Annex I 112

Lead or compounds thereof

Definition of causal agent

Lead is a soft, malleable, blue-grey metal characterized by high density, ductility and corrosion resistance. Its melting point is 327.4° C and it gives off fumes at temperatures greater than 500° C. Elemental lead is poorly soluble in water and in dilute acids. It dissolves in nitric acid, acetic acid and hot concentrated sulphuric acid.

The inorganic salts of lead (II), lead sulphide and oxides of lead are in general not very soluble in water. Of the common lead compounds, the acetate, the carbonate, the chlorate and the nitrate are easily soluble in water. Moderately soluble compounds include the chloride, the chromate and the stearate.

The most important organic lead compounds are tetraethyl lead (TEL) and tetramethyl lead (TML). They are practically insoluble in water but dissolve readily in organic solvents, fats and lipids.

Main occupational uses and sources of exposure:

Exposure occurs in lead mines and a wide variety of industries, including procedures involved in the production of lead metal and its compounds and alloys with antimony and copper, manufacture of batteries, accumulators, ammunition, ceramics, jewellery, glass and pigments, and in the pottery, shipbuilding, construction, demolition and scrap industries. High exposure is seen in lead scrap foundries, radiator repair, bronze foundries and during the grinding, welding and cutting off materials painted with lead-containing paints. The source of absorbed lead is mainly the inhaled fume and dust or ingested soluble lead salts.

The exposure to organic lead is declining with the lessening use of leaded gasoline. Inhalation and dermal exposure are the main routes of organic lead exposure.

Toxic effects of lead and its inorganic compounds

The adverse effects involve, nervous, gastrointestinal, renal, haematopoietic, cardiovascular and reproductive systems.

1. Acute and subacute poisoning

Lead is a cumulative poison and the acute symptoms are usually the manifestation of (sub)chronic poisoning.

☐ Non-specific signs

Signs and symptoms include pallor, malaise, asthenia, headache, dizziness, loss of memory, anxiety, depression, irritability, sleep disturbances, numbness of extremities, muscle and joint pain, lower back pain and limb weakness.

☐ Gastrointestinal tract

The manifestations include nausea, vomiting, constipation, anorexia, abdominal discomfort and colic.

☐ Nervous system

In severe cases, impaired consciousness and confusion may develop which may progress into stupor and coma, accompanied by seizures. Brain pathology shows oedema, increased permeability of capillary endothelium with perivascular hemorrhagic exudates.

☐ Haematopoietic system

Anaemia.

☐ Renal functions

Renal tubular defect with glycosuria and aminoaciduria, which may progress to oliguria and acute renal failure.

Exposure criteria:
Minimum intensity of exposure:
- Occupational exposure confirmed, and if possible assessed, by:
- history and study of the working conditions showing evidence of exposure to lead,
- and, if available:
  - biological monitoring:
    Blood: lead levels (B-Pb) > 80 µg/dl
- abdominal colic: rare below blood lead levels of 80 µg/dl,
- proximal tubular damage: unlikely below 100 µg/dl,
- encephalopathy: unlikely below 100-120 µg/dl.

Minimum duration of exposure: from a few hours to a few days depending on intensity of exposure.

Maximum latent period: uncertain

2. Chronic poisoning

☐ Gastrointestinal system

Similar, but milder as in acute poisoning (see above). A blue-gray pigmentation ("lead line") may be present at dental margins of the gums as a sign of exposure.

☐ Non-specific effects

Similar, but milder than in acute poisoning. Arthralgias and myalgias may occur proximally in the extremities.

☐ Haematopoietic system

Inhibition of the enzymes for haeme synthesis. Decreased activity of the delta aminolevulinic acid dehydratase (ALA-D), is the earliest detectable biochemical effect of lead. This results in abnormally high blood levels of free erythrocyte protoporphyrin (FEP) and urinary excretion of ALA, zinc protoporphyrin (ZPP) and coproporphyrin. Measurements of these metabolites have been used as diagnostic tests in lead poisoning. Hypochromic, normocytic or microcytic anemia occurs.

☐ Nervous system

Central nervous system effects range from subjective symptoms and neuropsychological performance impairment to progressive encephalopathy with psychiatric symptoms, fatigue and lethargy.
Peripheral nervous system effects range from reduced nerve conduction velocities to a predominantly motor type neuropathy. Distal sensory loss and muscle weakness may be present. Bilateral wrist drop is a rare event. Nerve biopsies indicate segmental demyelination and secondary axonopathy.

☐ Renal functions

High exposure can lead to tubular damage and chronic interstitial fibrosis. Tubular dysfunction presents with azotemia aminoaciduria, glycosuria and phosphaturia.

☐ Reproductive system

Female: Maternal exposure associates with miscarriage and low birth weight of infants.
Male: Lead associates to a reduced semen quality (sperm count and motility, volume, morphology).

Exposure criteria:

Minimum intensity of exposure:
Occupational exposure confirmed, and if possible assessed, by:
- history and study of the working conditions showing evidence of prolonged or repeated exposure to lead,
- -and, if available:
  - biological monitoring: These values are given as guide.
    Blood: lead levels (B-Pb) > 40 µg/dl

Erythrocyte protoporphyrin and urinary delta-amino laevulinic acid (ALA) are used as markers of biological effect.

Various adverse effects begin to occur after prolonged exposure to different levels of blood lead (B-Pb):
- subjective symptoms and objective cognitive performance impairment > 40 µg/dl
- tubular damage > 70 µg/dl (early tubular dysfunction > 40 µg/dl)
- reproductive effects > 40 µg/dl
- anaemia > 50 µg/dl
- gastrointestinal symptoms > 60 µg/dl,
- nerve conduction reduction > 70 µg/dl

Minimum duration of exposure: from a few months to a few years depending on the intensity of exposure.

Maximum latent period: Cannot be specified (renal and nervous system degeneration).

Toxic effects of organic lead

The clinical picture is dominated by central nervous system toxicity.

1. Acute (subacute) poisoning

Nervous system

Initial effects are anorexia, nausea, vomiting, insomnia, fatigue, weakness, headache, tremulousness, aggression, depression, irritability, restlessness, hyperactivity, disorientation, confusion and disturbing dreams. Massive intoxication presents with acute mania, psychosis, hallucinations (e.g. hair on tongue, insects on body), convulsions, delirium, tremulousness with choreiform movements and gait disturbances, coma and death.

Mucosal irritation

Inhalation induces sneezing, irritation of upper respiratory tract. Eye and skin contact induces itching, burning and redness.

Gastrointestinal system

Symptoms may include abdominal discomfort, anorexia, vomiting and diarrhoea.

2. Chronic poisoning

Signs and symptoms similar as in acute poisoning but may be subtle. The clinical picture typically includes irritability, insomnia, disturbing dreams, hallucinations, psychosis, anorexia, nausea, vomiting, tremulousness and ataxia.

***Exposure criteria*:**

Minimum intensity of exposure:
Occupational exposure confirmed by:
- history and study of the working conditions showing evidence of acute (often accidental), prolonged or repeated exposure to organic lead,
- -and, if available:
  - biological monitoring:
    Urine: urinary tetraethyl lead (U-Pb) levels > 150 µg/dl.

Note: absence of changes in the blood count or in the metabolites of haem synthesis. The blood lead (B-Pb) levels are normal or only moderately elevated < *50* µg/dl.

Minimum duration of exposure:
acute poisoning: hours;
chronic poisoning; from a few months to a few years depending on the intensity of exposure.

Maximum latent period:
acute poisoning: ten days;
chronic poisoning: years (nervous system degeneration).