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Metal neurotoxicity

AUTHOR

Jonathan S Rutchik MD MPH

EDITOR

Matthew Lorincz MD PhD

Introduction

Overview

This article aims to inform the reader of neurologic conditions associated with occupational or environmental exposures to heavy metals, such as lead and manganese. Metals are commonly found in the environment and in the workplace. These may be implicated in the development of neurologic symptoms, examination findings, or a diagnosis. Some metals, depending on the method and duration of exposure, may be the sole cause of a condition whereas others may contribute to the cause or accelerate a neurologic diagnosis. In some cases, halting exposures may lead to reversibility of a condition; however, stabilization or further deterioration may occur.

Key points

- Neurotoxic illness is often a diagnosis of exclusion after considering other more common presentations for a condition.

• Treatment may differ. Chelation is typically reserved for acute exposures that lead to dramatic consequences; otherwise, supportive measures are recommended.

• Conditions resulting from metal exposure may mimic routine neurologic disease, such as encephalopathy (eg, altered mental state), **movement disorders** (eg, tremor), neuropathy (eg, tingling or numbness in hands and feet), or seizures.

• There are not specific diagnostic tests to determine neurotoxic illness, and the most important item may be the occupational or environmental history.

Historical note and terminology

Consideration of neurologic disorders secondary to occupational or environmental exposure first became notable from case reports. These consisted of workers who were exposed to high doses of substances either by inhalation or accidental ingestion and began to develop irreparable neurologic damage. Some of these reports originated in industries where heavy metals exposure was common. However, few of the earlier studies report evidence of biological exposure indices or pathology to identify a corresponding dose that led to such a result.

Epidemiological studies have shown that occupational exposure to high doses of aluminum, arsenic, lead, mercury, or manganese as well as thallium and tin have led to persistent clinical neurologic or neuropsychological abnormalities. These studies have also shown that if symptoms are identified early and proper treatment and removal from exposure is provided, neurologic and or psychological function can remain stable or actually improve despite the earlier exposures. This is particularly notable with peripheral neurotoxicity.

As individuals age, cognitive function does also decline placing them at risk of developing neurodegenerative brain diseases; however, in a cross-sectional study conducted by Sasaki the workplace or the environment, could be responsible for neurodegenerative illness such as **Alzheimer disease**-type **dementia**, **Parkinson disease**, or **amyotrophic lateral sclerosis**. The neurologic, occupational, and environmental medical literature includes various papers assessing neurologic and neuropsychological function in workers with low-level chronic exposure. For example, there is a growing body of literature focusing on manganese exposure in welders, miners, and steel cutters with central neurologic sequelae. In some studies, researchers have assessed subclinical endpoints because workers have nonspecific symptoms or no symptoms. These studies help to develop evidence that certain clinical features are consistent with occupational or environmental neurologic changes and, if exposure continues, may lead to frank clinical and possibly irreversible health effects. Halting exposures and early recognition of these problems may prevent such outcomes.

Patients with Alzheimer disease or nonspecific dementias have been involved in case-control studies to assess occupational and environmental exposures. These have revealed small relative risk values for certain exposures and Alzheimer disease.

In light of the supporting research, occupational and environmental exposures to heavy metals must be considered when diagnosing **peripheral neuropathy**, dementia, or a movement disorder. This requires taking an accurate work and exposure history of patients in order to determine if such a possibility exists. Therefore, it is extremely important to gain an understanding and working knowledge of these types of exposures so as to make the correct diagnosis.

The term “heavy metal” (formerly included in this title) is no longer used because there is no clear distinction between “heavy” or “nonheavy” metals on the periodic table. Also, there is no clear distinction between the terms “toxic” and “nontoxic” as well as the term “essential” because many metals may become toxic with a high enough dose.

This article discusses seven heavy metals (aluminum, arsenic, lead, manganese, mercury, thallium, and tin), their uses, and occupational exposure pathways and reviews the various studies that evaluate exposures to heavy metals and corresponding health effects.

These metals are utilized in many industrial processes throughout the world. Table 1 describes their industrial uses and some of the possibilities for non-occupational exposures.

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Aluminum (Al)	Aluminum refinery, aluminum recycling, aluminum powder factory, welding	• Dialysis-associated exposure • Drinking water and food
Arsenic (As)	Pesticides, pigments, antifouling paint, electroplating, smelters, semiconductors, logging, alloy manufacturing, aniline color manufacturing, brass and bronze manufacturing, carpentry, ceramic manufacturing, drug manufacturing, enameling, fireworks manufacturing, gold and silver refining, lead shot manufacturing, painting, petroleum refining, printing, textile printing	• Seafood • Environmental waste
Lead (Pb)	Soldering and welding, lead shot/bullets, distilling of illicit whiskey, insecticides, automotive/storage batteries, lead-based paints and sprays, lead-stained glass, lead pipes and plumbing, production of plastics, mixing crystal glass mass, repairing automobile radiators, wire plating, cable makers, automobile repair and factory workers, ship repair, lead glass blowing, sheet metal production, brass and bronze works, canning, leather making and tanning, tile making, jewelry making, pottery glazers	• Pica (ingestion) from lead paint in infants • Drinking wine from leaded crystal glasses • Environmental waste (eg, air pollution from smelting operations, metal and battery recycling)

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	bleaching, leather tanning, electroplating. Ingredient in potassium permanganate, fungicides, germicides, and antiseptics. Used in production of dry cell batteries, glass, matches, fireworks, fertilizers, animal feed, paints, and varnishes. Organic compounds such as the fungicide Maneb (manganese ethylene bis dithiocarbamate) and the antiknock gasoline additive MMT (methyl cyclopentadienyl manganese tricarbonyl)	• Essential nutrient found in wheat, rice, teas, nuts, meats, poultry • Environmental waste (eg, air pollution from smelting operations, pesticide runoff)
Mercury (Hg)	Scientific instruments, electrical equipment, amalgams, electroplating, photography, felt making, taxidermy, textiles, pigments, chloralkali industry.	• Ingestion of pesticide residues as in Minamata Bay and Iraq
Thallium (Tl)	Rodenticides, fungicides, mercury and silver alloys, lens manufacturing, photoelectric cells, infrared optical instruments	• Cigarettes • Ingestion of fish and shellfish
Tin (Sn)	Coating for lead and zinc, prevents corrosion, reducing agent, solder for pipes and electric circuits, bearing alloys, window glass, tin foil, conductive coatings, mordant in printing processes, magnets, superconductors	• Ingestion of foods from unlacquered cans, tin foil, tin flavorings found in jarred foods.

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MedLink®, LLC
3525 Del Mar Heights Rd, Ste 304
San Diego, CA 92130-2122

Toll Free (U.S. + Canada): 800-452-2400
US Number: +1-619-640-4660
Support: service@medlink.com
Editor: editor@medlink.com
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