LEAD EXPOSURE IN THE WORKPLACE

A Physicians' Guide

Manitoba Department of Labour

Occupational Health Branch

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LEAD EXPOSURE IN THE WORKPLACE

Possible Sources of Exposure

- primary and secondary lead smelters and foundries
- battery manufacturing and battery reclaiming industry
- radiator and muffler repair shops
- gunsmiths and shooting galleries
- auto and ship paint industries
- glass and ceramics industries

Route of Absorption

Adults vary somewhat from children as to: source of lead, intake route and different absorption rates. Adults receive about 70% of their body lead burden from food and water and about 20% through inhalation, particularly in industry. Children receive most of their lead burden via the oral route, and about two-thirds from food and one third through oral contact with lead laced soil and old paint. G1 absorption in children is about 40% compared to adults at about 15%.

Biological and Health Effects of Lead

There is a "rapid turnover pool" which consists of blood and organs with a blood lead half-life of three to four weeks, and a "slow turnover pool" which consists largely of bones with a lead half-life of anywhere from 7 to 15 years and where 95% of the body lead burden is located.

1. **Deleterious effects** of lead occur at blood lead levels well below those at which clinical symptoms appear. Additionally there is poor correlation between blood lead levels and clinical effects. Haematopoietic effects (increase of delta-aminolevulinic acid (ALA)) may be demonstrable at B-Pb levels as low as 0.5 umol/l (10mg/dl). Free erythrocyte protoporphyrin (FEP) (or zinc protoporphyrin (ZPP) may begin to increase at B-Pb levels of 1 umol/L (20mg/dl). However, BPb correlates poorly with symptomatology and body lead burden. The FEP is a reasonable indicator of increased body lead burden

2. **Reproductive Effects** such as lower sperm count in males and fetal CNS development impairment may occur at blood lead levels below workplace intervention levels. Therefore women, especially in childbearing years, working in lead-using industries need to be advised accordingly, since for some lead-based industries it may be impossible to limit lead exposure to a level considered safe for normal fetal development.

3. **Clinical Signs and Symptoms**

The definition of lead poisoning is generally made clinically with blood lead levels representing only a rough estimate of the amount of exposure.

Acute lead intoxication is rare.

Chronic lead intoxication most commonly presents with:

- gastrointestinal complaints (constipation, colic, etc.)
- CNS effects (decreased mentation, lack of concentration, mood changes, etc.)
- peripheral neuropathy (wrist drop, muscle aches, etc.)
- other organ damage (kidney impairment, hypertension, anaemia)

Treatment and control

In Manitoba, the following guideline is used Workplace Safety and Health Division:

Interpretation of Lead Levels

LEVEL	INTERPRETATION
<1.4 umol/l (30ug/dl)	acceptable
1.5 – 1.9 umol/l (30-39 ug/dl)	caution – exposure should be reduced
2 – 2.4 umol/L (40-49 ug/dl)	caution – review of work practices; reduce exposure
>2.4 umol/L (50ug/dl)	removal from exposure – medical assessment is required – compensation is possible – a physician should be consulted.
Caution: lead-in-blood values do not provide information on the degree of burden of lead in the body	

NOTE: In the absence of characteristic symptoms or signs, the diagnosis of lead poisoning should not be made on the basis of laboratory data alone. The blood lead and other biochemical indicators of lead's effects on heme synthesis are useful in estimating the degree of exposure and hazard, but should be used in concert with clinical judgment.

Prevention

The most significant element in dealing with industrial lead poisoning continues to be prevention. Even if working conditions are not ideal, adequate protection can be provided using various protective methods and devices; respirators being the most prominent, but personal care and hygiene are the most important. Workers in industries where there is significant exposure to lead from dust or fumes (or indeed from any source) should be required to have blood lead level measured at least every six months.

Worker Removal (B-Pb > 2.4 umol/L)

After removal, the worker should be employed in safe surroundings until his blood tests fall to acceptable levels. Such removal may be prolonged in some cases or permanent if the worker has evidence of clinical disease. Workers Compensation Board policies allow for compensation of workers with excessive blood lead values or clinical symptoms, and provide for income maintenance during removal.

Treatment

Chelation is rarely necessary today since workplaces are required to provide adequate environmental and personal exposure controls thereby keeping B-Pb levels relatively low. If chelation is deemed necessary it should be based in a hospital with the specialized laboratory service necessary for patient monitoring. Consultation with a physician expert in heavy metal poisoning should be sought.

The Role of Manitoba Department of Labour

The role of Manitoba Department of Labour (includes Safety and Health Officers, Occupational Hygienists and the Chief Occupational Medical Officer) assesses workplaces where excessive lead exposure is deemed to have happened. Orders can be written which would include appropriate engineering controls to limit lead exposure, the provision devices such as respirators where environmental engineering cannot control the lead exposure appropriately. The employer is required to set an occupational exposure limit (OEL). the Manitoba Department of Labour recognizes 50 mcg/m^3 as a time-weighted average for the maximum allowable exposure.

Any suspect workplace induced lead poisoning should be reported to the Chief Occupational Medical Officer.

A guideline reflex generally recommended practice.

Reference: The College of Physicians and Surgeons of Manitoba: Guidelines & Statements Manual, p. 2-G15

Appendix 1

Action Levels For Lead –In-Blood Determinations

Blood Lead Level	Minimum Frequency of Follow-up	Required Actions
<1.5 umol/l (30 ug/dl and less)	every 6 months	Identify sources of exposure and reduce exposure to as low as possible.
1.5-1.99 umol/l (30-39 ug/dl)	every 3 months	Identify source of exposure and discuss with worker. Reduce exposure as possible and ensure safe work practices.
2.2.49 umol/l (40-49 ug/dl)	every 1 month	Identify source of exposure and ensure that airborne lead levels are below 50 ug/m^3 (considered as an eight hour average without reference to personal respiratory protection). Discuss level with worker and seek to reduce exposure through environmental controls if possible. Use personal protective equipment when environmental controls are not possible. An evaluation of the environmental controls at the work site shall be initiated.
≥2.5 umol/l (50 ug/dl and over)	as indicated by attending physician	Worker must be informed and removed from the lead-containing environment until his/her lead level returns to acceptable levels below 50 ug/dl. The worker may work in a job with minimal lead expsoure (30 ug/m^3 considered as an eight hour average) or if no such job is available, apply for compensation. The source of the exposure should be identified and corrected to ensure that no other workers are similarly affected. An evaluation of the environmental controls at the worksite shall be initiated.

Appendix 2

Summary of Lowest-Observed-Effect Levels for Key Lead-Induced Health Effects in Adults

Lowest observed-effect level (PbB)[O]	Heme synthesis and hematololical effects	Neurological Effects	Effects on the Kidney	Reproductive function effects	Cardiovascular effects
100-120		Encephalopathic signs and symptoms	Chronic nephropathy		
80	Frank anemla				
60				Female reporductive effects Altered testicular function	
50	Reduced hemoglobin production	Overt subenoephalopathic neurological symptoms			
40	Increased urinary ALA and elevated coproporphyrins	Peripheral nerve dysfunction (slowed nerve conduction)			
30					Elevated blood pressure (white males aged 40-59)
25-30	Eythrocyte protoporphyria (EP) elevation in males				
15-20	Erythrocyte protoporphyrin (EP) elevation in females				
<10	ALA-Dinhibition				

[o] PbB= Blood lead concentrations

Source: Toxicological Profile for lead Atlanta GA, US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry: 1990.ATSDR publication TP-88/17

Appendix 3

Minimum Components of a Medical Evaluation

Full work and medical history with special attention to:

- blood pressure
- gums and teeth
- pulmonary *(if respirator is to be used)*
- cardiovascular
- gastrointestinal
- hematologic
- renal
- neurological
- reproductive

Full physical exam with special attention to:

- blood pressure
- gums and teeth
- pulmonary (*if respirator is to be used)*
- cardiovascular
- gastrointestinal
- hematologic
- renal
- neurological

Laboratory:

- blood lead level (BLL)
- complete blood count with smear
- free erythrocyte protoporphyrin (FEP)
- blood urea nitrogen
- serum creatinine
- urinalysis
- pregnancy test (*if requested by employee or as requested by physician)*
- semen evaluation (*if requested by employee or as requested by physician)*

APPENDIX "A"

"ELEMENTS OF AN OCCUPATIONAL HEALTH SERVICE"

Through the authority vested in me under Section 53(2) of The Workplace Safety and Health Act I herein and below (sections A to H inclusive) specify the services to be provided by the Occupational Health Service.

A. Environmental Monitoring - covered by MR53/88

A.1 Monitoring, when required, shall be undertaken according to the protocol and criteria as outlined in **Appendix B.**

.A.2 Notwithstanding Sections 19 and 20 but in accordance with Section 23 of MR53/88, the occupational exposure limit (OEL) for airborne lead shall be 50ug/m^3.

A.3 The employer shall perform an assessment of individual exposures to hazardous substances including lead and work practices so as to minimize the risk of injury and illness.

A.4 The employer should perform an assessment of other physical, chemical, electrical, thermal, psychological, ergonomic and infective hazards.

Furthermore in situations where lead exposure is happening, Environmental Monitoring may be necessary. This shall be carried out as outlined in **Appendix B.**

B. Biological Monitoring

B.1 Routine monitoring of blood lead levels of all employees exposed to lead and corresponding action shall be performed in accordance with the requirements outlines in Schedule A. It is the responsibility of the contracted physician to ensure that each worker is informed of his/her blood lead level in such a manner that the worker understands the implications for health, work and compensation under the Workers Compensation Board. The contracted physician shall distribute the laboratory results forms to worker, employer, and workplace safety and health committee as outlined in **Appendix 1**.

C. Routine Physical Examinations

C.1 The employer shall cause routine medical examinations to be done on all workers exposed to lead including casual labour, at pre-placement and when returning from disability so as to ensure he/she is fit to work. Specifically, prior to starting

on the job each worker must have a medical examination including measurement of their blood lead levels. The action levels for new workers are mandated under **Appendix 1**.

D. Emergency and Trauma Care

D.1 The employer shall cause that the provision of reasonable emergency care, especially for known hazards in the worksite, be in place. This shall include adequate facilities (e.g. an eyewash station when acid is present), for dealing with known hazards in the worksite. A first-aid kit and staff knowledgeable in its use shall be present at the worksite at all times in accordance with Manitoba regulations.

E. Reports of the Occupational Health Service

E.1 There shall be regular meetings (minimum quarterly) between the employer, worker representative and occupational health nurse and the physician to review the state of occupational health in the workplace and plan for and implement improvements and make reports accordingly. These reports shall be available to the Chief Occupational Medical Officer on request.

G. Staffing

G.1 Physician Service:

The minimum time requirement is 1 hour every 3 months but shall be increased as necessary to carry out fully the functions as outlined in A to H.

G.2 The contracted physician shall be a duly qualified medical practitioner who is licenced to practice medicine in Manitoba. Training in occupational medicine is not required but the physician should seek consultation from experts as needed.

G.3 The contract between the physician and employer shall recognize the intrinsic Doctor/patient relationship between the physician and worker. Where a conflict of interest exists between the health professional's responsibility to the worker and his/her duties to the employer, the interests of the worker will take precedence.

G.4 Occupational Health Nurse:

The minimum time requirement is 2 hours every 4 weeks. This time shall be increased depending on implementation requirements and critical incidents review requirements pertaining to the lead exposure protection program as explained in sections B and E.

G.5 The occupational health nurse shall be registered to practice nursing in Manitoba. Certification in occupational health nursing is desirable.

H. Training

H.1 The employer, in consultation with the contracted physician, nurse and Workplace Safety and Health Committee or Workplace Safety and Health Representative shall establish and implement a training program so as to ensure that workers are knowledgeable of the hazards, safe work practices, proper use of safety equipment and remedial measures associated with lead exposure.

APPENDIX "B"

ENVIRONMENTAL MONITORING OF LEAD-IN-AIR

The primary focus of the health and safety program should be to control the exposure of the workers to lead. These controls include:

a) the installation of adequate engineering and ventilation controls to limit the exposure to lead;
b) the appropriate hygiene facilities to limit ingestion of lead and its transportation to the workers; homes;
c) the appropriate use of respiratory and other protective equipment as necessary;
d) the education fo workers sot that workers will understand the importance of personal hygiene and use of protective equipment; and
e) the supervision of workers to ensure safe and healthful work practices.

Under Section 21 of Manitoba Regulation 53/88, the Workplace Health Hazard Regulation, the occupational exposure limit for a worker to airborne lead shall be no greater than 50 micrograms per cubic meter of air, ($50ug/M^3$) considered as an eight hour time weighted average, without reference to respiratory protection. Manitoba Regulation 53/88, Section 31(1), further requires that you shall not consider the use of respiratory protection as a means of controlling worker exposure to airborne lead to below $50ug/M^3$ unless no other method of control is reasonably practicable.

Measurement of personal exposure to lead must be performed on all workers exposed to a lead-in-air concentration of greater than $30ug/M^3$ considered as an eight hour average (without reference to personal respiratory protection). Such tests are to be undertaken during representative work regimes. Advice about sampling and analysis is available from the Workplace Safety and Health Division, 200-401 York Avenue, Winnipeg, Manitoba R3C OP8.

Qualified persons or an agency acceptable to the Division shall perform the testing. Where a Safety and Health Committee or a Safety and Health Representative is required by law, management shall consult with the Committee or Representative respecting persons to be monitored and sampling times. The Worker Co-chairperson of the Workplace Safety and Health Committee or Safety and Health Representative shall audit the monitoring procedure and may make notes or observations to assist in interpretation of data. The duration of monitoring shall not be less than four hours exclusive of breaks (eg. lunch, coffee, etc.) providing that similar operations continue during the balance of the working day.

The following information must be recorded during monitoring:

i) site plan showing locations of lead sources and persons in the area specifying the workers being monitored,

ii) environmental conditions, including outside air temperature, wind direction, and barometric pressure,

iii) temperature at sampling locations, (eg. room temperature),

iv) production description and rate, including temperature of any heated product (what is happening and how much is being produced),

v) sampling times,

vi) names of persons being monitored and job descriptions,

vii) time and duration of "breaks" during monitoring, eg. lunch, coffee,

viii) observations of activities including "unusual" occurrence and any information which would assist in interpreting the data,

ix) description of personal respiratory protective equipment.

The report on the monitoring must be in writing and must include the above information plus the following:

a) pump calibration information, (litres/minute)
b) laboratory results respecting lead on filter data,
c) calculated lead in air exposures of workers in micrograms per meter cubed (ug/m^3),

The report shall be filed with the following persons or agencies:

1) contracted occupational health physician,
2) contracted occupational health nurse,
3) one copy to the worker co-chairperson, and one copy to the management co-chairperson of the Workplace Safety and Health Committee,
4) Safety and Health worker representative where no Safety and Health Committee is required,

5) Workplace Safety and Health Division,

6) a copy shall be posted in an area regularly used by workers (eg. Workplace Safety and Health Bulletin Board, lunchroom, etc.).

The report shall be communicated no later than 5 working days according to Section 27(2b) of MR 53/88 after test data has been received.