



Hunter's The Diseases of Occupations 1955-1975 Excerpts on Lead

Editor's Note: Originally typed by a LEAD Group volunteer in 2007, from now-lost photocopies of lead-related pages of *The Diseases of Occupations*, by Donald Hunter, Consulting Physician, The London Hospital, The English Universities Press Ltd, (1st edition 1955) 5th Edition 1975; typing corrected (without reference to the original) by Elizabeth O'Brien, The LEAD Group Inc, September 2019. If you can make corrections from the original, please send them in a Letter to the Editor.

These 1955 (revised edition 1975) excerpts need to be read with caution as many of the findings have been overturned, for example: "There seems little evidence, therefore, that lead significantly predisposes to hypertension" and "By attention to plant design, further catastrophies of this sort [occupational exposure to Tetra ethyl lead (TEL) or Tetra methyl lead (TML) – collectively known as Tetra alkyl lead] and severe health and behavior consequences] were avoided." Any reference to Kehoe should be particularly viewed with skepticism as Robert A Kehoe was the chief medical advisor of the Ethyl Corporation, a tetraalkyl lead (TAL) manufacturer, and according to Wikipedia: "Kehoe's work is now considered discredited." Eg Hunter quotes Kehoe as saying the following patently untrue statement: "To prevent such unnecessary exposures [of leaded petrol tank sludge cleaners who suffered consequent lunacy or death], adequate supervision of the cleaning of tanks has now been instituted all over the world (Kehoe, 1953)."

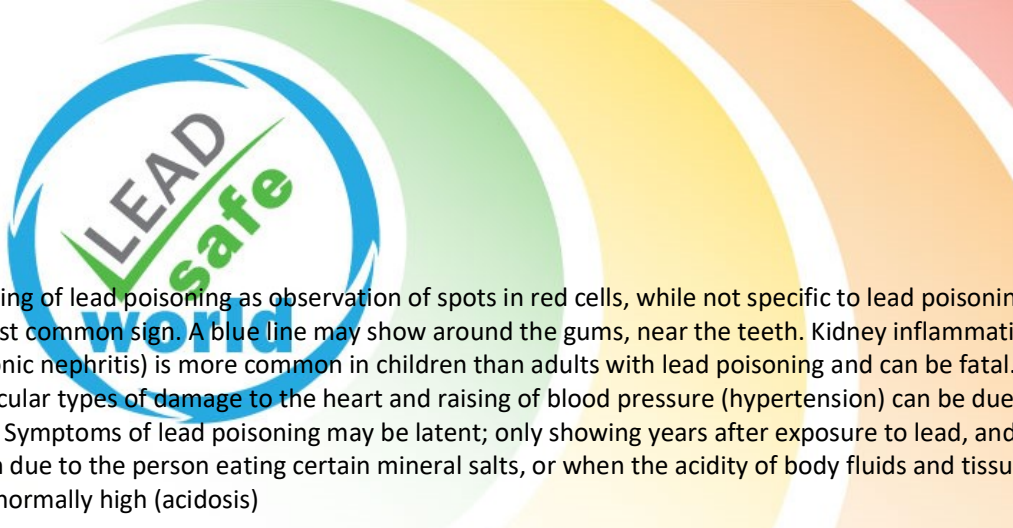
See 19651126 Dept of Health letter re safe handling & disposal of leaded sludge below this article.

One statement below completely contradicts the advice from Associated Octel in 1964, to clean up Alkyl Lead spilled on the skin, using gasoline. See 196405 Octel Bulletin No 12 *The Safe Handling of Octel Antiknock Compounds*, by Associated Octel, reprinted in this issue of *LEAD Action News*. By comparison, Hunter (1975) writes: "Although ethyl-petrol contains less than one part in a thousand of tetra-ethyl lead it should not be used for cleaning the skin, and to prevent this it is coloured by a dye."

Hunter's The Diseases of Occupations 1955-1975 – Excerpts on Lead

Diagnosing - some signs of lead poisoning

- A. Organic forms of lead such as Tetraethyl lead in leaded petrol produce effects on the brain as it is fat soluble and readily absorbed through the skin and lungs. A symptom of poisoning includes shakiness, insomnia, delusions. More severe poisoning can produce mania and violent movements and has been fatal, including workers who cleaned fuel storage tanks without adequate protection.
- B. Inorganic lead is acutely dangerous if breathed in as fumes or dust. If it enters the body orally it may pass through or be absorbed and cause immediate symptoms or be stored (without immediate harm) in the bones. Nerve inflammations (sometimes called encephalopathy) include muscle pain, weakness and shakiness, nerve swelling (papilloedema), coma, convulsions, head-ache, mental dullness, delirium, blindness and deafness. Palsy or paralysis, particularly of the wrist(s) was a common affliction of housepainters in the nineteenth century, using leaded paint. Lead colic is the most common form of lead poisoning and creates intense pain in the lower abdomen. Lead anemia is due to damage and destruction of red blood cells. A stained blood cell examination can give early

The logo features a circular emblem with a blue border and a green checkmark. Inside the circle, the word "LEAD" is written in blue and "Safe" in green. Below the circle, the word "World" is written in blue. The background consists of several overlapping semi-circular bands in shades of green, yellow, and orange.

warning of lead poisoning as observation of spots in red cells, while not specific to lead poisoning is a most common sign. A blue line may show around the gums, near the teeth. Kidney inflammation (chronic nephritis) is more common in children than adults with lead poisoning and can be fatal. Particular types of damage to the heart and raising of blood pressure (hypertension) can be due to lead. Symptoms of lead poisoning may be latent; only showing years after exposure to lead, and often due to the person eating certain mineral salts, or when the acidity of body fluids and tissues is abnormally high (acidosis)

Lead:

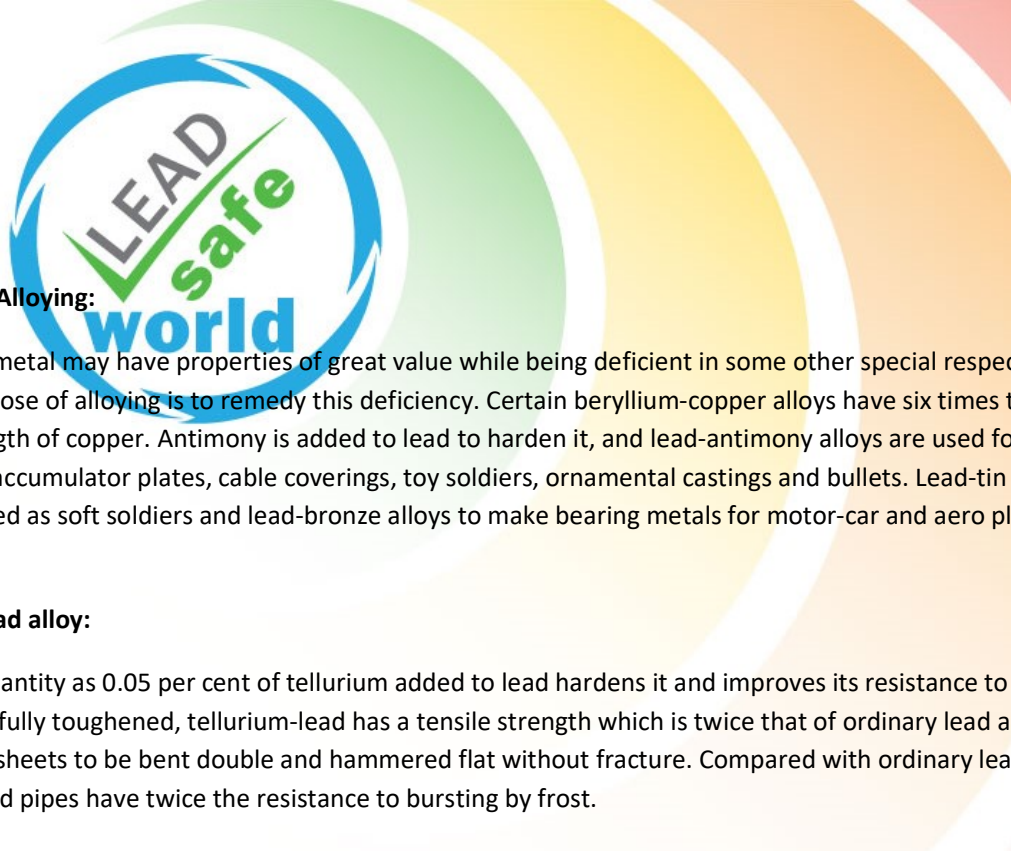
Lead, Pb, is a soft bluish-grey metal, heavy, malleable, and ductile. It is protected from corrosion by the formation of a thin coating of grey oxide. There is evidence that lead has been used for about 6,000 years, for there is a lead figure in the British Museum that was made before 3800 B.C. It was among the earliest metals used by man and was known to the early Egyptians and Hebrews. The Phoenicians mined it in Spain about 2000 B.C. The Hanging Gardens of Babylon had lead pans to hold plants, and the Romans, to satisfy their great enthusiasm for sanitation and bathing, exploited the lead mines in the Mendips, Shropshire, Derbyshire and Flint. Together with Spain, Britain became the principal source of lead in the Roman Empire. Lead pipes made 2000 years ago have been excavated in Pompeii, Rome and Bath, and found to be in good condition. In modern times the principal lead-production countries are the United States of America, Mexico, Australia and Canada. World production of lead for the year 1953 was 2,050,000 tons. The principal lead ore is galena, PbS, and this is usually associated with the sulphides of silver, copper, arsenic, antimony, bismuth and tin. Other common ores of lead are cerussite, $PbCO_3$, and anglesite, $PbSO_4$.

Uses:

Lead is so soft that it can be easily rolled into sheet and foil and extruded cold into rods, pipes and tube containers. In building construction it is used for roofing, cornices, tank linings, electrical conduit, water pipes and sewer pipes. Because of its weight and malleability it is utilized in yacht keels, plumb-bobs and sinkers in diving-suits. Alloyed with tin and antimony, lead proved the most satisfactory substance for casting type when movable type was invented in the fifteenth century, for it made a sharp impression and when broken could be easily recast. Antimonious lead is now the chief type-metal. Lead-antimony alloys are also used for accumulator plates, cable coverings, toy soldiers, ornamental castings and the fillings of bullets for small-arms ammunition. Soft solder, used chiefly for soldering tinfoil and lead pipes, is an alloy of lead and tin which remains in a plastic state sufficiently long to enable the plumber to wipe the joint. Certain lead-base alloys are used in engineering to make bearing-metals. Lead is now encountered in more than 200 industries. The annual world production of pig lead exceeds two millions tons, and in Great Britain alone more than 25,000 tons of white lead and 20,000 tons of red lead and litharge are manufactured annually. In 1951 in Great Britain there were more than 1500 workers in the lead industries and 150,000 painters.

Nature of Alloys:

Two or more metals when fused together usually form a homogeneous liquid; when this solidifies the resulting metallic substance is an alloy. It may be either a solid solution or a pure chemical compound.



Reasons for Alloying:

A particular metal may have properties of great value while being deficient in some other special respect and the purpose of alloying is to remedy this deficiency. Certain beryllium-copper alloys have six times the tensile strength of copper. Antimony is added to lead to harden it, and lead-antimony alloys are used for type-metal, accumulator plates, cable coverings, toy soldiers, ornamental castings and bullets. Lead-tin alloys are used as soft solders and lead-bronze alloys to make bearing metals for motor-car and aero plane engines.

Tellurium-lead alloy:

As small a quantity as 0.05 per cent of tellurium added to lead hardens it and improves its resistance to acids. When fully toughened, tellurium-lead has a tensile strength which is twice that of ordinary lead and this enables sheets to be bent double and hammered flat without fracture. Compared with ordinary lead, tellurium-lead pipes have twice the resistance to bursting by frost.

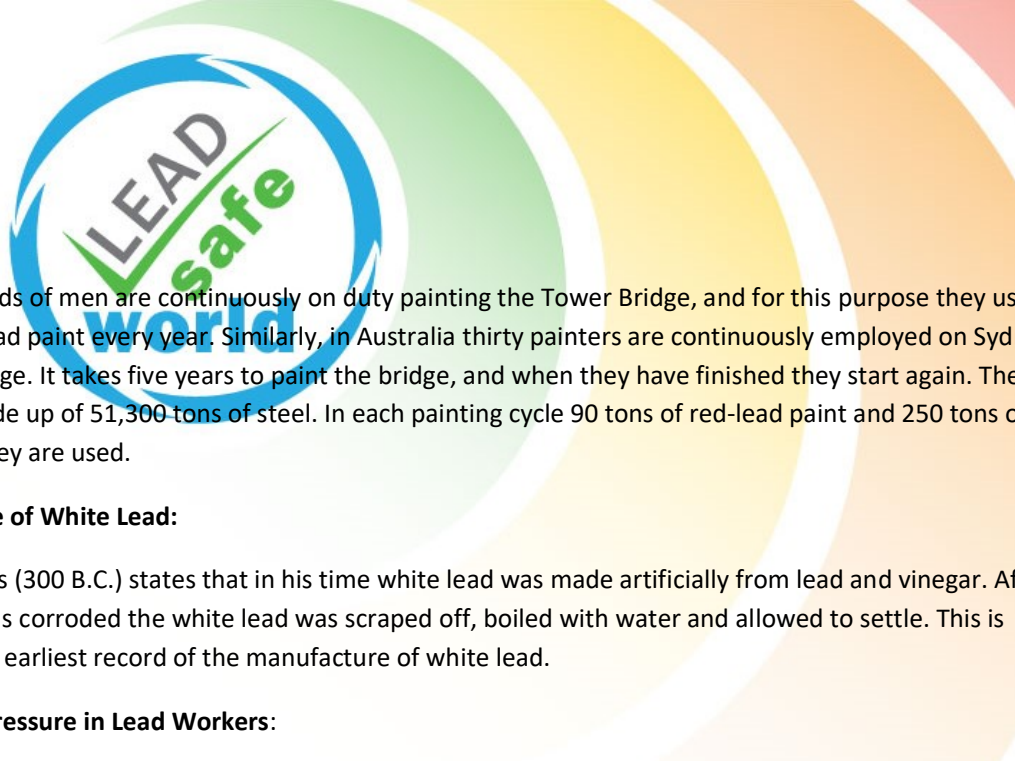
Lid Labels for Lead Paint:

The hazard of lead poisoning in children from ingestion of compounds of lead is serious especially during the age of teething. In Baltimore, U.S.A. between 1931 and 1959 a total of 744 such children were poisoned, and of these 123 died. A special ordinance for the City of Baltimore was adopted as a regulation on 27th April, 1959. The text of the regulation is as follows: "Lid Labels. No lid label bearing the warning as required by this ordinance shall be less than three inches in diameter for pint and larger size containers or less than one and one-half inches in diameter for cans smaller than pint size. In addition to the warning statement the lid label shall contain the name and address of the manufacturer. The word WARNING preceding the warning statement shall be of larger letters than the name and address of the manufacturer. The warning statement shall be as large as the lid will permit. The lid label shall adhere firmly to the lid of the container." The text of the label warning required by the Baltimore ordinance for all paint containing more than one per cent of lead reads as follows: "WARNING - Contains lead. Harmful if eaten. Do not apply on any interior surfaces of a dwelling, or of a place used for the care of children, or on window sills, toys, cribs, or other furniture."

Litharge Rubber:

The use of litharge rubber - that is, rubber in which litharge has been incorporated in excess in a mother batch even to the extent of to 90 per cent - has abolished lead poisoning in men who vulcanize rubber (Klein, 1952). The litharge rubber is manufactured in a central factory and is sent to scores of other factories where vulcanizers throw it in solid pieces into batches of crude rubber. Prior to the invention of litharge rubber they used powdered litharge, some of which inevitably they inhaled.

The rusting and corrosion of iron and steel is a phenomenon of great economic significance, resulting as it does in the financial loss throughout the world of many hundreds of millions of pounds per annum. The authorities responsible for ships, lighthouses, bridges, railways and other iron and steel structures are particularly alive to the value of lead paint as a protection against atmospheric attack. For example, in



London squads of men are continuously on duty painting the Tower Bridge, and for this purpose they use 25 tons of lead paint every year. Similarly, in Australia thirty painters are continuously employed on Sydney Harbour Bridge. It takes five years to paint the bridge, and when they have finished they start again. The bridge is made up of 51,300 tons of steel. In each painting cycle 90 tons of red-lead paint and 250 tons of battleship grey are used.

Manufacture of White Lead:

Theophrastus (300 B.C.) states that in his time white lead was made artificially from lead and vinegar. After the metal was corroded the white lead was scraped off, boiled with water and allowed to settle. This is probably the earliest record of the manufacture of white lead.

The Blood-pressure in Lead Workers:

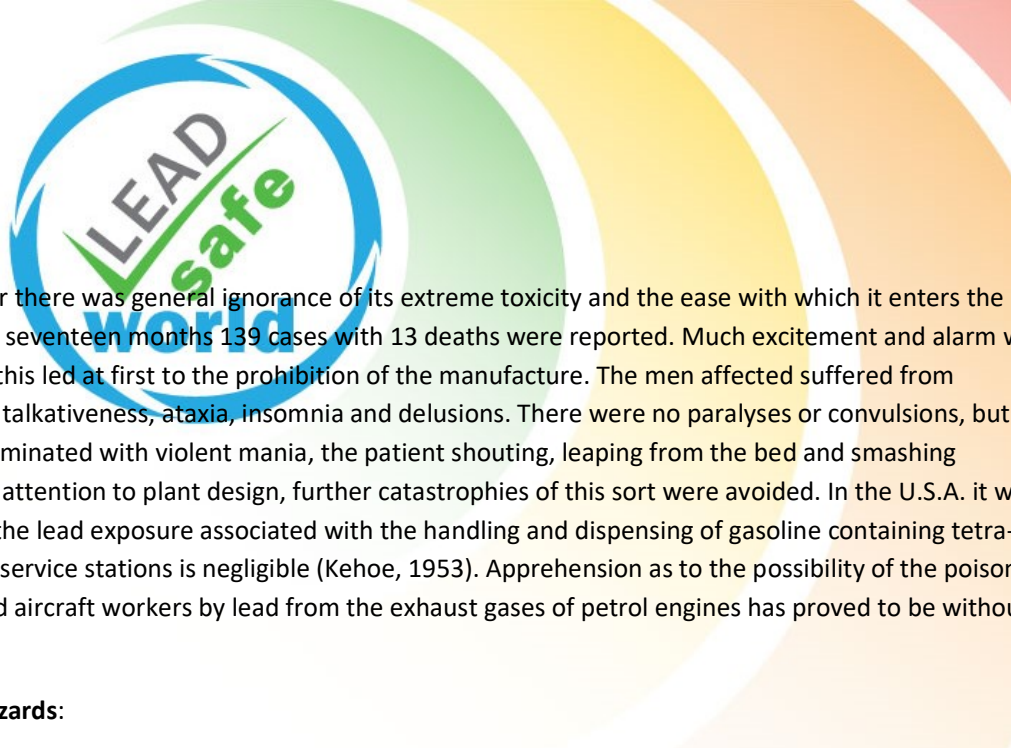
Vigdortchik (1935) found an association between lead absorption and hypertension, but he based this on single observations of the blood-pressure of 2,769 workers in whom only the systolic pressure was recorded. He gave no serial figures of individual cases and he omitted to state the amount of lead absorption in each worker. Belknap (1936) reported 2,600 serial blood-pressure readings made month by month for over a year in workers who had absorbed large amounts of lead. Of eighty-one men observed all were heavily exposed either to fume of molten lead or to dusts of lead oxides, and all showed either a blue line on the gums, punctate basophilia or high lead excretion in the urine. Fifty-eight per cent of them had been exposed for periods varying from five to nine years. The cases were studied by age-groups. The writer concluded that there was no variation from normal in the blood-pressure. Teleky (1937) disputed the validity of these results on the ground that the men had not worked long enough in the lead industries to develop high blood-pressure. He stated that he would have expected, from his experience, only sporadic cases of high blood-pressure in men exposed for such relatively short periods.

Standard Mortality in Paperhangers and Painters:

Fouts and Page (1942) failed to produce hypertension in dogs treated with lead for a long time. One animal received large amounts of lead for three years, a third of its life-span. Dreessen (1943) showed that among 776 workmen, albuminuria and symptoms of early plumbism were most common in those exposed to the highest atmospheric lead concentration, but the prevalence of arterial hypertension among these employees was not significantly different from that observed in other industrial workers. The figures of the Registrar-General for 1931 show there were then 178,170 paperhangers and painters in Great Britain and that deaths from cerebral vascular lesions numbered 398, arteriosclerosis 40, and Bright's disease 265. The standard mortality for the same disease was 263, 33, and 202. There seems little evidence, therefore, that lead significantly predisposes to hypertension or Bright's disease, except perhaps in children.

Historical Summary:

In 1923, when it [tetra ethyl lead (TEL)] was first manufactured in the United States of America, cases of encephalopathy began to occur in men employed on three separate plants. The victims were not only workmen engaged in blending and quite ignorant of any danger, but also chemists who handled the liquid



recklessly, for there was general ignorance of its extreme toxicity and the ease with which it enters the body. Within seventeen months 139 cases with 13 deaths were reported. Much excitement and alarm were caused, and this led at first to the prohibition of the manufacture. The men affected suffered from restlessness, talkativeness, ataxia, insomnia and delusions. There were no paralyses or convulsions, but the condition terminated with violent mania, the patient shouting, leaping from the bed and smashing furniture. By attention to plant design, further catastrophies of this sort were avoided. In the U.S.A. it was proved that the lead exposure associated with the handling and dispensing of gasoline containing tetra-ethyl lead at service stations is negligible (Kehoe, 1953). Apprehension as to the possibility of the poisoning of garage and aircraft workers by lead from the exhaust gases of petrol engines has proved to be without foundation.

Exposure Hazards:

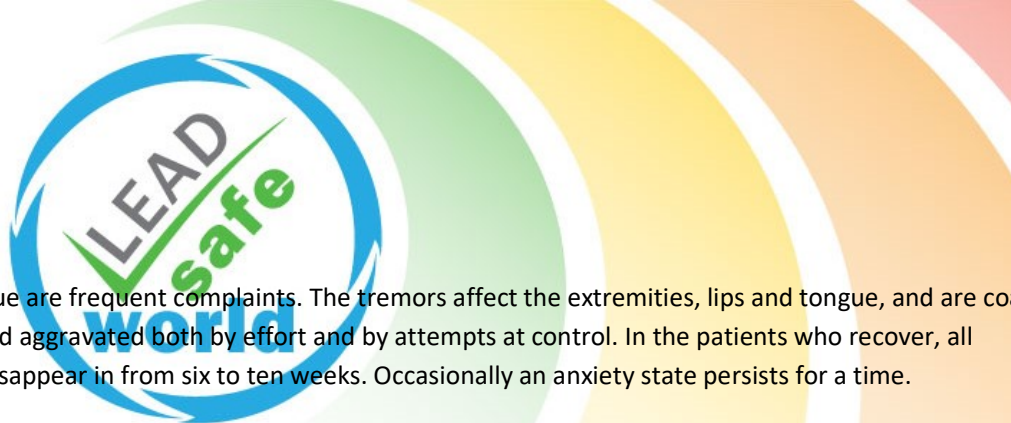
In the Second World War a new hazard arose in the process of cleaning storage tanks which had ethyl-petrol [leaded petrol / leaded gasoline]. In England some of these tanks were underground and were of 4,000 tons capacity. After the petrol had been pumped out and the air rendered gas-free by ventilation, the floors, walls and supporting pillars were scraped clean. Men engaged in the work were required to wear an air-line mask and were supplied with a complete outfit of clothing including boots, gloves and headgear. The protection afforded was satisfactory, but there were occasional instances of failure to obey the regulations, with the results that twenty-five cases of poisoning by tetra-ethyl lead occurred, two of them fatal (Cassells and Dodds, 1946). War conditions in countries of the Middle East and Far East made the cleaning of tanks difficult to supervise, and there were 200 cases of poisoning, with forty deaths. Unhappily many of these cases were not recognized soon enough. Mistaken for drunkards and lunatics, some-times they were starved and beaten instead of being treated properly. To prevent such unnecessary exposures, adequate supervision of the cleaning of tanks has now been instituted all over the world (Kehoe, 1953).

Symptoms and signs:

The early symptoms include insomnia, loss of weight, anorexia and morning nausea, but there is no colic. Metal manifestations dominate the clinical picture, and in severe cases restlessness, bad dreams, hallucinations and delusions are common. Several symptoms-complexes have been distinguished - the delirious, manic, confused, and schizophrenic (Machle, 1935). With severe exposure there may be the abrupt onset of acute maniacal symptoms with suicidal tendencies or the occurrence of a convulsion. Less severe cases begin with insomnia, sleep being difficult, broken and restless, sometimes with wild and terrifying dreams. By day, mental excitements may be marked, headache is usual and often severe, and vertigo is frequent. Blurred vision and diplopia owing to weakness of the extrinsic ocular muscles are occasional complaints. Evidences of meningeal irritation are absent; the cerebrospinal fluid may at times be under increased pressure, but it is not otherwise abnormal.

Colic, Palsy and Stippling are absent:

Punctate basophilia is absent or slight, and the test for its presence in the blood therefore has little significance. Anorexia, nausea and vomiting are constant, but colic does not occur. Many patients complain of a metallic taste in the mouth, and diarrhea sometimes occurs. Weakness, tremor, muscular pain and



ease of fatigue are frequent complaints. The tremors affect the extremities, lips and tongue, and are coarse and jerky, and aggravated both by effort and by attempts at control. In the patients who recover, all symptoms disappear in from six to ten weeks. Occasionally an anxiety state persists for a time.

Facilities from Dry Cleaning:

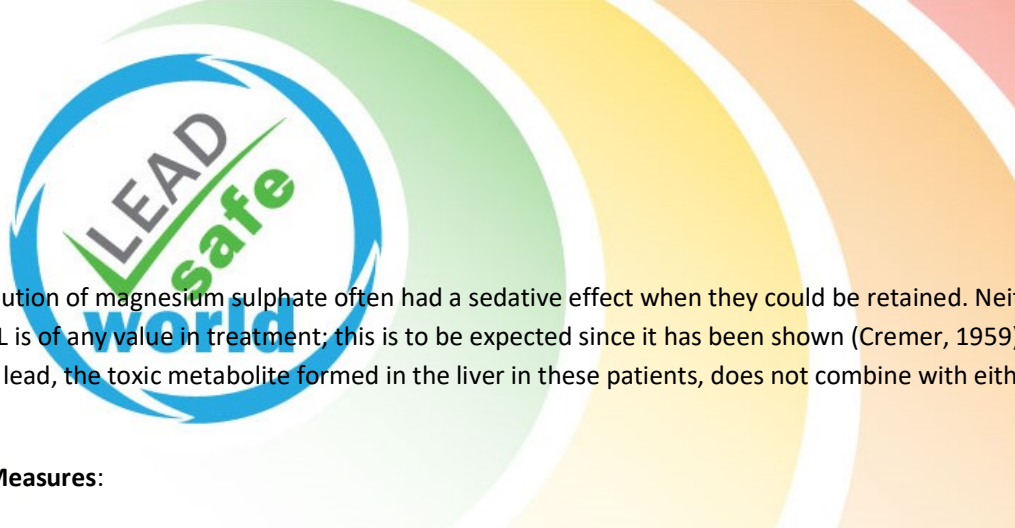
In 1947 Bini and Bollea described two fatal cases of poisoning, where ethyl-petrol intended for use as aviation fuel was used for the dry cleaning of clothes. The patients were Italians, aide men of American airmen stationed in Italy. They worked in a room which was small, closed and poorly ventilated, and they ironed the clothes while they were still wet with the leaded petrol. After a few days' exposure they suffered from anorexia, vertigo, general weakness and insomnia. About a week later there was psychomotor agitation, with a rapid stream of disconnected talking and mental confusion in the nature of a toxic confusional delirium with visual and auditory hallucinations occurring together, tremors affecting all muscles, myoclonus and choreiform movements. Two days later they became comatose and died with a temperature of 105 degrees F.

Conjugation and Pathology:

Tetra-ethyl lead is insoluble in water so that if it is inhaled it must be made water-soluble before it can be excreted. It does not concentrate in the brain as is sometimes supposed but is metabolized in the liver, where one of the ethyl groups is removed to form the water-soluble tri-ethyl lead ion (Cremer, 1959). This gets into the circulation, and by its interference with cellular metabolism in the brain it produces serious and often fatal effect. At necropsy the brain shows diffuse hyperemia of the cortical grey matter and the basal ganglia. Historically there are both diffuse and focal changes. Throughout the cerebral and cerebella cortex there are diffuse acute degenerative changes in almost all the nerve cells. In places, groups of nerve cells show severe degenerative changes with complete disintegration of the cell bodies. Focal lesions are found especially in the mamillary bodies [located on the undersurface of the brain] and to a lesser degree in the floor of the fourth ventricle [within the brain] and in the corpora quadrigemina [in the midbrain]. The nerve cells in the mamillary bodies appear to be severely injured and in some areas they completely disappear. In addition there is intense proliferation of the glia with predominance of microglia cells [located throughout the brain and spinal cord]. Where this occurs, there is also new formation of capillaries and perivascular infiltration with small round cells including mast cells.

Treatment:

In mild cases removal from exposure, a normal diet with extra fluids and the relief of insomnia by the proper choice of barbiturates are all that is required. Severe cases call for strict supervision and skilled nursing because of hallucinations and impulsive suicidal tendencies. Morphine is contra-indicated; the sedative actions of repeated doses of barbiturates together with adequate fluid intake are the essentials in treatment (Kehoe, 1953). Pentobarbitone sodium may be given in repeated full doses to obtain rest. Glucose, 5 per cent in saline, may be given intravenously up to 3 litres a day, and if it is given as a drip, hexobarbitone may be added. Machle (1935) recommends the intravenous administration of from 2 to 4 grams of magnesium sulphate in 2 per cent aqueous solution, accompanied by doses of pentobarbitone sodium up to 15 gr. daily by mouth. Cassells and Dodds (1946) found the enemata of 6 ounces of a



saturated solution of magnesium sulphate often had a sedative effect when they could be retained. Neither EDTA nor BAL is of any value in treatment; this is to be expected since it has been shown (Cremer, 1959) that tri-ethyl lead, the toxic metabolite formed in the liver in these patients, does not combine with either EDTA or BAL.

Preventive Measures:

By meticulous attention to detail, it is possible to manufacture tetra-ethyl and to blend it with petrol without risk to the workers. Both manufacture and blending are carried out in closed systems. Elaborate precautions are taken in transport, storage and handling of the fluid and great care is exercised to avoid leakage or spilling (Kehoe, 1935). In blending and laboratory works, impervious gloves and respirators are used. Strict regulations must be laid down for the cleaning of any tank which has contained leaded petrol. Those responsible should make it quite clear that such work is never to begin without reference to some authorized person. This makes it possible to do the work under supervision and to use trained workmen properly equipped with protective clothing (Kehoe, 1953). Although ethyl-petrol contains less than one part in a thousand of tetra-ethyl lead it should not be used for cleaning the skin, and to prevent this it is coloured by a dye. While decarbonizing engines which have burned leaded petrol, mechanics must wear dust masks. Routine medical examinations should be carried out whenever possible.
