Manganese or compounds thereof

Definition of causal agent

Manganese is a very hard steel-grey metal. The most common forms, metallic Mn, Mn^{+2}, Mn^{+3}, Mn^{+4} and Mn^{+7}, are found mainly as $MnCl_2$, $KMnO_4$,$MnSO_4$, $MnPO_4$, MnO_2 and Mn_3O_4. Mn is used in the hardening of alloys e.g. iron containing alloys. Ferromanganese contains at least 65% and manganese steel 10-14% manganese. The main organometallic manganese compounds are methylcyclopentadienyl manganese tricarbonyl (MMT) and manganese ethylene bisdithiocarbamate (Maneb).

Main occupational uses and sources of exposure:
Occupational exposure is mainly through the inhalation of dusts and fumes containing manganese. This may occur in ores during extraction and processing, or steel preparation using manganese, dry battery manufacturing, machining of manganese containing steel and in welding. Exposure may occur in the handling of gasoline and jet fuel with MMT.
Manganese oxides are used in lithium batteries, and in the dye, glass, ceramic and textile industry, and as an oxidizing agent in the chemical industry and in the manufacture of matches and fungicides (Maneb). Manganese chloride is a raw material for drugs e.g. multivitamin tablets and animal food supplements. Manganese sulphates are used in fertilizers, ceramics, glazes and varnishes, food supplements, and fungicides. Potassium permanganate is used as an oxidant in the production of circuit boards, in surface treatment of metals, in drug and chemical industry, and as a bleach, photographic development chemical, disinfectant, deodorizer, anti-algal agent in water treatment, raw material of dyes, auxiliary substance in tanning, and in the extraction of iron or manganese from solutions.

Toxic effects

☐ Acute poisoning

Skin and mucous membranes
Manganese compounds are irritant to the skin, eyes and mucous membranes, at high exposure levels. Sensitization occurs rarely. Potassium permanganate can cause considerable corrosive damage to the mucous membranes, skin and eyes.

Respiratory system
Inhalation may cause irritation and inflammation of the airways with cough, bronchitis, and pneumonitis, and impaired respiratory functions.

Exposure criteria:

Minimum intensity of exposure:
Occupational exposure confirmed, and if possible assessed by:
- history and study of the working conditions showing evidence of acute exposure to manganese;
- and, if available:
  - workplace air monitoring showing exposures considerably above occupational exposure standards.
  - serum, blood and urine manganese levels reflect recent exposure, but due to large inter-individual variation, the monitoring can only be done on a group basis.

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

Maximum latent period: 48 hours.

Chronic poisoning

Respiratory system
Effects similar to acute poisoning.

Central nervous system
Inhalation of manganese dusts or fumes can cause encephalopathy and manganism -which is a Parkinsonian syndrome with neuropsychiatric manifestations.
The early and most subtle non-clinical effects are mainly motor but may also be cognitive.

Manganism progresses through several stages:

(i) Symptoms such as malaise, somnolence, apathy, emotional lability, impotence, loss of libido, weakness, lethargy, anorexia, and headaches.

(ii) Impaired memory and judgement, anxiety and sometimes psychotic manifestations such as hallucinations.

(iii) Progressive bradykinesia, dysarthria, axial and extremity dystonia, paresis, gait disturbances, rigidity, intention tremor, postural instability, impaired coordination and mask-like faces. The disease may be reversible, but when advanced may progress many years after removal from exposure.

Manganism should be differentiated from Parkinson's disease (PD) and other forms of parkinsonism. Clinical picture is similar to PD, however, certain features support manganism: symmetric impairment, postural or kinetic tremor (vs. resting tremor in PD), early onset of gait dysfunction with peculiar high-stepped gait, tendency to fall backwards, pronounced dystonia, facial grimacing, psychiatric disturbances early in the course of disease, earlier age of onset (vs. on average >60 years in PD) and poor response to levodopa. Neuronal damage is mainly in the *globus pallidus*, with the *substantia nigra* not affected.

Magnetic resonance imaging (MRI) and positron emission tomography with DOPA capture (PET-DOPA) may assist in differentiating between Parkinson's disease and manganism.

Exposure criteria:

Minimum intensity of exposure:
Occupational exposure confirmed, and if possible assessed, by:

- work history and study of the working conditions showing evidence of prolonged/repeated exposure to manganese;
- and, if available:
  Workplace air monitoring consistently showing levels above 5 mg Mn /m^3 (inhalable dust) is associated with an increased risk of clinical manganism. Small non-clinical decrements in motor neurobehavioural function have been reported at levels above 0.1 mg/m^3 respirable or 0.5 mg/m3 inhalable manganese. Pulmonary effects are not expected at exposure levels $\leq$ 1mg/m^3.

Minimum duration of exposure: A few months

Maximum latent period: A few decades