CDC

ENVIRONMENTAL HEALTH ABSTRACTS & BIBLIOGRAPHY

April 1981

focus: LEAD POISONING

DEPARTMENT OF HEALTH AND HUMAN SERVICES - PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL, ATLANTA, GEORGIA 30333

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Foreword

Environmental Health Abstracts and Bibliography presents a survey of recently published literature in the field. Effort is made to keep the abstracts as current as possible and sufficiently informative to enable the reader to decide whether the original article would be of interest to him or her. The journals in which articles originally appeared should be checked for reprint addresses. The Centers for Disease Control is unable to supply reprints of articles which are cited in this publication.

In compiling these abstracts we utilize the National Library of Medicine's interactive retrieval service, MEDLARS II. Under this system, both foreign and domestic biomedical periodicals are searched for material dealing with or related to environmental health. We also utilize the libraries of Emory University, the Centers for Disease Control and other federal agencies. Abbreviations of periodical titles are those used by MEDLARS and listed in the National Library of Medicine's *List of Journals Indexed in Index Medicus.*

Future issues of *Environmental Health Abstracts and Bibliography* will be devoted to various environmental health topics. Individuals desiring to be placed on the mailing key to receive future issues as published should write to the Environmental Health Services Division, Center for Environmental Health, Centers for Disease Control, Atlanta, Georgia 30333.

Vernon N. Houk, M.D.
Director
Environmental Health Services Division

Contents

GENERAL

Social Policy Considerations of Occupational Health Standards: The Example of Lead and Reproductive Effects

A. Hricko. PREV MED 1978 Sep;7(3):394-406.

Author's abstract: Social policy considerations of occupational health standards are examined with a specific look at the case of lead exposure and its effects on reproduction. Because the lead standard will be the first to take into account the full range of reproductive effects—and the resulting social, political and legal issues—it may be precedent setting and could serve as a paradigm for future standards. Historical evidence on lead's adverse effects on reproduction is provided. In addition, data from scientific studies on the effects of lead on both males and females, as well as on the fetus, the nursing infant and the young child, are also presented. Industry and government responses to the conclusions of these studies are discussed, as well as the social and ethical implications of their current policies regarding protection of the work force. Possible options for the adoption of the lead standard are given, which are considered unacceptable by the author because they discriminate against certain working groups or ignore the evidence at hand and allow the continuation of unacceptably high levels of lead exposure. An alternate approach is preferred, and it is suggested that such an approach is appropriate for evaluating other toxins in the workplace as well.

Geochemical and Manmade Sources of Lead and Human Health

D. Barltrop. PHILOS TRANS R SOC LOND (BIOL) 1979 Dec 11;288(1026):205-11.

Author's abstract: Multiple sources of Pb have been identified for human populations, but there is little agreement as to their relative significance. Marked regional geochemical anomalies in the distribution of Pb have been identified and, in one district, their impact on rural communities has been determined. The absorption of ingested Pb is modified by its chemical and physical form, by interaction with dietary minerals and lipids, and by the nutritional status of the individual. Studies on children of various ethnic groups have demonstrated differences in soft tissue Pb burdens, which may, in part, have a nutritional basis. Erythrocyte protoporphyrin determinations suggest that metabolic disturbances attributable to Pb may occur at soft tissue burdens previously regarded as acceptable. The problem of defining an adverse health effect in relation to environmental sources of Pb is discussed.

Lead Poisoning: A Veterinary Responsibility?

B.J. McLeavey. NZ VET J 1979 Oct;27(10):199.

Lead poisoning is not a condition limited to humans alone; it is also a danger for animals. In fact, the symptoms are roughly the same for all species. Since household pets share the same environment as children, a dog or cat diagnosed as lead-intoxicated means that children in the same residence, particularly younger ones, are at substantial risk also. New Zealand has recently issued a directive requiring that all cases of lead poisoning in animals be reported to the health department so that the owner's family may be investigated. There are some limitations to this concept, but a reported case of lead poisoning in a family pet could result in the detection of subclinical lead intoxication in a child that might otherwise go unnoticed.

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*Abstracted

EPIDEMIOLOGY AND ETIOLOGY

Factors Influencing Household Water Lead: A British National Survey

S.J. Pocock. ARCH ENVIRON HEALTH 1980 Jan-Feb;35(1):45-51.

From author's discussion: Results are reported for lead concentrations in water samples taken in the morning before any other water had been run from 1,073 households with some lead in household and/or supply pipes. Water lead had approximately a log-normal distribution with median 0.042 mg/L. Evidently, pH is the most important factor with respect to water lead. Acid waters with a pH below 6.8 are very plumbosolvent, so that two-thirds of such dwellings had water Pb levels in excess of 0.1 mg/L. The high water Pb levels for alkalinity <10 mg/L can be explained by the fact that 75% of these dwellings had pH <6.8. Thus, once one allows for pH, there is no apparent additional plumbosolvency contributed by very low alkalinity. There appears to be a sharp distinction between those households with alkalinity above and below 100 mg/L. There is a continuous positive association between the length of Pb piping in the household and supply pipes and the water Pb level. The effects of increased length of pipe tend to diminish as one reaches 30 m or more. The percentage of lead piping in the household and supply pipes was clearly associated with water Pb. The age of the dwelling was a relevant factor in that post-war housing had somewhat lower water Pb levels. This could not be completely explained by the reduced usage of lead pipes in modern houses. A change in the type of lead piping installed post-1944 seems to be the most plausible explanation. The number of occupants was inversely related to water Pb, probably because a single occupant will normally consume considerably less water than a family of three, so that water will tend to stand in the pipes longer. However, once a family size of three was attained, any further occupants made no difference with respect to water Pb level.

Lead Pollution, Disease, and Behavior

D. Bryce-Smith and H.A. Waldron. COMMUNITY HEALTH (Bristol) 1974 Nov-Dec;6(3):168-76.

From authors' conclusion: We have allowed our environment to become contaminated to a dangerous degree with lead largely through carelessness and ignorance, but some of this contamination is now clearly willful, e.g., that from leaded petrol. There is clear evidence to support the thesis that current levels in the environment are capable of producing behavioral abnormalities of types associated with educational disorders and delinquency, and also evidence that delinquents tend to have abnormal lead metabolism.

In our considered opinion, a number of measures should be taken immediately to insure that the present heavy lead exposure is reduced: the upper permitted limits of lead in food and water should be reduced; lead should be banned as a component of any item liable to come into contact with food or drink; lead should be taken completely out of all paint; sewage sludge should not be dumped on agricultural land or in coastal waters used for fishing; and lead should be prohibited as an additive in petrol.

Heavy Metals in Some Asian Medicines and Cosmetics

M. Aslam, S.S. Davis, and M.A. Healy. PUBLIC HEALTH 1979 Sep;93(5):274-84.

Authors' abstract: Our study is the first to examine the role of Asian medicines in a Western community. The results we report here give rise to much concern. At the present time, there is considerable public interest centered on the role of lead in petrol and the possible environmental and health hazards which may occur because of this. However, if the lead levels in petrol are compared with the quantity of heavy metals which are regularly being ingested by consumption of some of the substances we have examined, the need for action becomes obvious. It is our firm belief, however, that legislation is only a partial solution and may, indeed, only serve to drive the problem underground. The prime requirement is for effective communication and education to bring about a change in attitude towards the use of these materials within the Asian community. Data we are still collecting indicate that the results we report here are but a small part of a much wider problem. The need for centralization and collation of this information is, we feel, paramount in order to assist in the treatment of Asian patients and bring about an awareness of the special risk to which they may be open.

Surma and Blood Lead Concentrations

S.D. Green, G.T. Lealman, M. Aslam, and S.S. Davis. PUBLIC HEALTH 1979 Nov;93(6):371-6.

Authors report on a study in Bradford (United Kingdom) relating use of surma to elevated blood lead levels. Surma is a fine powder that is applied to the conjunctival surfaces and has been used for many centuries in Muslim communities for religious, medical, and cosmetic reasons. Previously made from antimony sulfide, its main ingredient is now galen (lead sulfide), and it sometimes contains as much as 86% lead. This study confirmed other studies that had concluded that children of parents who used surma had significantly higher blood lead levels than children in either Caucasian or Asian control groups. At least one case of fatal lead encephalopathy in Great Britain has been associated with the use of surma. Some mothers admitted that, although they understood the dangers of using surma, they continued to use it because they were pressured by their mothers-in-law to maintain the tradition. Many surma-related cases may go unrecognized because the mothers are reluctant to admit to a Western doctor that they do use this product. In the non-surma-using Asian control group of 72 children used in study, six parents later told a Muslim doctor that they did use surma.

Increased Lead Absorption in Inner City Children: Where Does the Lead Come From?

E. Charney, J. Sayre, and M. Coulter. PEDIATRICS 1980 Feb;62(2):226-31.

Authors' abstract: Pica for lead-containing paint has been questioned as the principal mechanism for the widespread moderately elevated blood lead levels (30 to 80 μg/dl) in inner city children. This study explored the hypothesis that lead-contaminated household dust is a major source of lead for these children; hand contamination and repetitive mouthing is the proposed mechanism of ingestion. Forty-nine inner city children with blood lead 40 to 70 μg/dl were matched with 50 children with blood lead less than or equal to 29 μg/dl from the same inner city environment. House dust lead and lead on hands were found in significantly greater quantity among experimental subjects. Other factors differed between groups; lead content of peeling paint, soil lead, and pica affected more experimental than control children, but did not account for more than 50% of experimental cases. The cause of moderate blood lead elevation has many factors; no single source accounted for all children with elevated levels. However, lead contamination of house dust and hands appears to be a major factor in this condition.

Asbestos, Lead, and the Family: Household Risks

A. Fischbein, J. Cohn, and G. Ackerman. J FAM PRACT 1980 Jun;10(6):989-92.

Authors' abstract: Although the intrafamilial transmission of infectious diseases has long been recognized, the induction of environmental disease in household contacts is being increasingly documented and requires a higher index of suspicion. An incidental radiographic finding, such as pleural thickening or calcification, or even interstitial pulmonary fibrosis in a young person without obvious occupational exposure to asbestos, should prompt the physician to clarify the parental occupational history. Likewise, unexpected evidence of lead-induced abnormalities, such as elevated blood lead and/or erythrocyte protoporphyrin levels, should focus the examiner's attention on possible intrafamilial transmission, treatment, and prevention.

Surface Soil as a Potential Source of Lead Exposure for Young Children

N. Schmitt, J.J. Philion, A.A. Larsen, M. Harnadek, and A.J. Lynch. CAN MED ASSOC J 1979 Dec 8;121(11):1474-8.

From authors' discussion and abstract: The importance of dirt and dust as a cause of elevated blood lead levels in children has received increasing attention in recent years. It is thought that young children are particularly likely to ingest contaminated dust particles because they are more likely to play in the dirt and practice pica. Weathered lead-based house paint has long been considered one major source of soil contamination.

The article discusses other sources of soil contamination. Soil analyses revealed an elevated lead content in the surface soil of three British Columbia cities [1977]. These lead accumulations were largely attributed to dustfall from a nearby large lead-zinc smelter in Trail and to automotive traffic in Nelson and Vancouver. Although the mean concentrations of lead in the soil were relatively low at Nelson (192 parts per million (ppm)), in selected areas of Vancouver with heavy traffic, they were similar to those found within 1.6 km of the large smelter at Trail (1545 and 1662ppm, respectively).

In a study conducted in 1975, children aged 1 to 6 years in Trail and Nelson were found to have higher mean blood lead levels than students in the ninth grade. The findings of the later study [1977] support the view that particulate lead in surface soil and dust accounted for most of the greater lead absorption in the younger children.

Role of Chronic Low-Level Lead Exposure in the Etiology of Mental Retardation

A.D. Beattie, M.R. Moore, A. Goldberg, M.J. Finlayson, J.F. Graham, E.M. Mackie, J.C. Main, D.A. McLaren, K.M. Murdoch, and G.T. Steward. LANCET 1975 Mar 15;1(7907):589-92.

Authors' abstract: Water-lead levels were measured in the homes occupied during the first year of life by 77 mentally retarded children aged 2 to 6 years and 77 non-retarded matched controls and in the homes occupied by their mothers during pregnancy. The lead content of the water was significantly higher in the retarded group, and the probability of mental retardation was significantly increased when water lead exceeded 800 μg per liter. Lead levels in blood were also significantly higher in the retarded group. It is concluded that lead contamination of water may be one factor in the etiology of mental retardation and that every effort should be made to reduce the lead content of drinking water.

Age-Specific Risk Factors for Lead Absorption in Children

S.D. Walter, A.J. Yankel, and I.H. von Lindern. ARCH ENVIRON HEALTH 1980 Jan-Feb; 35(1):53-8.

Authors' abstract: The relationship of blood lead levels (PbB) to environmental and individual characteristics is analyzed in a large sample of children residing near a lead-smelting complex, with particular emphasis on the identification of age-related risk factors. Exceptional variation in both PbB and its determinants within the study region facilitated the simultaneous detection of several significant risk factors for each year of age from 1 to 9 years. The strongest predictor of PbB at all ages was air lead, but the secondary risk factors were age dependent. Household dust levels were significantly related to PbB in young children, especially those under 2 years of age; soil lead may be an important source of ingested lead for children between 2 and 7 years. Other significant effects included pica at about 2 years of age, a slight effect of the occupational category of the fathers of 5- to 8-year-old children, and a tendency for 8- and 9-year-old boys to have higher PbB than girls of the same age. Lead concentration in household paint was not a significant risk factor. These results suggest that a multi-faceted approach to the prevention of excessive lead absorption in children is required.

The Battle against Occupational Lead Poisoning in Finland: Experiences during the 15-Year Period 1964–1978

S. Hernberg and S. Tola. SCAND J WORK ENVIRON HEALTH 1979 Dec;5(4):336-44.

Authors' abstract: Occupational lead poisoning has been greatly reduced as a problem in Finland during the 1970's. Case-finding efforts and increased awareness of plant physicians first caused an increase of reported incidence with a peak of 89 reported cases in 1974. A sharp decline followed, and, although about 30 mild cases are still reported annually, classical clinical poisoning hardly exists anymore. An extensive regular monitoring program covering 8,000–10,000 blood lead (PbB) analyses a year also shows that exposure levels have been reduced. In 1977, only 70 PbB values, or 1%, were in excess of 70 μg/dl, and 243 values (4%) exceeded 60 μg/dl. All such values came from workers employed by less than 30 workplaces, and several of them belonged to workers monitored more than once a year. It is proposed that the general development of occupational health in Finland is to a great extent reflected in this favorable development; however, since special research, educational, and informative efforts have been devoted to the lead problem, it may well be that these measures have also influenced the outcome. The results show that, on a nationwide scale, the lead problem can be coped with much more effectively than one has been apt to think. Hence the nonfeasibility of lowering maximum permissible exposure levels has been put in serious doubt. There is no reason to allow unnecessarily high exposure in the vast majority of workplaces because only a small minority have technical difficulties.

Physicochemical Speciation of Lead in Drinking Water

R.M. Harrison and D.P. Laxen. NATURE 1980 Aug 21;286(5775):791-3.

Authors' abstract: Recent studies have highlighted the importance of drinking water as a route of human exposure to lead. While there are ample data on lead concentrations in drinking water, little is known of its physical and chemical forms (physicochemical speciation). Such information is important as the speciation of ingested lead influences the efficiency of absorption from the gastrointestinal tract. Knowledge of speciation should also provide a fuller understanding of the factors controlling the solubility of lead in potable waters and hence assist in devising the most cost-effective means of plumbosolvency control. We have determined experimentally the speciation of lead in three different tapwaters and report here diverse forms of dissolved and particle-associated lead, dependent primarily on the chemical matrix of the raw water.

Lead Exposure: Effects in Israel

E.D. Richter, S. Neiman, Y. Yaffe, and N. Gruener. ISR J MED SCI 1980 Feb;16(2):89-95.

Authors' abstract: Blood lead levels and parallel ambient lead exposure levels were studied in selected Israeli population groups. The studies were prompted by newly emerging findings on subtle renal, hematologic, and neurobehavioral effects of low levels of exposure to lead in both children and adults. There was a high correlation (r = 0.89) between individual blood lead levels in the groups studied and free erythrocyte protoporphyrin, a measure of the toxic effect of lead on hemoglobin synthesis. Hemoglobin depression was weakly associated (r = 0.66) with rises in blood lead levels. Blood lead and free erythrocyte protoporphyrin determinations can be jointly used in screening for lead toxicity and iron deficiency. Our data suggest that the Jerusalem population at large is experiencing lead exposure in the range of rural United States levels, but that, in Israel, there are several foci of medically significant exposure requiring a comprehensive approach to control of occupational and environmental hazards. Furthermore, children of workers from high-exposure locations may face an additional risk.

Lead in Albacore: Guide to Lead Pollution in Americans

D.M. Settle and C.C. Patterson. SCIENCE 1980 Mar;207(4436):1167-76.

Authors' abstract: Lead contamination in canned tuna, exceeding natural concentrations 10,000-fold, went undiscovered for decades because of analytical error. The magnitude of this pollution effect helps explain the difference between the lead concentration in the diets of present-day Americans (0.2 parts per million) and in the diets of prehistoric peoples (estimated < 0.002 parts per million). It also explains how skeletal concentrations of lead in typical Americans became elevated 500-fold above the natural concentrations measured in bones of Peruvians who lived in an unpolluted environment 1,800 years ago. It has been tacitly assumed that natural biochemical effects of lead in human cells have been studied, but this is not so because reagents, nutrients, and controls used in laboratory and field studies have been unknowingly contaminated with lead far in excess of naturally occurring levels. An unrecognized form of poisoning caused by this excessive exposure to lead may affect most Americans because magnitudes of biochemical dysfunctions are proportional to degrees of exposure.

Trace Elements in Baby Nutrition: Arsenic, Lead, Cadmium (German)

H. Woidich and W. Pfannhauser. Z LIBENSM UNTERS FORSCH 1980 Feb;170(2):96-8.

English summary: The intake by babies from nutritional sources of lead, cadmium and arsenic was evaluated during the first 12 months of life. Arsenic, lead, and cadmium consumptions were in the range of 0.03–0.15, 0.18–2.50, 0.04–0.61 mg/person and month, respectively. The total intake expressed in micrograms/kg body weight was compared with figures from a study undertaken with adults. In this comparison, arsenic and cadmium intake was within the same range. An exception was lead intake, which was much higher in babies than in adults.

Diet and Lead Toxicity

M.R. Moore. PROC NUTR SOC 1979 Sep;38(2):243-50.

From author's discussion: The principal source of Pb exposure is through the diet. Therefore, any component of the diet that will alter the absorption of Pb, or following absorption, alter the distribution of Pb within the body (such as by redistribution from the bone) or which influences the normal rate of excretion of Pb, is potentially hazardous. It is difficult to assess the potential effects of certain diets on the absorption and excretion of lead. Assessing the various effects of dietary components following absorption of Pb and prior to excretion also presents difficulties. One may conclude that only in circumstances where a single dietary component is found in great excess or in great deficiency will one be able to divide the likely outcome in terms of Pb toxicity.

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*Woidich H, Pfannhauser W: Trace elements in baby nutrition: arsenic, lead, cadmium (German). Z LEBENSM UNTERS FORSCH 1980 Feb;170(2):95-8.

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DIAGNOSIS AND SCREENING

Anemia Among Druze Children in the Golan Heights

C. Hershko, Y. Gaziel, D. Bar-Or, G. Izak, and E. Naparastek. ISR J MED SCI 1980 May;16(5): 384-8.

Authors' abstract: The prevalence and causes of anemia were studied in 294 Druze children aged 10 months to 6 years. The hemoglobin level was less than 11.0 g/dl in 19%; none of these anemic children had folate deficiency. Iron deficiency, diagnosed on the basis of abnormal values for at least two independent laboratory parameters, was the cause of anemia in all but two cases. The Pearson correlation coefficient for hemoglobin was highest with mean corpuscular volume, erythrocyte protoporphyrin, serum iron, transferrin saturation, total iron-binding capacity, and serum ferritin. Mean corpuscular hemoglobin and transferrin saturation were abnormal in greater than 90% of anemic children, whereas serum ferritin and total iron-binding capacity were abnormal in only 70%. In view of its limited sensitivity, serum ferritin appears to be a less useful diagnostic aid in iron-deficiency anemia than other, less expensive laboratory methods.

Anemia Due to Inadequate Iron Sources or Poor Iron Utilization

F.A. Oski and J.A. Stockman, 3rd. PEDIATR CLIN NORTH AM 1980 May;27(2):237-53.

Authors' abstract: Anemias due to dietary iron deficiency and anemias due to poor iron utilization have some features in common. In both, the anemia is hypochromic and microcytic. Also in both, the level of free erythrocyte protoporphyrin is increased, even though many of the causes of ineffective iron utilization are actually associated with normal or increased iron stores. Appropriate use of currently available assays, including a determination of the level of serum ferritin, can distinguish between many of these disorders. Above all, a logical approach with attention to the clinical response to treatment with medications containing iron will help achieve a rapid diagnosis.

Iron Deficiency in Infancy and Childhood

P.R. Dallman, M.A. Siimes, and A. Stekel. AM J CLIN NUTR 1980 Jun;33(1):86-118.

This article is a comprehensive review of iron metabolism and the etiology of iron deficiency. From the section **Laboratory diagnosis of iron deficiency**: Because of a considerable overlap of normal and abnormal values, a hemoglobin analysis alone is not an exact method for determining iron deficiency. It should be combined with other tests such as mean corpuscular volume, transferrin saturation, serum ferritin, and free erythrocyte protoporphyrin (FEP) levels. Abnormal levels of FEP can accumulate when there is insufficient iron to combine with protoporphyrin to form heme; this provides a useful method to distinguish between iron deficiency and thalassemia minor. FEP is somewhat elevated in iron deficiency, but is normal in thalassemia minor. However, FEP is also elevated in infectious disease and is a particularly important bioindicator of overexposure to lead. Some care must be taken when correlating FEP and iron deficiency in infants. Frequently, high FEP will be encountered in infants at 2 months of age, but this is not indicative of iron deficiency since iron stores are ample at this stage of life. Also, during the remainder of infancy, FEP values have been reported as being higher than in adults, but it has not been clearly demonstrated whether or not this is a result of iron deficiency.

Chromosome and Biochemical Studies of Women Occupationally Exposed to Lead

A. Forni, A. Sciame, P.A. Bertazzi, and L. Alessio. ARCH ENVIRON HEALTH 1980 May-Jun; 35(3):139-46.

Authors' abstract: Chromosome and biochemical studies were conducted for 18 healthy females occupationally exposed to lead in the manufacture of electrical storage batteries and in 12 comparable female controls. Biochemical indicators of dose (blood lead) and effect (erythrocyte protoporphyrin, delta-aminolevulinicacid dehydratase activity of red blood cells) were significantly different in the two groups. Cytogenetic studies were performed on lymphocytes cultured for 2 and 3 days with phytohemagglutinin to investigate the possible effect of culture time with respect to yield of chromosome aberrations. The results showed significantly increased rates of metaphases with chromatid and chromosome aberrations (excluding gaps) in the exposed vs. controls at both culture times. The yield

of abnormal metaphases was higher in the 3-day than in the 2-day cultures, both in the exposed subjects and the controls; the difference was moderately significant for controls and highly significant for those exposed. These results demonstrate that increased numbers of abnormal metaphases occur not only in men occupationally exposed to lead, as previously found, but also in women occupationally exposed to lead.

Lead Exposure in Two Pottery Handicraft Populations

G. Molina-Ballesteros, M.A. Zuniga-Charles, J.E. Garcia-de Alba, A. Cardenas-Ortega, and P. Solin-Camara. ARCH INVEST MED (MEX) 1980;11(1): 147-54.

Authors' abstract: Lead-poisoning studies were carried out in the populations of two potter towns in the State of Jalisco, Mexico. The first population (in Tonala) included 198 people who use lead monoxide (PbO) in making pottery. The second population (in El Rosario) included 187 people who do not use any lead salt in the pottery-making process. The studies included children, adolescents, and adults of both sexes. Analyses for lead in the blood (Pb-B), hemoglobin (Hb), hematocrit (Ht), and urinary delta-aminolevulinic acid (ALA-U) were carried out. In the population exposed to lead, abnormally high lead concentrations in blood and urinary delta-aminolevulinic acid were found in both sexes and in all age groups studied. When compared to the control group, the differences are statistically significant. The Hb and Ht results fell within the lower normal limits in both populations. No cases of acute lead poisoning were found, but the high amount of lead absorption in the Tonala population may be caused by the rudimentary means of meanufacturing their products.

Lead Polyneuropathy of Nonindustrial Origin

B. Tavolato, A.C. Licandro, and V. Argentiero. EUR NEUROL 1980;19(4):273-6.

Authors' abstract: A case of a subacute, distal, symmetrical polyneuropathy in a housewife is reported. The fact that the polyneuropathy affected almost only the motor fibers led us to suspect an exogenous intoxication. Blood lead level and the urinary excretion of lead after intravenous EDTA were very high. The blood lead levels were normal in the husband and children of the patient. A glazed cup used only by the patient to keep tea with lemon juice was found to release toxic amounts of lead with acidic solutions. The manufacturer of the cup was not identified by the enquiring authorities and therefore almost certainly other lead-releasing cups are still in use. The importance of suspecting lead intoxication in individuals not professionally exposed is stressed.

Blood Lead Levels in Papua, New Guinea Children Living in Remote Area

C. Poole, L.E. Smythe, and M. Alpers. SCI TOTAL ENVIRON 1980 Jun;15(1):17-24.

Authors' abstract: Improved contamination-free micro-blood sampling and chemical analysis techniques were used to study the lead in blood (PbB) levels in 100 Papua, New Guinea children living in a remote area. Six soil samples from different locations in the area were also chemically analyzed as a check on environmental conditions. The mean value for PbB was 5.2 micrograms/100 ml with a range of 1.0–13.0 micrograms/100 ml. The standard deviation was 2.5 micrograms/100 ml. The results indicate much lower PbB levels for children living in a remote area than the earlier commonly reported levels for similar areas. These results indicate a need to reappraise the comparisons often made with PbB levels for urban children.

Acute Lead Poisoning in an Adult from Ingestion of Paint (Letter)

M. Chiba, T. Toyoda, Y. Inaba, K. Ogihara, and M. Kikuchi. N ENGL J MED 1980 Aug 21;303 (8):459.

This letter emphasizes the need to identify even the most bizarre possibilities of exposure in diagnosing the causes of lead poisoning in human beings.

The case discussed concerns a 23-year-old man, an avid amateur painter, who suddenly had violent abdominal colic in November 1979. Laboratory findings led to a diagnosis of lead poisoning, despite the apparent lack of exposure of the patient to lead compounds.

After an intensive effort to identify a source of lead exposure, the patient, who at first denied exposure or access to lead, finally confessed that, before hospitalization, he had ingested lead white (basic lead carbonate), at least 15 g within a month, with the hope of having hallucinations that would lead to more creative imagery in his painting.

Acute Lead Poisoning with Hemolysis and Liver Toxicity after Ingestion of Red Lead

J.W. Nortier, B. Sangster, and R.G. van Kestern. VET HUM TOXICOL 1980 Jun;22(3):145-7.

Authors' abstract: A case of acute lead poisoning in a 21-year-old male following the single ingestion of a considerable amount of dried red lead is reported. The main clinical features were hemolysis and liver toxicity. The patient was successfully treated with calcium disodium EDTA.

Temporary Increase in Chromosome Breakage in an Infant Prenatally Exposed to Lead

Q.H. Qazi, C. Madahar, and A.M. Yuceoglu. HUM GENET 1980 Feb;53(2):201-3.

Authors' abstract: Chromosome analyses of lead-exposed humans and animals and studies of lead-treated lymphocytes in culture have provided evidence of chromosome aberrations due to lead ions. The predominant aberrations were of the gap and break type. Our report concerns a temporary increase in chromosome breakage in an infant who, in utero, was exposed to high levels of lead and to chelation therapy using calcium EDTA. The infant was found to have increased numbers of cells with chromosome breaks in blood samples obtained at 6 weeks and 3 months of life. Later samples did not show significant abnormality. Physical and neurological examinations of the patient up to 18 months of age gave results within normal limits.

Health Status of Cable Splicers with Low-Level Exposure to Lead: Results of a Clinical Survey

A. Fischbein, J. Thornton, W.E. Blumberg, J. Bernstein, J.A. Valciukas, M. Moses, B. Davidow, B. Kaul, M. Sirota, and I.J. Selikoff. AM J PUBLIC HEALTH 1980 Jul;70(7):697-700.

Authors' abstract: The results of a cross-sectional clinical field survey of 90 telephone cable splicers are presented. Despite the rare occurrence of clinically overt lead poisoning among cable splicers, the observed prevalence of symptoms was 29% for lead-associated central nervous system symptoms and 21% for gastrointestinal symptoms. These two groups of symptoms were directly related to zinc protoporphyrin (ZPP) levels, but no relationship was found between them and blood lead concentrations. Only 5% of the workers had significantly elevated blood lead levels (greater than 40 micrograms/100 ml). Because of the intermittent lead exposure encountered in this trade, individuals were identified with "normal" blood lead levels associated with "elevated" zinc protoporphyrin concentrations, indicating the difference in biological significance between exposure (blood lead) and biological-response tests (ZPP). Suggestion is made that both types of diagnostic tests be utilized in medical surveillance of lead-exposed workers.

Neurotoxic Effects of Heavy Lead Exposure Determined with Psychological Tests

E. Arnvig, P. Grandjean, and J. Beckmann. TOXICOL LETT 1980 May;5(6):399-404.

Authors' abstract: Nine men exposed to high concentrations of lead in their work at a battery plant were examined with the aid of psychological tests. Intelligence tests indicated normal intellectual potential, but memory, attention, concentration, and psychomotor performance were severely impaired. The clinical picture indicated an organic mental syndrome. Psychological tests are recommended for clinical evaluation of neurotoxic effects of lead exposure.

Evaluation of the Free Erythrocyte Porphyrin (FEP) Test in a Private Practice: The Incidence of Iron Deficiency and Increased Lead Absorption in 9- and 13-Month-Old Infants

M.S. Dine. PEDIATRICS 1980 Feb;62(2):303-6.

Author's abstract: With the free erythrocyte porphyrin (FEP)/hematocrit ratio as a screening test, three of 122 9- to 13-month-old children had iron deficiency (FEP 147 to 286 μg/100 ml of RBCs). The hematocrit alone could not identify these children. All three were drinking more than one quart of cow's milk per day. On followup examination of seven children with values of FEP of 100 to 140 μg/100 ml of RBCs, two children had become anemic and one demonstrated increased lead absorption. Children with values of FEP below 100 μg/100 ml of RBCs (2 SD above the mean) did not develop anemia. Teaching parents to restrict cow's milk intake below one quart per day could be an effective means of preventing iron deficiency as identified by FEP screening. The child with increased lead absorption could not have been recognized by hematocrit alone.

Lead Poisoning: 20 Years Later

G.J. Cohen. CLIN PEDIATR (Phila) 1980 Apr;19(4):245-50.

This report compares the clinical picture, diagnosis, treatment and outcome of children with lead poisoning in the 1950's and the 1970's. During this 20-year period, increasing attention has been given to lead poisoning both at the local and national level. This attention has produced legislation to fund screening programs and to reduce the allowable amount of lead in paint. Greater public awareness, more effective methods for screening both populations and environments, and a reduction in severe sequelae of lead poisoning have also been achieved.

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*Tavolato B, Licandro AC, Argentiero V: Lead polyneuropathy of nonindustrial origin. EUR NEUROL 1980;19(4): 273-6.

*Abstracted

RESEARCH AND EVALUATION

Levels and Temporal Trends of Trace Element Concentrations in Vertebral Bone

B.H. O'Connor, G.C. Kerrigan, K.R. Taylor, P.D. Morris, and C.R. Wright. ARCH ENVIRON HEALTH 1980 Jan-Feb;35(1):21-8.

Authors' abstract: An X-ray fluorescence analysis study of iron, zinc, rubidium, strontium, and lead in ashed vertebral column whole bone samples of 51 sudden death victims in western Australia gave median values of 893, 213, 25, 108, and 25 ppm, respectively. Highly significant concentration-age Spearman correlations were observed for iron-age (r_s = 0.45, $P < .004$), zinc-age (0.43, $P < .006$), and lead-age (0.63, $P < .001$), the mean per annum rates of increase being 26, 0.4, and 0.8 ppm, respectively. Marked concentration-concentration correlations were found for iron-lead (0.44, $P < .01$) and zinc-lead (0.29, $P < .10$). Other notable correlations are the concentration-sex values for zinc (-0.47 $P < .003$) and strontium (0.30, $P < .06$). The median zinc concentrations for the male and female subsets are 216 and 205 ppm, respectively; the corresponding values for strontium are 100 and 120 ppm.

Interaction of Calcium and Lead in Human Erythrocytes

C.N. Ong and W.R. Lee. BR J IND MED 1980 Feb;37(1):70-7.

Authors' abstract: The interactions of calcium and lead on human erythrocytes have been studied in vitro using 45Ca and 203Pb as tracers. The chemical groups binding calcium and lead on the erythrocytes were also investigated. Calcium ions in the plasma were shown to be capable of replacing the 203Pb on red cells. More than 85% of the 203Pb in the erythrocytes was associated with the cytoplasmic components, and the rest was bound to the stromal membrane. About 90% of the 45Ca was attached to erythrocyte membrane. Extraction of 45Ca-labelled and 203Pb-labelled erythrocyte membranes with chloroform/methanol mixture showed that the distribution patterns of these two nuclides are similar, with over 88% protein-bound, less than 10% lipid-bound, and traces in the aqueous phase. Chemical modification of erythrocyte membrane proteins with carbodiimide, p-chloromercuribenzoate (PCMB), and maleic anhydride suggested that the carboxyl groups are responsible for binding lead and calcium to the red cell membrane. The SH groups may have a minor role in the binding for both cations. Amino groups did not appear to affect the binding of these cations. Gel chromatography of 45Ca-labelled erythrocyte membrane indicated that Ca++ bound to the same fraction of membrane proteins as 203Pb, corresponding to a molecular weight of about 130 000 to 230 000. A possible implication of these findings is that lead and calcium may compete for the same binding site(s) on the erythrocyte.

Distribution of Lead-203 in Human Peripheral Blood in Vitro

C.N. Ong and W.R. Lee. BR J IND MED 1980 Feb;37(1):78-84.

Authors' abstract: In vitro experiments using 203Pb were performed to identify the lead-binding components in human peripheral blood. The distribution of lead in plasma, in the red cell membrane, and within the red cell was also investigated. Studies of the distribution of 203Pb in whole blood showed that at a lead concentration of 2.45 mumol/l (50 micrograms/100ml), about 94% of concentration of lead had been incorporated by the erythrocytes and 6% remained in the plasma. After extraction of lipid by a methanol/chloroform mixture, about 75% of the lead was found to be associated with the protein fraction. The lipid contained about 21% of the 203Pb, the remainder being in the aqueous plasma. SDS polyacrylamide gel electrophoresis of blood plasma showed that almost 90% of the 203Pb was present in the albumin fraction; the remainder was likely to be associated with higher molecular weight globulins. Several binding sites were identified on the erythrocyte membrane. The high molecular weight component, about 130 000-230 000, was the most important 203Pb binding site. Chemical modification of membrane proteins suggested that the carboxyl groups are the major ligand responsible for most of the lead binding. SH groups of the membrane may have a minor role, but amino groups did not appear to affect the lead binding. The binding of lead to erythrocytes was not confirmed to membranes; more than 80% of lead in blood penetrates into erythro-

cytes and binds to intracellular components. Gel chromatography of the hemolysate showed that more than 90% of the 203Pb was attached to the hemoglobin molecule.

Oral Absorption of Lead and Iron

W.S. Watson, R. Hume, and M.R. Moore. LANCET 1980 Aug 2;2(8188):236-7.

Authors' abstract: Oral lead and iron absorptions have been measured by the use of radioactive tracer techniques in 10 subjects, five of whom had low iron stores as shown by low serum ferritin. The absorption of both elements was abnormally high in these five and also in one subject with normal serum ferritin. The other four subjects, who were iron-replete, had absorption values in the normal range. The statistically significant positive correlation between oral lead and iron absorptions suggests that the sizeable proportion of the population "overabsorbing" iron may absorb two to three times more lead than the generally accepted value of 10% of dietary input.

High-Performance Liquid Chromatographic Determination of Protoporphyrin and Zinc Protoporphyrin in Blood

R.M. Smith, D. Doran, M. Mazur, and B. Bush. J CHROMATOGR 1980 Mar 14;181(3-4):319-27.

Authors' abstract: Zinc protoporphyrin and protoporphyrin free acid in blood were determined by high-performance liquid chromatography on a C18 column. Results for 63 human blood samples obtained through a lead-poisoning detection program compared favorably with the widely-used ethyl acetate-acetic acid extraction determination. Blood from 16 rats, which had been maintained on water heavily spiked with chloroform or bromodichloromethane, and blood from a lead-poisoned cow were examined by this procedure.

Cadmium Content of Vegetable Foods in the Effective Range of a Lead Smelting Plant (German)

E. Auermann, H.G. Dassler, J. Cumbrowski, M. Kneuer, and J. Jacobi. NAHRUNG 1979;23 (9-10):875-90.

English summary: In the effective range of a lead-smelting plant, the repercussions of cadmium emissions on vegetables, fruit, soil, and drinking water were investigated by means of atomic absorption spectrometry. As compared to the "normal" cadmium level, the cadmium content in vegetables and fruit was some 2- to 85-fold higher; the level in soils was some 70- to 230-fold. The mean content in vegetables ranged from 0.4 to 25.5 ppm (on a dry-weight basis) while that in fruit ranged from 0.09 to 1.17 ppm. Cadmium concentrations varying from 6.8 to 22.8 ppm were found in soil samples. The drinking water contained 0.009 ppm of cadmium. The mean cadmium content in the atmosphere and the sedimentary dust were 0.007 mg/m^3 and 0.550 $mg/m^2/30d$, respectively. In the territory investigated, the total human intake of cadmium supplied by vegetables, fruit, potatoes, drinking water, and air is 3.3-32.6 micrograms/d. The following cadmium levels were found in human organ samples obtained at necropsy: right and left renal cortex, 33.99 and 35.98 ppm, respectively; liver, 3.14 ppm; lungs, 0.63 ppm; pancreas, 1.47 ppm; brain stem, 0.16 ppm.

Lead Determination in Blood by Atomic Absorption Spectroscopy

C. Schmidt. AM IND HYG ASSOC J 1979 Dec; 40(12):1085-90.

This paper describes a one-tube sample preparation method for blood lead determination which is relatively simple to perform and which does not require background correction for matrix effects. The red cells are lysed with a dilute potassium cyanide solution and heat. A citrate buffer is added, and the solution is then extracted with ammonium pyrrolidine dithiocarbamate and methyl isobutyl ketone. An aliquot of the MIBK layer is applied to a carbon rod atomizer and the peak at 217.0 nm is measured. The method demonstrates an overall in-run reproducibility of 1.39 micrograms/100 ml blood standard deviation, a between-run standard deviation of 2.27 micrograms/100 ml blood, and a sensitivity of 0.012 micrograms/ml/1% nm.

Is Human Hair a Dosimeter for Endogenous Zinc and Other Trace Elements?

G. Chittleborough and B.J. Steel. SCI TOTAL ENVIRON 1980 Jun;15(1):25-35.

This work incorporates an assessment of the potential of human hair to monitor ingestion of trace elements from the environment. Included is a report of a study of zinc levels in the facial hair of one of the authors, who was dosed with $ZnSO_4$. Daily doses increasing from 100 mg to 300 mg of zinc were taken for 57 days. Analysis was by differential pulse anodic stripping voltammetry. No significant increase in beard zinc was found. Cadmium, lead, and copper were measured simultaneously. Studies of dosing with other elements are reviewed and a generalized pool model for the deposition of ingested trace elements in hair is presented. It is suggested that the concept of hair as a monitor of endogenous elements is a simplistic one which is better modified by the pool model, the precise form of which varies with the element under consideration.

Studies in Porphyria IX: Detection of the Gene Defect of Erythropoietic Protoporphyria in Mitogen-Stimulated Human Lymphocytes

S. Sassa, G.L. Zalar, M.B. Poh-Fitzpatrick, and A. Kappas. TRANS ASSOC AM PHYSICIANS 1979; 92:268-76.

Authors' abstract: We have demonstrated in this study that mitogen-stimulated lymphocytes from EPP subjects accumulate substantially greater amounts of protoporphyrin IX than do normal lymphocytes when incubated with ALA. Protoporphyrin IX formation by normal lymphocytes is stimulated by CaMgEDTA, an inhibitor of ferrochelatase, and is decreased by ferrous iron, which facilitates the utilization of protoporphyrin IX for heme synthesis. In contrast, protoporphyrin IX formation by EPP lymphocytes is less stimulated by CaMgEDTA than is the case with normal lymphocytes and is only slightly affected by iron. Clinically manifested EPP subjects and completely latent gene carriers of EPP can be identified using this lymphocyte culture technique. The data from this study provide clear evidence of a functional deficiency of ferrochelatase activity in human EPP lymphocytes. EPP thus represents the third of the three dominant porphyric disorders of man, including acute intermittent porphyria and hereditary coproporphyria, which can now be diagnosed using lymphocytes.

Simultaneous Liquid-Chromatographic Determination of Zinc Protoporphyrin IX, Protoporphyrin IX, and Coproporphyrin in Whole Blood

G.R. Gotelli, J.H. Wall, P.M. Kabra, and L.J. Marton. CLIN CHEM 1980 Feb;26(2):205-8.

Authors' abstract: We describe a method for simultaneously measuring concentrations of coproporphyrin, zinc protoporphyrin IX, and protoporphyrin IX in whole blood by liquid chromatography, with use of reversed-phase ion-pair system, fluorometric detection, and internal standardization. Each analysis requires 10 μl of whole blood and 15 minutes total analysis time. Analytical recovery ranged from 84% to 92%, day-to-day precision (CV) from 5% to 12%. Uroporphyrin, though not studied in detail, can also be detected by this method.

Inclusion-Bearing Cells in Industrial Workers Exposed to Lead

G.B. Schumann, S.I. Lerner, M.A. Weiss, L. Gawronski, and G.K. Lohiya. AM J CLIN PATHOL 1980 Aug;74(2):192-6.

Authors' abstract: Histochemical and microscopic studies have shown that a characteristic renal response to lead exposure is the formation of discrete, dense, staining intranuclear inclusion bodies in renal tubular epithelial cells. Cytologic examination of urinary sediment showed that four of 19 (21%) lead workers had exfoliated inclusion-bearing cells of proximal renal tubular origin. These lead-induced inclusion-bearing cells appeared distinctly different from viral-induced inclusions, degenerative or nonspecific intranuclear inclusions seen with tubular necrosis, or macronucleoli seen in reparative renal tubular epithelium. While their presence indicates cytologic evidence of tubular injury, the clinical significance of these cells and their application to medical monitoring is not clearly understood.

Estimation of Blood Lead Values from Blood Porphyrin and Urinary 5-Aminolevulinic Acid Levels in Workers

R.F. Herber. INT ARCH OCCUP ENVIRON HEALTH 1980 Feb;42(2):169-79.

Author's abstract: In about 100 workers from a secondary smelter, lead in whole blood (PbB), delta-aminolevulinic acid in urine (ALA-U), and porphyrins in whole blood (using various methods) were determined. Comparability in the dose-effect relationship between PbB and ALA-U in this experiment with [those reported in] literature was bad, but was better for PbB and the porphyrins. The best predictor for lead in blood was, of course, PbB itself, followed by porphyrins. The porphyrin level can be used as a predictor in:

1. Monitoring groups of workers.
2. As a rough indicator of PbB (error 100 μg/1 or 0.48 μmol/1) in individual workers with moderate to high levels of lead exposure (say 400 - 1,000 μg/1 or 1.9 - 5 μmol/1).

The ALA-U determination should be made more specific and accurate, while the porphyrin determination should be standardized. A possible procedure for standardizing a porphyrin-meter is given.

Intake of Protoporphyrin IX Isolated by Rat Liver Mitochondria

M.E. Koller and I. Romslo. BIOCHEM J 1980 May 15;188(2):329-35.

Authors' abstract: Rat liver mitochondria accumulate protoporphyrin IX from the suspending medium into the inner membrane in parallel with the magnitude of the transmembrane K+ gradient (K+ in/K+ out). Only protoporphyrin IX taken up in parallel with the transmembrane K+ gradient is available for heme synthesis. Coproporphyrins (isomers I and III) are not taken up by the mitochondria. The results support the suggestion by Elder & Evans [(1978) Biochem. J. 172,345-347] that the porphyrin to be

taken up by the inner mitochondrial membrane belongs to the protoporphyrin(ogen) IX series. Protoporphyrin IX at concentrations above 15 nmol/mg of protein has detrimental effects on the structural and functional integrity of the mitochondria. The relevance of these effects to the hepatic lesion in erythropoietic protoporphyria is discussed.

Red Blood Cell Protoporphyrin Accumulation in Experimental Lead Poisoning

David Hart, Joseph Graziano, and Sergio Piomelli. BIOCHEM MED 1980 Apr;23(2):167-78.

Authors' abstract: An animal model was sought for the increase in red blood cell protoporphyrin which is observed in human lead poisoning. Lead-intoxicated guinea pigs and rats manifested small changes in RBC PP, while rabbits could be induced to produce several-fold RBC PP elevations with prolonged lead administration. Rabbits responded to a single sublethal intravenous dose of lead acetate with: (a) a rapid rise in blood lead, (b) a rapid rise in RBC PP as a result of free (unchelated) PP production in young RBC, (c) a hemolytic anemia.

This pattern of increased free PP in the youngest RBC continued to be observed, contrary to the expectation that the aging RBCs would retain their increased RBC PP content as time from lead administration passed. Following a return to baseline, a secondary increase in RBC PP (predominately the Zinc-PP chelate) was noted at 30-40 days.

The extremely high levels of Zn PP which accompany human lead poisoning were not found in the animal species studied.

Diagnostic Value of Free Erythrocyte Porphyrins and Blood Lead as a Screening Test for Lead Exposure

C. Van Peteghem, A. Heyndrickx, and R. Vereecke. J PHARM PHARMACOL 1979 Aug; 31(8):551-2.

Authors' abstract: Ingested lead interferes with heme synthesis and, although the exact mechanics are not completely understood yet, it is clear that one result of abnormal lead absorption is an accumulation of protoporphyrin in red blood cells. A survey was made in a random population of people suspected of lead or heavy metal poisoning to determine the correlation between blood lead levels (PbB) and free erythrocyte protoporphyrin (FEP). If 24-hour urine samples were available, urinary lead and urinary delta-aminolevulinic acid were measured also. The results seem to confirm that FEP increases exponentially with PbB concentrations and that there is a reasonably good correlation (r = 0.97) between the two. However a test revealing elevated FEP and normal PbB should be checked by differential diagnosis to identify other possible abnormalities such as impaired iron metabolism, anemias, or overproduction of porphyrins. Although only a limited number of observations were possible, it appears that there are no equivalent relationships between FEP and urinary lead or urinary delta-aminolevulinic acid.

The Free Erythrocyte Protoporphyrin Assay in Monitoring Lead-Exposed Workers. Comparison of Two Fluorometric Methods

S. Vaccaro, C. Barghigiani, G. Colombetti, F. Lenci, A.M. Loi, P.L. Paggiaro, G. Pagano, and G. Toma. INT ARCH OCCUP ENVIRON HEALTH 1980 Jan;45(1):35-48.

Authors' abstract: We have performed a comparative analysis of two different fluorometric methods used to determine free erythrocyte protoporphyrin (FEP) blood concentration. The first method is based on an extractive procedure, whereas the second one involves the direct fluorometric analysis of whole blood. Our results show that the extractive procedure is probably the most reliable technique available for FEP determination, but it is not so suitable for mass screening, whereas the direct fluorometric determination of FEP blood concentration is probably less reliable, but sufficient for mass screening. We have furthermore investigated whether the FEP test could be used as a unique monitoring method for subclinical lead poisoning. Our findings indicate that the FEP test can detect very early metabolic alterations, but it is not so suitable for determining lead absorption and should therefore be used in mass screening together with a dose indicator, such as blood lead concentration.

Effect of Toxic, Chemical, and Environmental Factors on the Kidney

R.A. Goyer. MONOGR PATHOL 1979;20:202-17.

Authors' abstract: There are at least two stages of lead nephropathy; the first stage is acute and reversible, but the second stage is chronic and terminal. The first stage consists of morphologic and functional changes in the proximal renal tubular lining cells; inclusion bodies (lead-protein complexes) are formed mainly in the nucleus, while mitochondria are affected in the cytoplasm. The intranuclear inclusion bodies may be a protective device for the cell. In cases of lead poisoning, most of the lead is found in the nucleus and most of this is concentrated in the inclusion bodies; this protects the other functioning organelles. Inclusion bodies are removed by EDTA, a chelating agent. In children, mitochondria show swelling and dilution of matrical granules, probably

secondary to increased membrane permeability. Adults show marked distortion of cristae as well. Malfunctioning of these mitochondria may account for the Fanconi syndrome or the increased urinary excretion of amino acids, glucose, and phosphates that occurs in acute lead nephropathy. The second state has the appearance of an interstitial nephritis. It becomes progressively more severe with tubular atrophy and eventually reduced glomerular filtration and renal failure. This process may continue for a period of years without renal failure, so it is possible that there may be other extraneous factors that influence the ultimate course of this disorder.

Renal Function Impairment in Secondary Lead Smelter Workers: Correlations with Zinc Protoporphyrin and Blood Lead Levels

R. Lilis, J. Valciukas, A. Fischbein, G. Andrews, I.J. Selikoff, and W. Blumberg. J ENVIRON PATHOL TOXICOL 1979 Jul-Aug;2(6):1447-74.

Authors' abstract: Potential kidney function decrement with long-term lead exposure is important in the overall assessment of adverse health effects of lead in industrial workers or other exposed groups. Two clinical field studies of secondary lead smelter workers have shown that a significant proportion of workers had slightly to moderately elevated BUN and creatinine levels; the prevalence was higher in those with longer lead exposure. Since a decrement of kidney function with age has been documented, and, since duration of lead exposure may also be strongly related to age, it was necessary to assess the age-dependent renal function decrement in a control (nonlead-exposed) population. BUN and creatinine levels in the lead-exposed workers showed a much more significant correlation with age than that which was found in the non-exposed population; the correlations between the indicators of renal function, BUN and creatinine, and duration of lead exposure remained statistically significant after removing the age-dependent decrement derived from the control population. Moreover, a highly significant correlation between BUN and zinc protoporphyrin levels was found. The results indicate a sizeable and significant decrement in kidney function in the secondary lead smelter workers studied; by removing age-dependency, this effect was found to be lead-induced.

Exposure to Lead in Childhood: The Persisting Effects

M.R. Moore. NATURE 1980 Jan;283(5745):334-5.

Author's abstract: The effects of long-term exposure to comparatively low levels of lead are not so dramatic as those of acute lead poisoning, but it is a severe health problem in its own right. It has been blamed for some cases of mental retardation, kidney damage, and changes in cardiovascular function. Because present tests can accurately measure current and recent exposure only and there is no satisfactory method to determine the effects of long-term exposure, there is no general agreement on the threshold of permissible exposure over a long period of time.

More important than the quantity of ingested lead is the amount that is actually absorbed by the body. This depends on several factors such as diet and age. Infants and young children retain a far greater percentage of available lead than do adults. One source of lead specific for infants that may go unsuspected is prepared formula. Proprietary dried milk feeds contain very small amounts of lead, but sometimes they are mixed with water that has a high lead content.

In growing children, the tissues most susceptible to injury by lead are those in the brain and the central nervous system. Any changes in these are certainly irreversible and will result in permanent neurological damage. This is even more likely when the exposure has taken place early in life. Lead also acts on the neuro-active metabolites that effect heme biosynthesis and the adrenergic and cholinergic nervous systems, but these changes are probably reversible. Recent studies have linked chronic exposure to low lead levels to mental retardation, I.Q. drops of four to seven points, decreased attention span, and diminished classroom performance.

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