LEAD EXPOSURE

MEDICAL SCREENING GUIDELINE FOR WORKERS

Manitoba Department of Growth Enterprise and Trade

Workplace Safety and Health

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A. INTRODUCTION

Lead can be found everywhere in our indoor and outdoor environment. It is found in the air, soil, dust, drinking water, food and various consumer products, such as paints, batteries, children's jewelry, art supplies, solder and canned foods, crystal, ammunition, ceramic ware, screen monitors, vinyl blinds, candles, children's toys, shot, jiggers, and sinkers. Concentrations of lead in the environment increased most dramatically since the 1920s, following the introduction of lead additives in automobile gasoline. Over the past 25 years, Health Canada, Environment and Climate Change Canada, and other Canadian regulatory agencies have substantially reduced Canadians' exposure to lead by legislating and enforcing maximum lead concentrations in gasoline and house paints. Also, the use of lead-soldered food cans has been virtually eliminated through an agreement negotiated with Canadian canneries. Lead concentrations in the air have declined significantly since the introduction of unleaded gasoline in Canada in 1975. Currently, the level of lead in the air of most Canadian cities is below the detectable level. However, lead particles from gasoline emissions are still a source of lead in our environment today. In addition, leaded gasoline is still being used in many countries, so contamination of the atmosphere continues. Most of the lead in soil comes from particles falling out of the air and from rocks that contain lead. Lead-contaminated dust and soil can cling to skin, hair, shoes, clothing and vehicles and be carried indoors. Lead may enter potable water at several points between water treatment plants and people's homes. Potential sources of lead include valve parts or gaskets found in treatment plants as well as in older distribution mains and service lines. In dwellings, pipe jointing compounds, soldered joints and brass fixtures are also possible sources of lead.

This guideline relates to industries and workplaces where there is a potential for workers to be exposed to lead. Some workplaces where this hazard may be present include, but are not limited to:

- 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
- certain paints in disrepair, renovation, or demolition projects

Route of Absorption - Adults vary somewhat from children as to source of lead, intake route and absorption rates. Adults receive about 70% of their body lead burden from food and water and about 20% through inhalation, particularly from their workplaces. Children receive most of their lead burden via the oral route--about two-thirds from food and one third through oral contact with lead-laced soil and old paint. Gastrointestinal (GI) absorption in children is about 40% compared to adults at about 15%[1]. Household members of workers with lead exposure are at increased risk for lead poisoning if lead is carried home on the worker's body, clothes, shoes, or in a personal vehicle ("take-home" exposure).[2]

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 (BLLs) well below those at which recognizable clinical symptoms appear particularly in children. No safe blood lead level in children has been identified. Even low levels of lead in blood have been shown to affect IQ, ability to pay attention, and academic achievement. Additionally there is poor correlation between blood lead levels and clinical effects at lower levels. Hematopoietic effects (increase of delta-aminolevulinic acid (ALA)) may be demonstrable at BLLs as low as 0.5 µmol/L (100 µg/L). Free erythrocyte protoporphyrin (FEP) (or zinc protoporphyrin (ZPP)) may begin to increase at BLLs of 1 µmol/L (200 µg/L). However, BLL 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 impaired fetal CNS development may occur at blood lead levels below workplace intervention levels. For some lead-based industries, it may be impossible to limit lead exposure to a level considered safe for normal fetal development. Therefore, women and men working in lead-using industries, especially those in the childbearing years, need to be advised accordingly.

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 body burden.

   Lead intoxication most commonly presents with:

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

B. PURPOSE OF A MEDICAL SCREENING PROGRAM

Definition of Lead Exposed Worker – A "lead-exposed worker" is defined as any worker who is handling or disturbing materials with a significant lead content in a manner that could reasonably be expected to cause potentially harmful exposure through lead dust inhalation or ingestion, regardless of airborne lead concentrations, surface contamination levels, or type of respiratory protection being used.[3]

Prevention - The most significant element in dealing with industrial lead poisoning continues to be prevention. In workplace processes where it is shown that engineering controls to mitigate the risk of worker exposure to lead are not feasible or practicable, adequate protection can be provided using personal protective equipment (PPE) such as respirators, protective clothing (gloves, boots, coveralls, face shields), etc. as may be required. However, personal care and good hygiene (hand washing, laundering, etc.) are essential preventative measures in the workplace.

Role of the Workplace Safety and Health Branch – Workplace Safety and Health enforces The Workplace Safety and Health Act and its three associated regulations in order to ensure Manitoba's workplaces are safe and healthy. Manitoba Regulation (MR) 217/2006, Part 36[4] requires employers to conduct a risk assessment to determine if lead present in the workplace presents a risk to the health of the workers. The risk assessment will involve a review of work processes including, but not limited to, the collection of air samples at worker breathing zones (personal monitoring) and in the general work areas (area sampling), an evaluation of the effectiveness of engineered control measures and personal protective equipment (PPE) being used for the work process, and the safe work procedures. The assessment must be carried out by a competent person who is knowledgeable, experienced and trained in occupational hygiene practice, which includes hazard identification, chemical routes of entry and their effects on body systems, sample collection, data interpretation and reporting.

Role of the Chief Occupational Medical Officer (COMO) - In general, workers in industries where there is a risk of exposure to lead from liquids, dust, fumes or any source may be required to have blood lead levels measured regularly as part of a medical surveillance program. Section 50 of the *Workplace Safety and Health (WSH) Act W 210, http://web2.gov.mb.ca/laws/statutes/ccsm/w210e.php* empowers the Chief Occupational Medical Officer (COMO) of the WSH Branch to order health surveillance monitoring of workers, where considered desirable for administration of the WSH Act. Consistent with the COMO's power, employers must ensure that all workers who are at risk of repeated or excessive exposure to lead in the workplace undergo health surveillance monitoring (medical screening) as outlined in this guideline.

If the results of medical screening indicate an abnormality, WSH may review the employer's risk assessment, safe work practices, engineered control measures, PPE, worker training and/or the individual worker habits to incite any required improvements at the workplace.

C. MANAGEMENT OF LEAD INTOXICATION

The preferred sample for monitoring and management of lead intoxication is a whole blood sample. While other samples may be more convenient to collect, a whole blood sample provides the best understanding of lead intoxication. The blood sample must be collected in a metal-free container in addition to any other sample collection requirements specified by the laboratory performing the testing.

The amount of lead found in a whole blood sample may be measured in micrograms of lead per deciliter (1 dL = 100 mL) of blood (µg/dL), micromoles of lead per liter of blood (µmol/L), and micrograms of lead per liter of blood (µg/L). While much of the literature describes lead levels in µg/dL, especially in the United States, Manitoba currently get reports in µmol/L and µg/L. The molar mass of lead is 207.2 g/mole, so multiplying a value expressed in µmol/L will convert the value to µg/L.

0.24 µmol/L is equivalent to 0.24 µmol/L * 207.2 g/mole = 50 µg/L, which is equivalent to 5 µg/dL

Worker Removal (BLL > 0.97 µmol/L) –Where health surveillance indicates BLL > 0.97 µmol/L, the worker shall be removed from the hazardous environment. After removal, the worker should be employed in safe surroundings until his/her blood tests fall to acceptable levels. Such removal may be prolonged in some cases or permanent if the worker has evidence of clinical disease.

Treatment – The most important aspect of treatment is stopping ongoing exposure. Chelation is only necessary for severely symptomatic individuals. Consultation with a physician expert in heavy metal poisoning should be sought if chelation is being considered.

Ongoing communication with the Chief Occupational Medical Officer is vital to ensuring other workers in the workplace are screened, hazardous exposures are properly managed, and workplaces remain compliant with Health and Safety standards and legislation. Reporting to Manitoba WCB as required should continue.

D. EMPLOYER AND EMPLOYEE RESPONSIBILITES

The employer is responsible for establishing a medical screening program in his/her workplace that is consistent with this guideline. All workers deemed to be at risk of exposure to lead from workplace activity must have full access to the program activities and comply with the components outlined in this document (Section 5 Duties of Workers of the WSH Act). The employer is responsible for all the expenses incurred in the medical screening program, including the cost of baseline tests, intermittent tests and any medical referral (eg. following an abnormal lab test) required to establish a diagnosis and determine its work-relatedness. The employer must make the arrangements for payment of tests.

A health care professional must administer the lead medical screening program. The employer must protect the confidentiality of the worker's specific, personal medical information. It must not be included in the worker's regular personnel file.

Larger companies may have an occupational health service. Smaller employers may contract with community-based healthcare providers (eg. local physicians, clinics, biomedical testing agencies, etc.). If the employees' personal physicians are to be used for surveillance, the employer must either provide the appropriate requisitions created by the pre-arranged laboratory/service provider or the billing information/account number to the employees to give to their respective physicians or laboratories for payment of services.

In addition, employers shall report medical evidence of worker exposure to lead to the:

- Workers Compensation Board of Manitoba (WCB)
- COMO where the exposure to lead is known, or suspected, to have resulted from work carried out at the workplace.

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.

E. WHO SHOULD UNDERGO SURVEILLANCE

This Guideline applies to workplaces where workers work with or near lead or lead containing substances in the form of liquids, dust, fumes, or any source while carrying out their daily tasks at the workplace.

Worker exposure to lead can occur when working in an environment below the Occupational Exposure Limit, through dermal contact or any manner identified by the risk assessment carried out under Part 36 for Chemical and Biological Substances of Manitoba Regulation (M.R.) 217/2006, regardless of the type of respiratory or other protection used. While the most common routes of exposure for inorganic lead are inhalation and ingestion, dermal contact plays a larger role in exposure to organic lead [tetraethyl lead, $(C_2H_5)_4Pb$], as this type of lead is more likely to be absorbed through the skin than inorganic lead.[5]

F. SCREENING PROGRAM COMPONENTS

1. Preplacement, baseline medical screening

According to the results of a risk assessment required under Part 36 of M.R. 217/2006, all workers anticipated to be at risk for exposure to lead must have the following at the start of employment:

(a) A medical and occupational history (refer to Appendix A)
(b) Recorded BLL

2. Periodic medical screening

According to the results of the risk assessment requirement under Part 36 of M.R. 217/2006, all workers at risk for exposure to lead must have the medical surveillance at the indicated intervals in the Table in Appendix B, for the duration of their employment:

A full medical examination and consultation with BLL shall be made available to an employee as soon as possible on notification that he or she has developed signs or symptoms of lead intoxication, desires medical advice concerning the effects of lead (past or current) and the ability to procreate a healthy child, or who has difficulty in breathing during respirator fit test or use.

3. Reporting and Actions

A. Recording and reporting of individual result

- Each worker is made aware of the results of all his/her screening test results and provided with further instruction and advice as indicated. This may be carried out by the employer's designated Occupational Health Physician/Occupational Health Nurse or the worker's personal physician.
- The name and address of the worker's personal physician and date of screening must be recorded on the worker's chart.
- If the worker has gone to a private physician/clinic, the worker should provide the physician with an employer's form for signature indicating whether the worker is fit for usual work, able to work with specified restrictions or is unfit for work. The worker is then to return this signed form to the employer.
- A record of all individual workers' medical test results must be kept in a confidential file by the employer and accessible only by designated occupational health personnel. This file must be made available for 10 years.
- Confidential medical information, such as individual test results, can only be shared with the express written permission of the worker, except as stated above.
- **Report BLLs > 0.5 µmol/L to the COMO at WSH-COMO@gov.mb.ca or fax (204) 948-2209.**

B. Results

The employer is responsible for setting up an 'Occupational Health Service' to ensure that the following instructions are carried out. This may be done by establishing a complete occupational health service that may include its own physician and nurse to carry out all aspects of the medical screening program, it may be contracted out or a system may be devised for workers to attend their own physicians. If, however, a worker does not have a personal physician, the company will have to 'contract' with a physician to interpret and advise on the results.

The employer must have a process in place for ensuring that the worker is properly assessed for medically indicated work restrictions.

This may be provided by the designated occupational health physician or, if necessary, by the worker's own physician.

All abnormal results are to be forwarded to the worker's physician upon the worker's agreement.

The appropriate medical investigation, treatment, and follow-up are the responsibility of the worker's primary care physician. This follow-up includes the explanation of test results and their implications, especially as they relate to work.

Note: All abnormal results determined to be work-related shall be reported to the COMO and may require medical and workplace investigation and/or further treatment.

The COMO may be in contact with the worker's physician to discuss the work-relatedness, management plan, and prognosis. A workplace safety and health investigation and improved preventative steps may be necessary to ensure worker protection from exposure.

The employer and physician must also report work-related disease to the Workers Compensation Board on a case-by-case basis.

C. Annual Report

The employer must produce an annual report which includes:

- the number and list of workers who undergo surveillance **each** year
- the physician(s) performing the surveillance program and contact information
- the work location and type of work performed by each worker.
- a summary of the screening program test results
- a summary of the actions taken by the employer to reduce worker exposure to lead.

The Annual Lead Surveillance Report must be forwarded to the Chief Occupational Medical Officer at the Workplace Safety and Health Branch at the contact information above, and be shared with the joint workplace safety and health committee.

Appendix A: Minimum Components of a Medical Evaluation

The medical evaluation should include the following:

History:

The initial medical and occupational history should include enquiries about the worker's previous exposure to lead (both occupational and non-occupational), personal habits (smoking and hygiene), and history of present or past gastrointestinal, hematologic, renal, reproductive, cardiovascular/blood pressure, endocrine, or neurological disorders.

At subsequent evaluations, the history should be updated to include:

- information on the frequency and duration of exposure to lead since the previous examination;
- the occurrence of signs and symptoms that may be an early indication of lead intoxication, e.g., abdominal pain, constipation, vomiting, asthenia, paresthesia and psychological change.

Laboratory:

blood lead level (BLL)

Complete physical examination and supporting laboratory tests such as the following should be done with the occurrence of signs and symptoms of lead toxicity or with BLL >= 200 µg/L or 0.97 µmol/L:

complete blood count with smear

free erythrocyte protoporphyrin (FEP)

serum/plasma urea

serum/plasma creatinine

serum/plasma uric acid

urinalysis

pregnancy test (*if requested by employee or as requested by physician)*

semen evaluation (*if requested by employee or as requested by physician)*

If the employee does not provide the employer-specific requisition and the employer and account number is known, physicians should check the box for “Other” under the Payment Agency Responsibility part of the general requisition and include these details along with the word “Surveillance”. Please include: “**Dr. Denise Koh, COMO fax (204) 948-2209”** on the CC part of the requisition.

Appendix B: Interpretation, Action Levels, and Monitoring for BLLs[6-19] in Adult Workers

BLL µg/L (µmol/L)	Interpretation		Management/Action Required	Recommendations for Biological Monitoring
	Short-term risks (Lead Exposure < 1 year)	**Long-term risks (Lead Exposure ≥ 1 year)**		
All workers with lead exposure			Baseline or preplacement medical history Baseline BLL then BLL **in 6 months. Continuing BLL depends on results of most recent BLL.**	
<50 (0.24 µmol/L)	None documented	None documented	None indicated	BLL every year for 3 years. If 3 consecutive annual tests < 0.24 µmol/L, can discontinue regular BLLs. Take new BLL if worker symptomatic or change in work tasks
50-90 (0.24-0.47)	Possible spontaneous abortion Possible postnatal developmental delay	Possible spontaneous abortion Possible postnatal development delay Possible hypertension and kidney dysfunction ALA-D inhibition	Identify source of exposure and consider protection measures. Discuss health risks. Reduce lead exposure for women who are or may become pregnant. Reduce exposure to as low as possible & ensure safe work practices, including work hygiene recommendations.	BLL **every 6 months** BLL frequency depends on results of most recent BLL.
100-190 (0.48-0.96)	Possible spontaneous abortion Possible Postnatal developmental delay Reduced birth weight	Possible spontaneous abortion Reduced birth weight Possible postnatal development delay Hypertension and kidney dysfunction Possible subclinical neurocognitive deficits Erythrocyte Protoporphyria (EP) elevation in females	Identify source of exposure and review protection measures, including work hygiene recommendations. Ensure that airborne lead levels are below 50 ug/m³. Discuss level with worker and seek to reduce exposure through environmental control if possible. Use personal protective equipment when environmental controls are not possible. Increase biological monitoring. Forward result to COMO.	BLL **every 3 months** BLL frequency depends on results of most recent BLL.
200-290 (0.97-1.44)	Possible spontaneous abortionPossible Postnatal developmental delayReduced birth weight	Possible spontaneous abortion Possible postnatal development delay Hypertension and kidney dysfunction Possible subclinical neurocognitive deficits Erythrocyte Protoporphyria (EP) elevation in males	Worker must be informed and removed from the lead-containing environment until lead levels return to acceptable levels below 200 µg/L. The source of the exposure should be corrected to ensure that no other workers are similarly affected. Initiate evaluation of control measures. Forward result to COMO.	**Monthly** BLL testing needed. Add supporting laboratory tests in Appendix A. Consider return to lead work after 2 BLLs < 150 µg/L a month apart, then monitor based on most recent BLL.
300-390 (1.45-1.92)	Spontaneous abortion Possible Postnatal developmental delay Reduced birth weight	Spontaneous abortion Reduced birth weight Possible postnatal developmental delay Hypertension and kidney dysfunction Possible neurocognitive deficits Possible non-specific symptoms**	Remove from lead exposure. Evaluate exposure, engineering controls, and work practices. Consider return to lead work after two BLLs < 150 µg/L 1 month apart. Forward result to COMO.	**Monthly** BLL testing needed. Add supporting laboratory tests in Appendix A.
>=400 (> = 1.93)	Spontaneous abortion Possible Postnatal developmental delay Reduced birth weight Non-specific symptoms** Neurocognitive deficits Sperm abnormalities	Spontaneous abortion Reduced birth weight Possible postnatal developmental delay Non-specific symptoms** Hypertension Kidney dysfunction/nephropathy Subclinical peripheral neuropathy Neurocognitive deficits Sperm abnormalities Anemia Colic Possible gout	Remove from lead exposure. Prompt medical evaluation and consultation advised for BLL > 400 µg/L. Consider chelation therapy for BLL > 500 µg/L with significant symptoms or signs of lead toxicity. Forward result to COMO.	Remove from exposure. Monitor BLL and supporting laboratory tests as indicated by attending physician.

*** Medical conditions that may increase the risk of continued exposure include chronic renal dysfunction (serum creatinine > 15 mg/L for me, > 13 mg/L for women, or proteinuria), hypertension, neurological disorders, and cognitive dysfunction.**

****Headache, fatigue, sleep disturbance, anorexia, constipation, arthralgia, myalgia, decreased libido etc.**

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