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PATHCHAT

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Diagnosis and investigation of occupational exposure to metals:

A general review

Exposure to metals in the workplace presents serious and significant health risks. The hazards that metals present are a function of the toxic properties of metals and include the duration, dose and route of exposure, and health history of the individuals exposed to them. Controlling and preventing metal exposures often involves a multidisciplinary team, usually beginning with the primary healthcare provider.

Many strategies exist to this end and include the screening and surveillance of exposure, public education and awareness programmes, environmental control of exposure, the availability of adequate and accessible employee health services, worker safety programmes and medical programmes.

In general, the clinical suspicion of occupationally related diseases is very low. It is frequently undiagnosed as a result of poor occupational history taking.

This document is a simple guide for the diagnosis of occupational health effects and disease in workers exposed to common metals encountered in the workplace.

A. Occupational history taking

Obtaining such history does not require detailed knowledge of toxicology. In seeking history, the health worker should consider all possible exposures that may occur in the community where the patient lives and/or works.

Taking an exposure history involves gathering information about the individual's work activities. Below is an approach to good occupational history taking.

(a) Current job of the patient – job title, type or nature of work, and any protective equipment on the job
(b) The patients' perception of whether or not their presenting symptoms are related to their work or the environment in which they live
(c) Information on whether others at home or work present with similar problems
(d) Employment history and chronology of jobs held; temporal relationship is explored
(e) Relationship between work and health problems
(f) Environmental (non-occupational) exposures – hobbies, smoking, household, herbal products and community
(g) Specific environmental and/or occupational exposures – fumes, dust, metals and chemicals
(h) History of any co-morbid conditions

B. Clinical examination and investigations

Medical practitioners do not require special skills to diagnose occupational and environmental health problems. A practical approach to examination and tests is useful in day-to-day practice.

As most metals affect multiple organs and systems, it is recommended to conduct a complete systemic examination with a special focus on the blood, cardiac, gastrointestinal, lung, liver, central nervous system and kidney.

Laboratory testing should include the following:

- Full blood count
- Urine analysis
- Kidney function
- Liver function tests

Chest X-ray and pulmonary function, ECG, and allergy testing may be performed where relevant.

The determination of metals in blood, urine and tissues are used to confirm the diagnosis.

It should be noted that, generally, each metal produces a constellation of symptoms and a clinical picture unique to the metal (Table 1). The tests required for exposures are metal-specific.

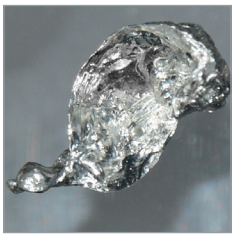
METAL	CLINICAL MANIFESTATION/S	BIOLOGICAL MONITORING
ARSENIC	Garlic odour on breath and tissue fluids; "raindrop pigmentation" of temples, eyelids and neck with hyperkeratosis; encephalopathy; peripheral neuropathy ("glove and stocking" distribution); "Mees" lines (white striae on fingernails); cardiac arrythmias, hepatic and renal damage; haemolytic anaemia in the case of arsine gas exposure; known human carcinogen(skin, lungs)	Urinary arsenic level is the most reliable indicator of recent exposure to arsenic. Arsenic in hair and fingernails can indicate exposure to high levels in the past 6–12 months.
ALUMINIUM	Chronic obstructive airways disease (Shaver's disease); asthma; multiple fractures; osteomalacia, dementia; proximal muscle weakness; microcytic anaemia	Aluminium estimation in urine and serum
ANTIMONY	Dermal effects (antimony spots – pustules and eruptions near sebaceous glands); ECG changes (altered T waves); increased blood pressure; pneumoconioses, chronic bronchitis and emphysema; pleural adhesions; inactive tuberculosis	Urine antimony levels
CADMIUM	Proteinuria; ulceration of nose; loss of sense of smell; severe back pain and joint pain (waddling gait); Fanconi's syndrome; hypercalciuria with renal stone formation and osteomalacia; emphysema; prostate cancer	Urine and blood cadmium levels
CHROMIUM [hexavalent]	Bronchitis; pulmonary fibrosis; chronic asthma; lung and skin cancer; ulceration and perforation of nasal septum; "chrome ulcers" on skin and in nose; nasal polyps; rhinitis; sinusitis	Total chromium in urine Chromium in plasma, whole blood, red cell
LEAD	Encephalopathy; anaemia; abdominal pain (lead-colic often mistaken for an acute abdomen); nephropathy; foot-drop; wrist-drop	
MANGANESE	Severe chemical pneumonia from inhalation of fumes (manganism); central nervous system effects, which include Parkinson-like syndrome; bulbar paralysis; extrapyramidal features; multiple sclerosis	Manganese in blood and urine
MERCURY	Nausea; bronchial irritation and erosive bronchitis; gastrointestinal and renal tubular necrosis; metallic taste; gingivostomatitis; intention tremour; neuroasthenia; paraesthesia of extremities and face; ataxia; dysarthria; concentric constriction of fields of vision; behaviorial and personality changes; delirium; hallucinations; nephrotic syndrome; hypersensitivity	Total inorganic mercury in urine Total mercury in blood
NICKEL	Irritation of nose and sinuses with loss of smell and perforation of nasal septum; asthma; allergic contact dermatitis ("nickel itch"); pulmonary fibrosis; reduced sperm count; nasopharyngeal, lung and gastrointestinal tumours; nephrotoxic effect	Urine nickel
THALLIUM	Usually starts with gastroenteritis, followed by a peripheral neuropathy, and thereafter hair loss; alopecia; neurologic disorders; anorexia; nausea; vomiting; diarrhoea, followed by constipation, with a burning sensation of the tongue and stomatitis	Urine thallium Hair and nails for thallium estimation
VANADIUM	Chemical pneumonitis; chronic bronchitis; allergic dermatitis; nervous system effects; cardiovascular effects	Urine vanadium

Table 1: The clinical manifestation/s of common metal exposures and their investigation

ARSENIC

ALUMINIUM

ANTIMONY



CADMIUM

CHROMIUM

LEAD

A note on the effects of metal occupational exposure on reproduction and fertility

The effects of occupational exposure on the reproductive system of men and women may become manifest as alterations in sex hormone levels (endocrine disruptors), diminished libido and potency, menstrual disorders, premature menopause, delayed menarche, ovarian dysfunction, impairment of semen quality and reduced male and female fertility. Toxic exposures can cause direct cell damage in the developing sperm and eggs. Cell damage may also be in the form of chromosomal abnormalities and gene mutations. The exposure dose is important – a low dose can result in birth defects, while a high exposure dose can result in miscarriage or infertility. Maternal exposure during pregnancy may disturb foetal development by either directly or indirectly interfering with maternal, placental or foetal membrane functions. Toxic exposures can induce many wide-ranging effects, such as foetal death, miscarriages (exposure in first trimester) intrauterine growth retardation, preterm birth, birth defect, postnatal death, disturbances in cognitive development, and changes in immunological sensitivity or childhood cancer. The mother's exposure at work to chemicals may also cause contamination of her breast milk. The most studied metals are lead and mercury (Table 2).

METAL	MALE EFFECTS	FEMALE EFFECTS
LEAD	Reduced sperm quality, reduced fertility, foetal loss	Reduced fertility; foetal loss; preterm birth; low birth weight; birth defects; impaired cognitive development
MERCURY	Foetal loss	Reduced fertility; menstrual disorders foetal loss

Table 2: Reproductive and fertility effects of lead and mercury

Occupational carcinogens

It must be noted that the only metals that have been demonstrated in epidemiological studies to have correlated with an increased cancer incidence in humans are nickel, chromium, arsenic, cadmium and beryllium. There is a great lack of human data in this field of occupational disease.

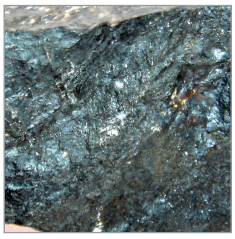
Table 3 shows the global consensus with regard to the classification of human carcinogens, while Table 4 shows the current information available on the different metals with their carcinogenic classification and the organs known to be affected.

GROUP 1	Carcinogenic to humans
GROUP 2A	Probably carcinogenic to humans
GROUP 2B	Possibly carcinogenic to humans
GROUP 3	Not classifiable as to its carcinogenicity to humans
GROUP 4	Probably not carcinogenic to humans

Table 3: Classification of metals as per the International Agency for Research on Cancer (IARC)

METAL	CLASSIFICATION	AFFECTED ORGAN
ARSENIC	Group 1	Lung and skin
ALUMINIUM	Not classified	
ANTIMONY	Group 2B	
CADMIUM	Group 1	Lung
CHROMIUM [hexavalent]	Group 1	Nasal cavity and lung
LEAD	Group 2B	
MANGANESE	Not classified	
MERCURY	Group 3	
NICKEL compounds	Group 1	Nasal cavity and lung
THALLIUM	Not classified	
VANADIUM	Group 2B	
WELDING FUMES	Group 2B	

Table 4: Metal exposure, IARC classification and affected organ


MANGANESE


MERCURY


NICKEL


THALLIUM


VANADIUM


WELDING FUMES

Please refer to Figure 1 below as a guide to the target organs affected by chemical exposure in general in the workplace. Note that this diagram includes metals and other chemicals such as organic solvents and petrochemicals.

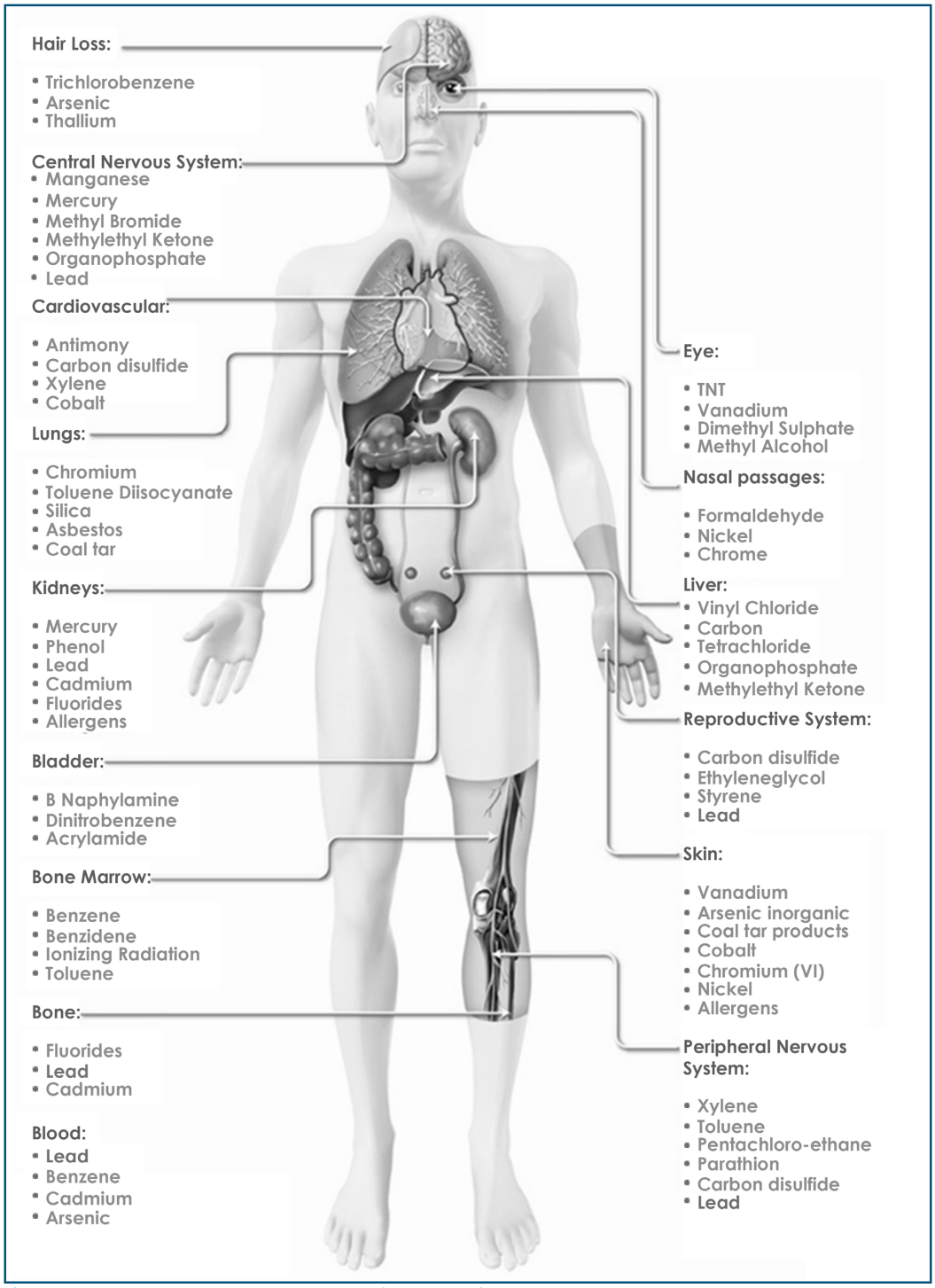


Figure 1: Target organs affected by occupational chemical exposures

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