised cognition particularly spatial attention and executive functioning (Surkan et al 2007).

In France, all house owners who have houses built prior to January 1st 1949, as of legislative changes in 2004, are required to undertake mandatory lead testing of premises prior to being sold or rent, by an accredited professional (Republique Francaise 2004). If the assessment is not performed, the owner will face civil and criminal charges.

The French Government has also implemented legislation for reporting on cases of lead poisoning. Any case of lead poisoning equal or superior to 10 µg/dl (or 0,5 µmol/l) must be reported to the State's representative in the department or region. All reports of lead poisoning diagnosed by a physician must contain the address of the building and the causes of lead exposure. As soon as the report is received by the state representative, a lead assessment will be ordered. This assessment has to be performed by an accredited professional. If the report is positive, the state representative will order renovation to be done. The work has to be paid by the owner of the premises. If he can't afford it, the government can either choose to provide financial aid or to do the work and then turn to the individual and ask for the full amount due for the work done. Following its removal, the State representative will have to ensure that the site is inspected and that any dust found on the ground is analysed for lead. (French Health code Article R1334-1 to Article R1334-13).

As a result of the serious health impacts of lead exposure and lead poisoning on childhood health as well as adult health it is important that home renters and buyers are given all known information on the lead based hazards that exist prior to settlement of the property.

38. The contract for buying or renting should include a lead warning statement. This must comply with the notification requirements to the buyer or renter that the property may contain traces of lead. The possible sources of lead must be identified and located where possible.

39. Develop Regulations and Education Packages to promote recycling, testing and awareness of lead.

40. Develop campaigns to create public and professional awareness of sources and impacts of exposure to lead and guidance on the management and treatment, by nutritional intervention of elevated blood lead levels.

Current health promotion education regarding lead poisoning prevention and treatments are not well publicised. The LEAD Group Inc. is the leading health promotion charity for the prevention of blood lead poisoning, and provides fact sheets and information on how to treat lead contaminated areas, health risks from lead, advocacy for legislation on blood lead levels, sources of lead and symptoms of blood lead poisoning.

In New Jersey, a comprehensive health campaign involving the 'Citizen Action' Group (Liebman, 2010) gains attention for their holistic lead prevention strategies. These include

- Educating parents and public about hazards of lead poisoning and the resources available to them,
- Offering free lead 'Train the Trainers' program to ensure health, building and construction professionals working on lead safety issues are informed about the latest laws and regulations,
- Distributing free home lead testing kits ,
- Helping property owners across the state remove lead hazards from their homes using funds from the Lead Hazard Control Assistance Fund, and
- Holding state and local officials accountable to policies that emphasize prevention by ensuring an adequate stock of lead safe housing.

The 'Citizen Action' group gains media attention as well as state and local funding and support. This has also been similar to the 'New York City Outreach Campaign' (WE ACT, 2010), as both campaigns have been successful due to State awareness. Education in Australia for health professionals and the public (including links to all web-published government info) is accessible on The LEAD Group's website due to annual grants (currently from the federal Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)) but other state and federal Government websites and information services do not fund nor promote these prevention strategies adequately. Governments at local, state and federal level need to fund research, create regulations and provide the public with the latest information regarding lead management, new discoveries or legislation. This will be publicized, as it is a government initiative, and it raises the lead-awareness of the general public who often turn to government websites for information.

The Federal Government set up a campaign called 'Lead Alert' which gives information to people about the risks associated with paint in housing built pre 1970s but the Lead Alert guide for health professionals was only ever printed and distributed to doctors in 1994 and is only now online due to the kindness of one of it co-authors, Dr Roscoe Taylor, in scanning it and giving permission for The LEAD Group to web-publish it (Alperstein et al 1994). The US CDC (Centers for Disease Control and Prevention) by comparison, has published and distributed guidance to health professionals on lead poisoning prevention and management since 1975, with revised policy documents being produced in 1978, 1985, 1991 and 2005 (CDC 2010).

More of these following types of initiatives should be in place more generally in Australia:

Lead Awareness Week, lead education at community events and schools, and the provision of information to the community. Educational material including brochures on Lead and Your Family's Health, Lead and Pregnancy, Lead and Nutrition, Lead and Home Cleaning, Lead and Your Backyard, and Lead and Home Renovations are a couple of examples of health promotion implemented by the Mount Isa community in Queensland.

41. Extend Producer Responsibility legislation and education on the safe removal and recycling of household and consumer products containing lead, such as lead acid batteries, paints, lead flashing and damp coursing and mirrors. Local councils should be involved and establish specialized collection sites or services.

The largest use of lead acid batteries in Australia is for transport vehicles and communication and over 90% of all used lead acid batteries are collected and recycled (Australian Government for the United Nations Environment Programme, 2005). As discussed earlier in relation to E-waste, Producer Responsibility legislation should also be applied to lead acid batteries, paint, lead flashing and mirrors, as one day these products will come to their end of life and need to be recycled. Adding an extra cost onto the product at the time of purchase ensures that the product is more likely to be collected and recycled properly, either by using the money to invest in more collection points with safer collection containers, and more collection agents with adequate safety training. Lead Acid batteries are classified as a hazardous waste under the Australian *Hazardous Waste (regulations of Exports and Imports) Act 1989* and there are strict regulations on the export of this waste to other countries. As a result, it is important the recycling of lead-based products such as lead acid

batteries be conducted in Australia on a national scale, and the batteries not exported overseas.

To achieve this, household chemical waste collection services should be expanded nationally. The 'Household Chemical CleanOut' is a successful free service developed by the NSW Government Department Environment, Climate Change and Water (2010). They are successfully reducing toxic materials in landfill, educating the community about correct disposable of toxic wastes, making home and work environments safer, reducing the illegal dumping of toxic materials, particular into the water; and, most importantly, they are collecting "data to inform and prepare a way for Extended Producer Responsibility (EPR) Schemes" (NSW Environmental Trust, 2007-2008: 5).

42. Educational awareness acknowledging the impacts of nutrients, including calcium, iron, vitamin C, zinc, phosphorous and selenium that reduce lead absorption. Also, thiamine (vitamin B1), folate (vitamin B9) and pectin have been shown to increase the body's lead excretion. Educational awareness is essential for children, parents and doctors working in lead mining or smelting towns.

As mentioned above, nutrients and lead are interrelated and can impact on absorption and storage of lead. Information regarding the impact of nutrition on lead absorption should be made available to schools where fact sheets can be distributed to parents if they are concerned about a child's changing behaviour, as it could be attributed to lead. Doctors can gain this information from established journals and the journal published by the government (as proposed in 40, above). Nutrition needs to be used as a prevention and intervention process to decrease absorption and storage of lead.

43. Government-approved home lead testing kits on sale in hardware and gardening specialty stores would be useful secondary prevention strategy.

44. Direct the National Institute of Clinical Studies (NICS) commission development of clinical practice guidelines for secondary lead poisoning management by health professionals, for web-publication at the NHMRC's Guideline Portal (www.nhmrc.gov.au/publications/subjects/clinical.htm) Direct the NCIS to incorporate lead management guidelines into relevant clinical practice guidelines, e.g., "Male Infertility" and "Management of Early Pregnancy Loss."

45. Award a Translating Research Into Practice (TRIP) Fellowship to an early-to-mid-career clinical leader to research approaches in applying research to improve clinical practice in management of recently-identified lead poisoning cases and secondary lead poisoning prevention (preventing further lead poisoning in those cases).

46. Re-educate health professionals and employers on new blood lead level targets, set by the National All-ages Survey, and have the Register provide continuous updates on lead statistics and lead prevention information.

47. New information based on policy changes, research studies and health promotion campaigns.

Tertiary Prevention

48. Carry out research and conduct studies to verify existing, and establish new links, between lead and whole-of-life adverse health effects. Also, carry out or encourage research linking lead poisoning treatments and any resulting reduction in adverse health effects.

The health effects resulting from exposure to lead are well documented and researched, including developmental problems in children and renal failure in older people. There is a general medical understanding that lead present in the bones and blood stream adversely affects a person's health. Links with blood lead poisoning and certain medical conditions are strong, through studies conducted by researchers and their literature reports, such as Needleman and Bellinger (1991). If lead can be proved to affect the health status of people, then lead could be linked with more health risks than are currently known. Continued research into this and report collaboration is needed to establish treatment for patients with health issues induced by the presence of lead. Once health issues have been identified as being exacerbated by lead poisoning, treatment associated with the health risk and the presence of lead can be established. Research should be carried out as to how effective treatments and reduction processes are on eliminating or reducing the impact of the disease.

Current health effects linked with lead poisoning include, but are not limited to the following (Vella, O'Brien & Idris, 2010);

Children;

Nervous System;

- Altered function of developing brain
- Encephalopathy (brain disease)
- Neurotransmitter release disrupted
- Convulsions

Peripheral Nervous System;

- Proprioceptive* pathways involved in balance altered.
- Peripheral nerve disturbances
- Decreased reaction time

Growth and Development;

- I.Q level decrease.
- Cognitive function deficits
- Decreased educational performance
- Verbal function/linguistic deficits

Behavior;

- Aggression, violence, hostility, anti social or delinquent behavior
- Attention problems
- Hyperactive behaviors
- Irritability

Hearing;

- Auditory evoked response patterns altered.

Sight;

- Retinal degeneration.
- Perceptual function deficits
- Depressed sensitivity of rod photoreceptors.

Movement and Muscular;

- Visual motor skills deficits.
- Impaired muscular strength and endurance
- Motor function deficits

Digestive System;

- Impaired vitamin D metabolism
- Colic
- Constipation and diarrhea and anorexia

Renal, blood and circulation;

- Renal disease
- Anemia.

Adults;

- Altered testicular functioning
- Pituitary effects
- Sterility, infertility
- Effects on ovaries
- Decreased libido / sex drive

- Impotence

Kidneys;

- Renal damage
- Chronic lead nephropathy [kidney disease]
- Death from nephritis [kidney inflammation]
- Renal hypertension
- Increase in creatinine concentration

Nervous system;

- Encephalopathy
- Cerebrovascular diseases, stroke, cerebral haemorrhage
- Peripheral nervous system impairment
- Peripheral Arterial Disease
- Slowed nerve conduction velocity
- Tremor

Cardiovascular and circulation;

- Hypertension, elevated blood pressure
- Increased systolic blood pressure in men
- Cardio-toxic effects
- Increased risk of cardiovascular disease
- Coronary artery disease
- Anaemia; falling haemoglobin levels
- Platelet dysfunction
- Increased erythrocyte [red blood cell] protoporphyrin
- Increased protoporphyrin in urine
- Increased risk of early death from heart attack or stroke

Intellectual and mental;

- Depression
- Anxiety
- Personality changes
- Death from violence, suicide, accidents
- Impaired concentration
- Deficits in short term memory
- Cognitive function deficit

Behaviour;

- Sleep disturbance, insomnia
- Irritability, agitation, restlessness, aggression

Sensory;

- Abnormalities in visuomotor coordination
- Abnormalities in fine motor control
- Deficits in visual acuity
- Hearing loss

Gastrointestinal / Digestive

- Loss of appetite
- Nausea
- Constipation, diarrhoea
- Weight loss, anorexia

Bone, muscle and joint;

- Bone marrow alterations
- Muscular weakness
- Arthralgia (joint pain)
- Bone marrow alterations
- Bone lead mobilisation during menopause leads to decreased neurocognitive performance and increased systolic blood pressure in post-menopausal women
- Long term effect: linked to osteoporosis which has symptoms of decline in bone density and increase risk in fractures, also inhibit normal fracture healing

* **Proprioception** (from Latin *proprius*, meaning "one's own" and perception, is the sense of the relative position of neighbouring parts of the body. (Wikipedia 2010b)

Lead is already associated with a vast list of medical and behavioural problems, but research into strengthening these links and to establish any new links is warranted – just when you think lead couldn't possibly do any more damage than we already know about, another startling finding of harm at even lower blood lead levels is published.

49. The NHMRC supports research into synergistic effects of lead and other heavy metals, lead and pesticides, lead and other toxics. In particular, investigate the feasibility of developing a lead-free or even heavy-metal-free

cigarette so that the synergistic effects of smoking and lead exposure can be researched.

Investigation into the possibility of a lead-free cigarette must note the chemical composition and source of those chemicals within the cigarette. Jones (2010) produced an informative paper as to why people should stop smoking and the main conclusion was because tobacco is grown in radium rich soils. Radium releases radon gas which enables polonium and lead particles to attach to surrounding dirt and tobacco leaves. When radon gas decays, lead 210 and polonium 210 are produced. The fine extensions on tobacco leaves allow lead to stick to the leaf, even up to human consumption. Lead is not soluble in water, thus any washing of the leaves does not result in the removal of lead. Martin (2010) notes that radioactive elements found in cigarette smoke stick to the tar and are collected in the airways. Polonium 210 and lead 210 build up in these areas where cancer can be produced over time. Polonium 210 and lead 210 are poisonous radioactive heavy metals present in tobacco smoke. Radium is also present in phosphate fertilizers used in tobacco farming.

Based on this evidence, the feasibility of a lead-free cigarette lies in action from farmers and State government to oversee the reduction of radium in tobacco- farming soils. Environmental factors and soil composition affect the lead characteristics in cigarettes. Linking effects of smoking and lead exposure could be researched by testing the amount of lead in particular brands and places where cigarettes and tobacco are made. Articles outlining initial research into effects of cigarettes and lead exposure have emerged, but the relationship between soil composition and the tobacco plant should be researched for the presence of lead.

50. Fund clinical, double-blind* trials to test whether certain intervention protocols regarding the removal of lead from the body succeed in reducing risk of known health effects of low blood lead levels, specifically, levels below 10 μg/dL. These interventions should include low-dose chelation, Vitamin C, Pectin and Chorella.

* In a double-blind experiment, neither the individuals nor the researchers know who belongs to the control group and the experimental group. Only after all the data have been recorded (and in some cases, analyzed) do the researchers learn which individuals are which. (Wikipedia 2010c)

A study by Benjelloun, Tarras, Hachim, MedKouri, Gharbi-Benghanem and Ramdani, (2007) of patients with chronic lead nephropathy saw results when using chelation therapy which improved renal function and slowed the progression of renal insufficiency. The injection of ethylene-diamine-tetraacetic acid (EDTA) binds lead in the body and is removed by the kidneys. The success of chelation therapy is increased when the patient is removed from the primary lead source.

Chelation therapy can cause a depletion in the vitamins and minerals that are natural and essential to the body, so supplements are usually taken whilst the body flushes out lead. Under one protocol, it is a 12 week process, where the EDTA cleans the lead from blood and soft tissues, but lead in the bones cannot be removed by chelation therapy. Lead stored in the bones transfers back into the soft tissue and blood and breaks down over time. There are side effects associated with the therapy, so it is only used on patients with high blood lead levels. Succimer is a pill alternative to the IV drip of EDTA.

51. Design and implement a study to investigate the links between elevated blood lead levels and what are regarded as normal symptoms of ageing. Research the link between minerals returning to the blood stream as bones demineralise with age, and health effects including cardiovascular disease, high blood pressure, stroke, renal failure and osteoporosis.

Cardiovascular disease and stroke

Low bone mineral density has been linked to increased cardiovascular mortality, morbidity and atherosclerosis. Aortic calcification creates a barrier for blood flow to the heart. Osteoporosis and cardiovascular disease can be linked together by the presence of minerals, such as calcium and lead. Ageing causes demineralization of the bones as they break down when trying to regenerate and repair (Farhart & Cauley. 2008).

Navas- Acien, Guallar, Silbergeld, and Rothenberg (2006) studied the relationship between lead exposure and cardiovascular disease through a response method with lead exposure. They found hypertensive and cardiovascular health issues occurring at lead levels as low as 5µg/dL and below. Two explanations for this were oxidative stress and calcification of minerals. This links renal disease and cardiovascular pressure.

MacAulay- McDonnell (2008) states "a blood lead level of 2 µg/dL has been connected in a study by the US Centers for Disease Control and Prevention (CDC) with higher rates of cardiovascular disease. A blood lead level of 3.63 µg/dL or greater was connected with an 89% greater rate of death from heart attack, and a 250% greater chance of stroke. A higher rate of Arteriosclerosis has been found in adults with blood lead levels of greater than 10 µg/dL."

High Blood pressure

Navas-Acien et al. (2006) observed an inverse association between estimated glomerular filtration rate* and blood lead has been observed at blood lead levels less than 5 µg/dL. Lead-induced reductions in renal function could be linked with hypertension. They concluded that the higher the blood lead level, the higher the systolic blood pressure. A study by Brautbar (2008), found a relation between low blood lead levels and increased blood pressure. This shows that national and occupational blood lead levels must be lowered.

* **Glomerular filtration rate** (**GFR**) is the volume of fluid filtered from the renal (kidney) glomerular capillaries into the Bowman's capsule per unit time (Wikipedia 2010d).

Renal failure

Benjelloun, Tarras, Hachim, MedKouri, Gharbi-Benghanem and Ramdani (2007) reported a case of a man who spent his life working in a lead risk job and with a blood lead level of 9.2 µg/dL presenting with chronic lead nephropathy. He was prescribed medicine to reduce high blood pressure and underwent chelation therapy. Renal failure is linked with osteoporosis and high blood pressure. The 'diseases of ageing' are intertwined and related to the process of bone demineralization.

Lin, Dan-Tzu, Kuang-Hung and Chun-Chen (2003) researched patients with chronic renal insufficiency; some of the study group were assigned lead-chelation therapy with EDTA. Chelation therapy improved renal function compared to the control group, and they concluded that low level lead exposure accelerates renal insufficiency.

Osteoporosis;

Osteoporosis is a reduction in bone mass sufficient to increase the risk of fracture. The study by Campbell and Auinger (2007) concluded that there was an inverse association between lead exposure and bone mineral density in people over 50 years of age, due to longer lead exposure time and storage in the bones. Calcium interrupts the absorption of lead that interferes with red blood cell production.

Lead causes the bones to stop growing before natural growth has finished, and depresses the regeneration of bone throughout the lifetime. Therefore, the bone is not maintaining density (Rico, 1991). Lower bone density occurs in people with higher blood lead levels. The body releases calcium stores when needed but the body cannot distinguish between calcium and lead so both are reintroduced into the bloodstream (Farhart and Cauley, 2008).

Mental decline

The Associated Press (2008) suggests that long exposure to lead makes an aging person's brain work as if it's five years older than it really is, suggesting that reductions in environmental lead have not stopped the effects of lead. Symptoms like forgetfulness or tremors appear when brain cell reserves are depleting. Lead is easier to measure in the shinbone and shows the accumulation of lead over time. They gave each participant a mental ability test and found that the higher the lifetime lead dose, the poorer the performance across a wide variety of mental functions. From low to high doses of lead, the difference in mental functioning was equivalent to ageing by two to six years.

Ageing is becoming a more publicized issue, which highlights the need for decreased blood lead levels as the accumulation of lead in the bones is the most commonly documented as the cause of premature ageing.

52. Direct the National Institute of Clinical Studies (NICS) to commission the writing of Tertiary Lead Poisoning Prevention Clinical Practice Guidelines for web-publication at the NHMRC's Guideline Portal (2010) and to organise for lead management knowledge to infiltrate all other relevant clinical practice guidelines e.g. "Calcium and Bone Health", "Clinical Guidelines for Management of Cardiovascular Risk", "My hands shake: Classification and Treatment of Tremor."

International extension work

Extend the benefits of this policy internationally, in accordance with Australia's commitment to the OECD Declaration on Risk Reduction for Lead 1996).

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