



## Health surveillance – Lead (inorganic)

Medical practitioners undertaking health surveillance are required to have an understanding of the potential adverse health effects of inorganic lead and to use their clinical knowledge to advise on health surveillance for workers in the workplace.

### Sources

Occupational exposure to inorganic lead occurs in a wide range of industrial, manufacturing, construction and mining activities which produce lead dust or fumes.

Lead is present in significant quantities as a contaminant in the processing and smelting of mineral ores and hence in mining wastes. Lead is used as an additive in fire assay laboratories and gold processing. Inorganic lead itself is mined as lead sulphide (galena) or lead carbonate resulting in exposures from mining, processing, transportation and storage.

Lead was historically used in fuel and paint, resulting in environmental contamination of soil. It is present in solder, metal alloys, radiators, old paintwork, detonators, explosives, bullets, batteries and lead shielding from radiation.

Lead-risk industries include lead soldering, radiator repair, lead alloys, fire assay laboratories, foundries (melting, casting, machining), lead battery manufacture or its breaking and dismantling, the welding, cutting or cleaning surfaces coated with lead or paint containing more than 1% lead, and its removal by abrasive blasting and high pressure water jet or machining.

Non-occupational exposure can be significant from activities such as melting lead sinkers (fishing), home renovations, lead paint removal, use of cosmetics (kohl), lead glazed food containers and glassware.

### Toxicokinetics

Inorganic lead enters the body through inhalation and ingestion. About 10% of ingested lead is absorbed in the gut. Between 50-80% of inhaled lead is absorbed through the lungs. Lead is excreted predominantly by the kidneys (70%).

Lead is distributed in three compartments in the body:

- a) blood (binds quickly to red blood cells) with a half-life of 30-40 days
- b) soft tissues (kidneys, brain, liver, bone marrow) with a half-life of 40 days, and
- c) bone with a half-life of up to 25 years.

Ninety per cent of the total body lead is stored in bone. Lead released from bone in osteoporosis, pregnancy and fractures will raise the level of lead in blood.

Lead inhibits enzymes (including ALA dehydratase and ferrochelatase) which are involved in the synthesis of haem, an essential component of haemoglobin in red blood cells. Lead shortens the lifespan of red blood cells. Anaemia develops when the lifespan has been

reduced from 120 days to 30 days. Affected red cells are more fragile and their removal from circulation stimulates bone marrow production resulting in stippled red cells.

Lead crosses the blood-brain barrier and placenta. Lead can be transferred from the mother to the infant through breast milk.

## Health Effects

Lead is a cumulative toxic substance.

In adults with chronic low level exposure, there may be effects on the body's digestive, cardiovascular, renal, reproductive and neurological functions. Chronic exposure to levels above 20 µg/dL can cause subclinical effects on cognitive function and adverse effects on sperm quality. However, symptoms may be absent or mild until blood levels are significantly elevated. Mood changes, anaemia, abdominal colic and constipation may be more apparent when blood lead levels exceed 60 µg/dL.

Exposure to high levels of lead dust or fumes cause anaemia, peripheral neuropathy, and damage to kidney and brain (encephalopathy). However, severe health effects are now extremely rare in Australia.

Young children (under five years) are more vulnerable. They absorb 3 times more lead than adults from ingestion. They are more prone to encephalopathy at a lower blood lead level as their brains are rapidly developing. Blood lead levels greater than 10 µg/dL may potentially be harmful with reports of impact on IQ, and behavioural disturbance. Ingested lead is absorbed at a higher rate in children. Hence, personal hygiene of the worker is vital to avoid contamination of the home environment.

**Table 1 Adverse effects of lead**

Blood lead level (µg/dL)	Signs and/or symptoms may include:
10-20	Increased blood pressure, abnormal renal function
20-40	Reduced renal function, reduced nerve conduction and abnormal postural balance
60	Neurobehavioural affects - tiredness, moodiness, headache and vague aches
80	Anaemia develops
70-90	Encephalopathy in children (headache, vomiting, ataxia, seizures, paralysis, stupor, coma)
100	Abdominal colic, peripheral nerve palsies, muscle wasting and encephalopathy
150	Encephalopathy in adults

## Non-occupational exposure levels

The average background blood lead level among Australians is less than 5 µg/dL (NHMRC, 2015; NHMRC, 2016). Levels above 5 µg/dL are considered to be consistent with exposure above the background level e.g. from work activities, hobbies or home renovations.

## Surveillance guidelines

A baseline health surveillance is recommended prior to commencement of work, then at two and six months after the initial test. Thereafter, the frequency of testing is determined by the blood lead levels as outlined in the tables below.

Important considerations in the assessment of risk and the potential for elevated blood lead levels are:

- Nature and duration of the exposure, including the year of first exposure;
- Work environment controls;
- Personal hygiene;
- Smoking history; and
- Age and gender, specifically females of reproductive age.

Monitoring blood lead levels enables early intervention by the medical practitioner. Early intervention includes:

- education (lead hazard and health effects)
- counselling (safe work practices, personal hygiene)
- temporary removal from lead work
- re-instatement when appropriate
- feedback to the employer for remedial measures (to improve safety controls).

Workplaces should provide amenities for hot water for hand washing and showering. Personal hygiene must be strictly monitored (washing face and hands before eating; no smoking, eating or drinking in lead work area; laundry provisions, showering and changing into clean clothes before leaving work). It is essential that workers do not bring lead dust home from work.

## Threshold actions

The removal level of females of reproductive capacity is 10 µg/dL.

The removal level for males and females (not of reproductive capacity) is 30 µg/dL.

Pregnant and breast-feeding women must be removed from lead-risk work.

**Table 2 Male workers, and female workers (not of reproductive capacity)**

Blood Lead Level (BLL)	Actions
Less than 10 µg/dL	Re-test six monthly.
10 to below 20 µg/dL	<ul style="list-style-type: none"><li>• Counsel worker and review personal hygiene/work practice.</li><li>• Liaise with employer regarding remedial measures (review personal hygiene, investigate workplace exposure and safety controls).</li><li>• Re-test at three months.</li></ul>
20 to below 30 µg/dL	<ul style="list-style-type: none"><li>• Counsel worker and review personal hygiene/work practice.</li></ul>

	<ul style="list-style-type: none"> <li>• Consider removal from lead work when BLL exceeds 25 µg/dL.</li> <li>• Liaise with employer regarding remedial measures (as above).</li> <li>• Re- test in 6 weeks.</li> <li>• Consider medical examination.</li> </ul>
30 µg/dL or greater	<ul style="list-style-type: none"> <li>• Remove from lead work and notify all parties including WorkSafe without delay.</li> <li>• Conduct medical examination within 7 days.</li> <li>• Counsel employee and review personal hygiene/work practice.</li> <li>• Liaise with employer regarding remedial measures (as above).</li> <li>• Re-test in one month and so forth.</li> <li>• Medical practitioner may certify suitable to return to lead work when BLL is less than 20 µg/dL.</li> </ul>

### Table 3 Female workers (of reproductive capacity)

Pregnant and breast-feeding women must be removed from lead-risk work (reg. 5.63).

Blood lead level	Actions
Less than 5 µg/dL	<ul style="list-style-type: none"> <li>• Six monthly testing.</li> </ul>
5 to below 10 µg/dL	<ul style="list-style-type: none"> <li>• Counsel worker and review personal hygiene/work practice.</li> <li>• Liaise with employer regarding remedial measures (review personal hygiene, investigate workplace exposure and safety controls).</li> <li>• Re-test at 6-8 weeks.</li> <li>• Consider medical examination.</li> </ul>
10 µg/dL or greater	<ul style="list-style-type: none"> <li>• Remove from lead work and notify all parties including WorkSafe without delay.</li> <li>• Conduct medical examination within seven days.</li> <li>• Counsel worker and review personal hygiene/work practice.</li> <li>• Liaise with Employer regarding remedial measures (as above).</li> <li>• Re-test at one month and so forth.</li> <li>• Medical practitioner may certify suitable to return to lead work when BLL is below 5 µg/dL.</li> </ul>

### Health counselling

The medical practitioner has an important role in educating and reinforcing good personal hygiene and safe work practices through the following:

- Inform workers of potential adverse health effects from lead exposure to themselves and their family.
- Counsel all workers to stop smoking.
- Advise workers to be clean shaven to permit effective respiratory protection.
- Reinforce safe work practices (such as effective local exhaust ventilation, avoidance of dry sweeping, cleaning of the work area with HEPA filter vacuum cleaner, use of respirators with appropriate level of protection.).
- Reinforce personal hygiene and cleanliness, including:
  - washing face and hands before eating or drinking

- avoiding eating, drinking or smoking in the workshop
- showering and changing into clean clothes and footwear before leaving work.

### Removal from lead-risk work

The medical practitioner removes the employee from lead-risk work when the removal threshold is exceeded or when the blood lead level is close to approaching the removal threshold.

The medical practitioner arranges the removal of the employee from lead work immediately by notifying the regulator, employer and employee, and arranges a medical examination of the employee within seven days of the removal.

The frequency of blood lead level testing is at the discretion of the medical practitioner. The employee must not return to lead work until:

- the blood lead level is less than 20 µg/dL for male employees and female employees not of reproductive capacity, or
- the blood lead level is less than 5 µg/dL for female employees of reproductive capacity and
- has been certified as suitable to return to lead work.

### Role of the medical practitioner

The medical practitioner:

- supervises the health surveillance,
- informs the worker and explains the results of the assessment,
- informs the employer of the outcome of the assessment and advises on the need for remedial action (if any)

#### For mining operations (Mines Safety)

The employer submits the biological monitoring results to Mines Safety via SRS.

#### For all other industries (WorkSafe)

The appointed medical practitioner (AMP) has a duty to notify health surveillance results to the regulator. The AMP forwards the completed [Health Surveillance Notification Form- Lead](#) along with the pathology laboratory report, to [safety@dmirs.wa.gov.au](mailto:safety@dmirs.wa.gov.au).

### References

- [Occupational Safety and Health Regulations 1996](#), Subdivision 2 – Lead.
- [Health surveillance – Information, guides and forms](#) – WorkSafe website
- [Health monitoring for registered medical practitioners guide \(2020\)](#) Safe Work Australia
- [Hazardous chemicals requiring health monitoring \(2013\)](#) Safe Work Australia
- [Information Paper: Evidence on the effects of lead on human health](#). National Health and Medical Research Council (NHMRC), May 2015
- [Managing individual exposure to lead in Australia – A guide for health practitioners](#). National Health and Medical Research Council (NHMRC), April 2016. A30008549