

The Silent Threat: Understanding and Managing Lead Exposure in Police Work

LEOSH - Collingwood

Dr. Michael Schweigert

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Learning Objectives

- Be able to explain what is lead.
- Understand the history of lead in industry.
- Be aware of the harmful effects of lead.
- Understand what is a control program.
- **Explain why all workers should participate in a control program.**

The Good

What is Lead?

- Lead is a metallic element – galena (PbS) is primary ore
- Symbol Pb (from Latin plumbum) and atomic number 82.
- It is a heavy metal that is denser than most common materials.
- Lead is soft and malleable and has a relatively low melting point.
- When freshly cut, lead is a shiny gray with a hint of blue.

English Language Derivation of Plumbum

- Plumbing – lead pipes
- Plumber – someone who works with lead pipes
- Plummet – to fall







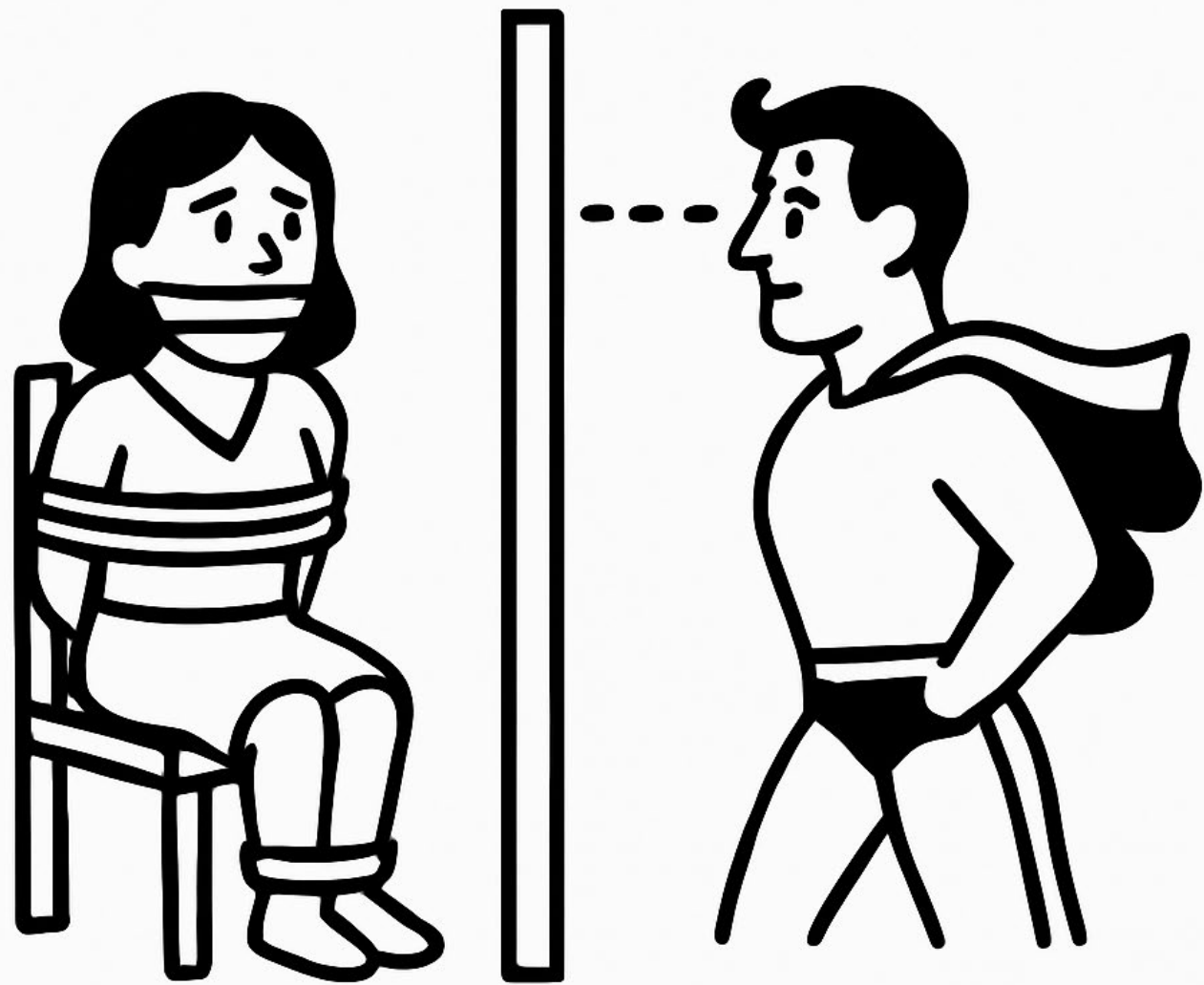
Historic and Current Use

- Archeological evidence of lead usage since 6500 BC
 - Roman aqueducts, plumbing and drinking vessels
 - Paint – brilliant colours and durability
 - Fuel – anti knock agent in combustion engines
- Current common uses
 - vehicle batteries
 - solder
 - diver weights and fishing sinkers
 - **ammunition**

Lead – Inert or Active?

- Lead is found naturally mostly in the earth
- Stable in the environment forming compounds with sulfur
- **Biologically active** in the body
- Can't be seen or smelled when airborne

The Bad



Pb

Elimination of Lead from Society

- Lead is a serious health hazard
- Ongoing effort to get rid of lead since the 1970s
- Most notable in plumbing, paints and fuels

Lead in the General Population

- Everyone has some lead in them.
- Result of human activity digging up and using lead for thousands of years.
- Blood lead will never be zero, so lead in blood ***not necessarily*** caused at work nor cause for alarm
- More recent analogy: micro-plastics

What is the Safe Level of Lead in the Body

- A) It's safe as long as I don't know how much is in me
- B) There is no safe level
- C) As long as my wrists and feet aren't "dropping" it's fine
- D) If it wasn't safe, it wouldn't taste sweet
- E) A safe level depends on the lab reference range




Symptoms of Acute Lead Exposure

- Associated with higher levels of exposure:
 - Irritable, mood changes, fatigue
 - Headaches, numbness and tingling
 - Joint pain
 - Abdominal cramping, weight loss

The Ugly

Symptoms of Chronic Lead Exposure

- Mostly symptom free (**silent**) 
- Most common health effects:
 - Hypertension
 - kidney damage
 - Cognitive decline
 - Adverse reproductive outcomes
- Note: children are particularly vulnerable
 - Delayed development and lowered IQs

Pharmacokinetics

- How the body handles lead:
 - Absorption
 - Distribution
 - Metabolism
 - Excretion

Absorption

- Inhalation: likely the most relevant route at the firing range
 - Fine particles inhaled through lungs
 - 30-50% of inhaled lead absorbed
- Ingestion: an important route when work practices breakdown
 - Adults absorb 10-15% of ingested lead
 - Children absorb up to 50%
- Dermal: negligible (but can provide route to be ingested)

Distribution

- Three major compartments for lead in body:

| Compartment | % of total body burden | Turnover |
|------------------------------|-------------------------------|----------------------|
| Blood (bound to RBCs) | ~1–2% | Half-life ~30 days |
| Soft tissues | ~8% | Kidney, liver, brain |
| Bone | ~90% | Half-life: decades |

- Bone acts as long-term reservoir and released slowly over time, especially during pregnancy, lactation or fractures
- Lead mimics calcium and is incorporated into the bone

Metabolism

- Not “metabolized” in the usual sense (it is an element) but interferes with other metabolism pathways (e.g. blood production and vitamin D metabolism)

Excretion

| Route | Description |
|-------------------|--|
| Urine | Primary excretion route for circulating lead (filtered by kidneys). |
| Feces | From unabsorbed lead in GI tract and some biliary excretion. |
| Hair/Nails | Minor amounts, used in forensic or historical exposure analysis. |
| Sweat | Negligible, but some alternative therapies promote this route. |

Clinical Implications

- Blood lead levels reflect recent exposure, not total body burden.
- Long-term effects can arise from mobilized bone stores, especially under physiological stress.
- Children are particularly vulnerable due to higher absorption, developing nervous systems, and hand-to-mouth behavior.

Pharmacodynamics

- What lead does to the body:
 - Mechanisms of action
 - Biological effects

Underlying Mechanism of Toxicity

- Lead mimics and disrupts essential divalent cations, particularly calcium (Ca^{2+}), zinc (Zn^{2+}), and iron (Fe^{2+}), which are critical for cellular signaling, enzyme function, and structural integrity.
- This ionic mimicry allows lead to interfere broadly with biological processes across organ systems.

Clinical Outcomes

- Almost every organ system can be affected
- Nervous system
 - Peripheral weakness (wrist and foot drop)
 - Cognitive dysfunction (memory, concentration)
 - Mood changes (irritability, depression)
 - Children: decreased IQ, behavioural problems
 - Lead disrupts neurotransmitter release, damages white matter

Clinical Outcomes

- Blood
 - Microcytic anemia
- Skeletal System
 - Interferes with bone structure and serves as a lead holding area
- Kidneys
 - Damages function and ultimately can cause hypertension and renal failure
- Reproductive System
 - Decreased sperm count and increased risk of miscarriage

Clinical Outcomes

- Heart
 - Heart disease
- Teeth and gums
 - Deposition in gums (Burton's lines in severe cases)
 - Children: effects enamel formation
- Endocrine
 - Impairs vitamin D formation

Clinical Summary

- **Lead acts as a toxic molecular impostor**, hijacking the roles of essential metal ions and interfering with critical cellular processes, particularly in tissues that rely on calcium and zinc for function and structure.
- Chronic exposure even at low levels can cause harm
- There is no known safe level of lead in the body – **however lower is better!**

Police Work and Lead Exposure Risk

Ranked Highest to Lowest



Indoor firearms training instructor



Firearms cleaning in poorly ventilated areas



Ballistic breaching training with lead rounds



Handling spent brass and range cleanup



Outdoor shooter occasionally



Traffic stop occupant exposures from lead dust



LEAD CONTAMINATION ZONE

Is lead a risk in the lunchroom?

- A) yes, but only a little bit
- B) not if there are lead warning signs posted
- C) only if my job is to clean up the shooting range
- D) only if my hands look dirty
- E) none of the above



Hierarchy of Control

- **Elimination** – Physically remove the hazard
(e.g., eliminating the use of lead-based ammunition entirely)
- **Substitution** – Replace the hazard
(e.g., switching to lead-free bullets or frangible ammunition)
- **Engineering Controls** – Isolate people from the hazard
(e.g., high-efficiency ventilation systems at indoor ranges, bullet traps, negative pressure airflow)
- **Administrative Controls** – Change the way people work
(e.g., limiting time on the range, rotating staff, lead awareness training, hygiene protocols)
- **Personal Protective Equipment (PPE)** – Protect the worker with equipment
(e.g., gloves, respirators, lead-removing wipes, dedicated uniforms)

Reduce Lead Exposure

- Remove the source
 - Eliminate or substitute
- Stop the source to member exposure
 - Airflow compliant
 - Areas cleaned properly
 - Food and drink prohibited
 - PPE provided when required

Education and Awareness

- Identify areas of contamination
- Posted signs and warnings
 - Restricted food and drink zones
 - Water and soap to wash
 - Tack mats
- Regular and proper cleaning schedule
- Unobstructed ventilation

Occupational Lead Exposure in Ontario

- Lead is covered under the designated substance legislation
- Exposure control program required where there is exposure
- Medical surveillance is an important part
- Employers must assess and control hazard
- Workers exposed must be ***offered*** training, tools (including PPE where required) ***periodic blood lead testing***

Ontario Legislation - O. Reg. 490/09

Designated Substances

- Section 29(2):
 - The physician who conducts the medical examination or supervises the clinical tests **shall advise the worker and the worker's employer** whether the worker has **an occupational illness because of exposure to a designated substance** and whether the worker is fit, fit with limitations or unfit to continue working in exposure to the designated substance.
- Section 29(6):
 - On **advising the worker and the worker's employer** that the worker is **fit with limitations or unfit to continue working in exposure to a designated substance**, the physician shall **also advise the joint health and safety committee**, in writing and on a confidential basis, and in giving the advice shall indicate his or her opinion as to the interpretation to be placed on the advice.
- Section.29(7):
 - On advising the worker and the worker's employer that a worker is fit with limitations or unfit to continue working in exposure to a designated substance, **the physician shall promptly communicate that advice to the Provincial Physician.** O. Reg. 490/09, s. 29

Ontario OHSA 1990

- Section 63(2):
 - **No employer shall seek to gain access**, except by an order of the court or other tribunal or in order to comply with another statute, **to a health record concerning a worker** without the worker's written consent.

Employees must consent to share results.



OUT
OF
ORDER

CDC: Evaluation of Lead Exposure at an Indoor Law Enforcement Firing Range (2017)

- Air sampling for lead below exposure limits
- Lead and copper on all tested surfaces
- Instructors had lead on work clothes, hands and footwear as they left work
- Dry sweeping methods used
- Ventilation not performing adequately
- Blood leads elevated in all instructors

CDC: What the Employer Can Do

- Test and balance the ventilation
- Remove materials in firing lines that block air flow
- Use wet cleaning methods, avoid dry sweeping
- Provide instructors with clothes and shoes to wear only at work, two lockers to separate street clothes from work clothes


CDC: What Employees Can Do

- Participate in training and follow safe work practices
- Wash hands with lead-removal soap each time you leave the range. Wash hands with regular soap and water before eating while at work.
- Participate in medical monitoring

CDC: Blood Lead Level Testing

Instructors appeared to request BLLs **at their own discretion depending on their perceived level of lead exposure risk.** 

Instructors had their BLLs done through the local FOH clinic. These results were reviewed by an FOH physician and reported back to the individual.

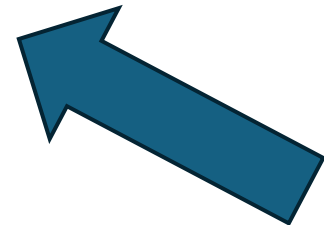
The two instructors removed themselves from the range for 2 months. They returned after their BLLs had dropped to 14 $\mu\text{g}/\text{dL}$ [0.676 $\mu\text{mol}/\text{L}$] in July 2016. The decision to return to work was made by the instructors themselves. **The physicians reviewing the BLL results did not communicate their findings with the employer.** 

CDC: Conclusions

- Lead was detected on surfaces throughout the building, in the breathing zone of instructors and shooters, and also on instructors' hands
- A combination of ventilation system issues, insufficient range cleaning services, poor handwashing practices, and the lack of a comprehensive lead exposure monitoring program may have contributed to detectable BLLs among instructors.

CDC: Recommendations

- **Engineering controls** – ventilation
- **Administrative controls** – washing hands, avoiding dry sweeping, do not store materials impeding air flow, implement regular refresher training for safe work practices, provide disposable shoe covers
- **PPE** – disposable nitrile gloves to be provided
- **...recommended BLL testing for all lead-exposed employees, regardless of the airborne lead concentration.**



Why Get my Blood Lead Tested?

- A) so that I can get Health and Safety off my back
- B) to show my spouse I am a safe worker
- C) so my family doctor can explain it to me
- D) so that management can evaluate the control program and take action
- E) it's pointless as Dr. Schweigert says I'll eventually pee it out anyways

Implications of Blood Lead Results

- For the workers:
 - Early warning before symptoms.
 - Indicates when lead exposure is too high to keep working in area
 - Identifies whether or not the control program is keeping them safe.
- For the employer:
 - Helps identify high-risk tasks.
 - Verifies ventilation, housekeeping, ammunition and work practices.
- For the H&S team and JHSC:
 - Participation allows for system-level corrections.
 - Supports informed joint health and safety work.

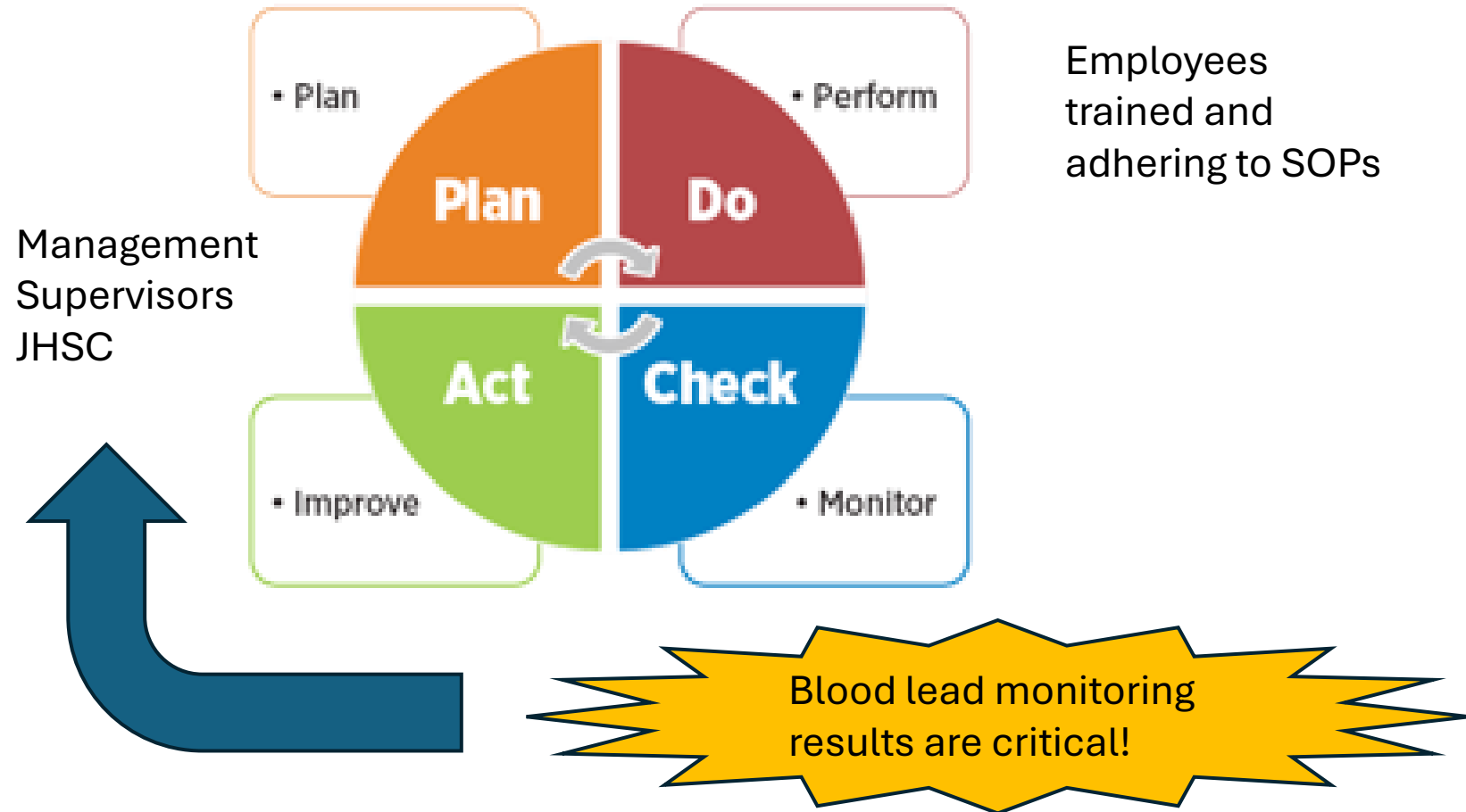
Importance of Participation and Sharing

- Participation isn't just going to your family doctor - it's a pool of **everyone's** data to validate the control program.
- Individual action may be required if action levels exceeded.
- Encourage opt-in with assurance: results can drive workplace improvements without stigma.
- Action level to remove worker is temporary to protect their health
- Emphasize building trust around participation.

The Shared Responsibility

- Members **CAN NOT** be expected to recognize or manage this invisible threat on their own
- **Management CAN manage the risk but needs data**
- Health and safety, the association, industrial hygiene have supportive roles

Integrity of the Control Program



Blood Lead Action Levels

- Simple test to evaluate current exposure to lead

Ontario action levels:

- 0.50 $\mu\text{mol/L}$: review of control program
- 1.40 $\mu\text{mol/L}$: removal from exposure
- 0.70 $\mu\text{mol/L}$: return to work setting

*pregnant and vulnerable population values differ

Blood Lead Levels (BLL) and Associated Health Effects

| Blood Lead Level (µmol/L) | Common Health Effects | Notes |
|---------------------------|--|---|
| < 0.50 µmol/L | <ul style="list-style-type: none"> - Subclinical neurocognitive effects in children - Hypertension (some adult evidence) - Decreased renal function (emerging evidence) | Even low levels may contribute to long-term cardiovascular and kidney effects |
| 0.50–1.39 µmol/L | <ul style="list-style-type: none"> - Subclinical or mild symptoms (e.g., fatigue, irritability) - Early kidney dysfunction - Increased blood pressure - Reproductive toxicity (e.g., sperm quality) - Impaired cognitive performance (especially in children) | Ontario requires program review at 0.50 µmol/L, but adverse effects are already possible |
| ≥ 1.40 µmol/L | <ul style="list-style-type: none"> - Fatigue, abdominal pain, joint pain - Anemia - Nephrotoxicity - Peripheral neuropathy (e.g., wrist or foot drop) - Early signs of lead colic or encephalopathy (rare at this level in adults) | Ontario requires removal from exposure at this threshold |

Regulatory benchmarks should not be misinterpreted as “safe levels”.



Reference: Kosnett MJ, Wedeen RP, Rothenberg SJ, Hipkins KL, Materna BL, Schwartz BS, Hu H, Woolf A [2007]. Recommendations for medical management of adult blood lead exposure. Environ Health Perspect 115(3):463–471, <https://doi.org/10.1289/ehp.9784>.

Lead is Stealthy but not Magic

- Elevated blood leads from occupational exposure may seem mysterious but by applying scientific principles and review of the control program the route of entry can be identified
- But this requires ***management to be aware*** of elevated blood leads of employees in a systematic fashion
- A high participation level in the blood lead monitoring provides the data required for management to effect changes to the control program as required

What can Employees do to Reduce the Risk?

- Learn about ***sources of lead at your work***
- ***Educate yourself*** regarding the lead control program elements
- Understand how your behaviours reduce lead exposure and practice behaviors that ***protect yourself and your family***
- Have your blood lead measured and share results in an ***acceptable form*** with the organization
- Understand that removal due to high leads is temporary, important and ***not*** disciplinary

Questions & Discussion

