EPIDEMIOLOGY

Areawide Chemical Contamination: Lessons from Case Histories

R.W. Miller. JAMA 1981 Apr 17;245(15): 1548-51.

Author's abstract: Nine case histories illustrate the mounting problems owing to chemical contamination that often extends beyond the workplace into the community. [One case history describes the absorption of lead in two young siblings who lived within 3 km of a large lead smeltery. Blood lead levels of the children were 68 and 81 mg/dl. Radiological examinations of their knees revealed characteristic lead lines.] The effects include not only carcinogenesis and teratogenesis, so much in the public's mind, but also severe neurological and gonadal disabilities immediately after exposure. Recognition of causal relationships is often made by astute clinicians. The experience of the Atomic Bomb Casualty Commission in studying Japanese survivors in Hiroshima and Nagasaki serves as a model for future studies of communities exposed to unusual environmental contamination.

Exposure to Lead by the Oral and the Pulmonary Routes of Children Living in the Vicinity of a Primary Lead Smelter

H.A. Roels, J.P. Buchet, R.R. Lauwerys, P. Bruaux, F. Claeys-Thoreau, A. Lafontaine, and G. Verduyn. ENVIRON RES 1980 Jun;22(1):81-94.

Authors' abstract: Yearly from 1974 to 1978, a medical survey was carried out among 11-year-old children attending schools situated less than 1 and 2.5 km from a lead smelter. Age-matched control children from a rural and urban area were examined at the same time. The blood lead levels (PbB) of the children living in the smelter area (mainly those attending schools located less than 1 km from the smelter) were higher than those of rural and urban children. The mean PbB levels were usually lower in girls than in boys, especially in the smelter area. Despite a slightly decreasing trend in the annual mean airborne lead (PbA) concentration at less than 1 km (mean PbA: from 3.8 $\mu g/m^3$ in 1974 to 2.3 $\mu g/m^3$ in 1978), the PbB levels there did not improve, whereas 2.5 km from the plant a significant tendency to normalization of PbB became apparent. Therefore, in the third survey, the medical examination was combined with an environmental study which demonstrated that lead in school-playground dust and in air strongly correlated. Lead on the children's hands (PbH) was also significantly related to lead in air or lead in dust. Less than 1 km from the factory boys and girls had on the average 436 and 244 μg Pb/hand, respectively, vs. 17.0 and 11.4 μg Pb/hand for rural boys and girls, respectively. Partial correlations between PbB, PbA, and PbH indicated that in the smelter area the quantitative contribution of PbA to the children's PbB is negligible compared with that of PbH. Thus, the control of airborne lead around the lead smelter is not sufficient to prevent excessive exposure of children to environmental lead. In view of the importance of lead transfer from dust and dirt via hands to the gastrointestinal tract, remedial actions should be directed simultaneously against the atmospheric emission of lead by the smelter and against the lead particulates deposited on soil, dust, and dirt.

Environmental Influences on Mouthing in Children with Lead Intoxication

N.A. Madden, D.C. Russo, and M.F. Cataldo. J PEDIATR PSYCHOL 1980 Jun;5(2):207-16.

Authors' abstract: The relationship of mouthing behavior to different environmental conditions was evaluated for three young children with asymptomatic lead poisoning. Specifically, the amount of mouthing; involvement with materials, adults, and other children; and noninvolvement were measured across daily sessions in three environments: group play, individual impoverished

play, and individual enriched play, using an interval-recording system. For each of the children, the results indicated that mouthing was exhibited significantly more in the impoverished setting as compared with either group play or individual enriched environments. The results suggested that simple environmental enrichment may hold promise in the reduction of mouthing and pica. Further research evaluating procedures for reduction of mouthing and pica is suggested.

Placental and Stillbirth Tissue Lead Concentrations in Occupationally Exposed Women

A.K. Khera, D.G. Wibberley, and J.G. Dathan. BR J IND MED 1980 Nov;37(4):394-6.

Authors' abstract: The lead values in maternal and infant blood, in placental tissue, and in stillbirth liver, kidney, and rib- and skull-bones have been determined in samples from the Stoke-on-Trent area. The lead values in antenatal blood and placenta increase with occupational exposure; liver and kidney stillbirth lead values are lower than those of much older children, and rib-bone lead values from stillbirths were on the average three times as high as those from a control group comprised of cot deaths and early infant deaths from accidental causes.

Occupational Exposure of Women to Inorganic Lead (Italian)

A. Cavalleri and F. Candura. MED LAV 1979 Sep-Oct;70(5):341-4.

English summary: The permissible limits for occupational exposure to lead have been the subject of ample discussion and reexamination in the last few years, but little attention has been given to the problem of the exposure of women in childbearing age and the consequences for the fetus. The fetus is an organism particularly sensitive to lead, to which it is exposed through the mother, since the metal easily passes the placental barrier. Since the level of lead in blood that is considered critical for the fetus is at values lower than those considered dangerous for the adult, the blood lead level of the mother should also be kept below this value. Attention is drawn to the necessity of regulatory action to deal with this problem, which appears to be of considerable importance in view of its health and social implications.

A Neurological and Biochemical Study of Early Lead Poisoning

J.A. Ashby. BR J IND MED 1980 May;37(2):133-40.

Author's abstract: Changes in nerve conduction velocity were found in 94 workers exposed to lead in a battery factory compared with 94 age-matched controls. There was no clinical evidence of nerve damage in the lead workers. The mean blood lead concentration in the 94 lead workers was 2.9 μmol/l (60 μg/100 ml), and their length of exposure to lead ranged from 6 months to 33 years. All mean maximum motor nerve conduction velocities (MMCV) measured were highly statistically significantly lower in the lead-exposed group compared with their age-matched controls. Thus mean ulnar MMCV was 53.4 m/s in lead workers and 55.6 m/s in control subjects ($p < 0.0005$); mean median MMCV was 55.9 m/s in lead workers and 57.3 m/s in control subjects ($p < 0.01$); mean radial MMCV was 63.9 m/s in lead workers and 71.1 m/s in control subjects ($p < 0.0005$); mean peroneal MMCV was 46.1 m/s in lead workers and 47.6 m/s in control subjects ($p < 0.005$). The amplitude of the muscle action potential produced by proximal stimulation of a nerve was expressed as a percentage of the amplitude of the muscle action potential produced by distal stimulation and the percentage amplitude thus obtained used as an indicator of the conduction velocity of slower fibers (SFCV). Peroneal nerve percentage amplitude of lead workers was statistically significantly lower ($p < 0.005$) than in the control group (means 86.6% and 90.3%, respectively). There were, however, no significant differences in the percentage amplitude in the ulnar and median nerves. It is suggested that percentage amplitude is an inappropriate indicator of SFCV in ulnar and median nerves. There was no statistically significant correlation to indicate that progressive slowing of nerve conduction (MMCV and SFCV) was associated with increasing exposure to lead (as indicated by blood and urine lead concentrations) or with the commonly measured biochemical changes associated with disturbed hemopoiesis in lead exposure (δ-aminolevulinic acid dehydrase; free erythrocyte protoporphyrin; hemoglobin and urinary δ-aminolevulinic acid). MMCV of the ulnar nerve was the only conduction velocity statistically significantly correlated with length of exposure to lead. Increased length of exposure to lead was associated with a decrease in the ulnar MMCV. Only 13 of the subjects had been exposed to lead for 2 years or less, and in none of them had the blood lead ever risen above 3.9 μmol/l (80 μg/100 ml) in 3 monthly tests (mean blood lead concentration at time of testing: 2.8 μmol/l). In these subjects the MMCV of ulnar, radial, and peroneal nerves and the peroneal percentage amplitude were statistically significantly reduced. The results from this group suggest that the onset of nerve conduction

changes occurs within 2 years and at concentrations of lead in blood of less than 3.9 μmol/l (80 μg/100 ml).

Assessment of Renal Function of Workers Exposed to Inorganic Lead, Cadmium or Mercury Vapor

J.P. Buchet, H. Roels, A. Bernard, and R. Lauwerys. JOM 1980 Nov;22(11):741-50.

Authors' abstract: The renal function of workers occupationally exposed to cadmium (n = 148), to mercury vapor (n = 63), or to inorganic lead (n = 25) has been compared with that of workers with no occupational exposure to heavy metals (n = 88). A moderate exposure to lead (Pb-B < 62 μg/100 ml) does not seem to alter renal function. Excessive exposure to cadmium increases the urinary excretion of both low- and high-molecular-weight proteins and of tubular enzymes. These changes are mainly observed in workers excreting more than 10 μg Cd/g creatinine or with Cd-B above 1 μg Cd/100 ml whole blood. Occupational exposure to mercury vapor induces glomerular dysfunction, as evidenced by an increased urinary excretion of high-molecular-weight proteins and a slightly increased prevalence of higher β_2-microglobulin concentration in plasma without concomitant change in urinary β_2-microglobulin concentration. β-galactosidase activity in blood and in urine is also increased. The likelihood of these findings is greater in workers with Hg-B and Hg-U exceeding 3 μg/100 ml whole blood and 50 μg/g creatinine, respectively. The hypothesis is put forward that the glomerular dysfunction induced by cadmium and mercury might result from an autoimmune mechanism.

Detection of Early Kidney Damage in Workers Exposed to Lead, Mercury, and Cadmium (German)

K.H. Schaller, J. Gonzales, J Thurauf, and R. Schiele. ZENTRALBL BAKTERIOL (B) 1980 Sep; 171(4-5):320-35.

English summary: Our study was performed to evaluate potential adverse effects on the kidney caused by an occupational exposure to cadmium, lead, and mercury, respectively. We examined 81 individuals from a Zn-Cd-plant and a Ni-Cd-battery factory occupationally exposed to cadmium. In a chemical company synthesizing mercury compounds, we analyzed 23 exposed workers. The 21 persons with an exposure to lead were employed in a secondary lead smelting plant. To evaluate the degree of the occupational exposure, we analyzed the concentrations of the heavy metals in blood and urine samples. As indicators of an adverse effect on the kidney, the renal elimination of specific proteins was determined. The analysis of proteins with a higher molecular weight, such as albumin and acid α_1-glycoprotein, was performed by using a newly developed laser nephelometric method. Patterns of renal-eliminated proteins with a lower molecular weight were characterized by applying a radioimmunological determination of β_2-microglobulin. The results found in workers exposed to cadmium verified previous studies. The occurrence of a characteristic β_2-microglobulinuria takes place after a sufficiently long period of exposure. In addition to this, cadmium-exposed workers had an increased elimination of total protein. Persons with an exposure to mercury also showed a slightly increased elimination of β_2-microglobulin and total protein. An intensive long exposure to mercury and its (in-)organic compounds seems to induce an increased renal elimination of proteins. No increased renal elimination was found in persons occupationally exposed to lead.

Erythrocyte Lead-Binding Protein after Occupational Exposure. I. Relationship to Lead Toxicity

S.R. Raghavan, B.D. Culver, and H.C. Gonick. ENVIRON RES 1980 Jun;22(1):264-70.

Authors' abstract: Lead content was determined in various fractions of red blood cell (RBC) hemolysates from normal controls and from three groups of lead-exposed workers: without toxicity, toxicity associated with high blood lead levels, and toxicity associated with low blood lead levels. The most significant finding was a decrease in the lead bound to a 10,000 molecular weight protein in the group of workers with toxicity at low blood lead levels (43 to 54 μg%). These results suggest that workers who have diminished capacity for synthesizing this low-molecular-weight lead-binding protein are at increased risk for developing lead toxicity at relatively low blood lead levels.

Epidemiological Study on the Relationships between Lead Exposure and Porphyrin Metabolism

A. Seubert, S. Seubert, L. Nottbohm, and H. Ippen. INT J BIOCHEM 1980;12(5-6):891-5.

Authors' summary: 5-Aminolevulinic acid dehydratase, erythrocyte porphyrins, blood lead, and urinary 5-aminolevulinic acid were determined in 53 patients not exposed to lead. A seasonally significant fall could be determined for 5-aminolevulinic dehydratase in the erythrocytes and for urinary 5-aminolevulinic acid. On the basis of the longitudinal study, it could be observed in persons with high lead exposure for the first time

that the individual bioparameters react to lead exposure in a different way. Whereas 5-aminolevulinic acid and porphyrins fall rapidly in the urine after ending exposure, blood lead and erythrocyte porphyrins remain raised over a long period. After renewed exposure, 5-aminolevulinic acid and blood lead remain in the industrial medically tolerable range, whereas the erythrocyte porphyrins rise markedly. The investigations on 314 lead workers show that values for blood lead, erythrocyte porphyrins, and urinary 5-aminolevulinic acid are in good agreement. The duration and intensity of the exposure do not have a large effect on the level of the values according to our results. Diurnal fluctuations in the bioparameters show marked variations of the urinary values, whereas blood lead and erythrocyte porphyrin values remain almost constant.

Genetic Effect of Low Doses of Radiation in Occupationally Exposed Workers in Coal Mines and in Coal-Fired Plants

D. Horvat, A. Bauman, and J. Racic. RADIAT ENVIRON BIOPHYS 1980;18(2):91-7.

Authors' abstract: Analyses of structural aberrations of chromosomes and of the body burden of lead-210 were carried out in a group of workers occupationally exposed to chemical pollutants and low doses of ionizing radiation during a technological process in which coal is used as fuel. A parallel study was performed in a control group of workers. In the exposed group the percentage of chromatid and chromosome aberrations and the results of radiochemical analyses were higher than in the control group.

Lead Levels in Human Lungs

E.M. Ophus and E.A. Mylius. BULL ENVIRON CONTAM TOXICOL 1977 Dec;18(6):734-41.

In this study, samples of lung tissue were obtained from autopsies on 250 individuals who died in Sor-Trondelag County, Norway, in the period 1974-76. Of the total, 139 were inhabitants of the city of Trondheim (population 120,000), and 111 were inhabitants of mainly rural areas. It was shown that the concentration of lead in the lungs of the urban group was significantly higher than in the rural group. Of the 250 individuals studied, 6 distinguished themselves as occupationally exposed. These six had a mean lead concentration in the lungs of 1.81 ppm dry weight, a lung lead level which was considerably higher than that found in any of the other lung tissue samples analyzed. Of the six occupationally exposed individuals (all males), three were employed in industry (factory and machine shop) and three were vehicle drivers. The relatively high content of lead in the lungs of the six men indicates that occupation is the most crucial parameter correlated with lung lead concentration.

Cigarette Smoking and Lead Levels in Occupationally Exposed Lead Workers

C.P. Brown, G.H. Spivey, J.L. Valentine, and B.L. Browdy. J TOXICOL ENVIRON HEALTH 1980 Jul;6(4):877-83.

Authors' abstract: One hundred and eleven workers at a secondary Pb smelter were surveyed to determine smoking and personal hygiene habits. Fifty-three percent of the smokers had blood Pb levels in excess of 60 μg/dl, compared with 31% of nonsmokers ($p = 0.02$). Among smokers, 66% of "heavy" smokers (those who smoked one pack or more cigarettes per day) had blood Pb levels over 60 μg/dl, compared with 39% of the "light" smokers ($p = 0.05$). Those who kept their cigarettes on their person had a higher proportion of blood Pb greater than 60 μg/dl than workers who kept their cigarettes elsewhere (63% versus 36%, respectively; $p = 0.08$). The difference in blood Pb levels between smokers and nonsmokers may be due in part to direct environmental contamination of cigarettes or impaired lung clearance mechanisms, and could be important in workers with already elevated blood Pb levels.

Blood-Lead and Cadmium in Human Hypertension

D.G. Beevers, J.K. Cruickshank, W.B. Yeoman, G.F. Carter, A. Goldberg, and M.R. Moore. J ENVIRON PATHOL TOXICOL 1980 Sep;4(2-3):251-60.

Authors' abstract: An epidemiological study among hypertensives and normotensives in Renfrew, Scotland, where drinking water hardness is very low (5 ppm) and water-lead levels are commonly high, has shown a significant association between high blood-lead levels and high blood pressure. No association was found with indices of renal function, plasma renin or angiotensin II concentrations, or serum uric acid levels. In a parallel study of blood-lead levels in Birmingham, England, where water hardness is low (20 ppm) but water-lead levels are also low, high blood-lead levels were not found, no relationship was found with blood pressure, and the prevalence of hypertension was lower than in Renfrew. We conclude that subclinical lead exposure from drinking water may be a factor in the development of hyperten-

sion. A study of blood-cadmium levels has shown no association between high blood pressure and subclinical cadmium exposure, but has confirmed a close relation between blood-cadmium and cigarette smoking. We conclude that previous reports of a cadmium-blood pressure link may be confounded by failure to allow for the cigarette smoking habits of the subjects studied.

Exposure to Trace Elements and Cardiovascular Disease

N.O. Borhani. CIRCULATION 1981 Jan;63 (1):260A-263A.

From author's summary: Perhaps among all trace elements implicated, the role of zinc, copper, cadmium and lead, individually or in combination, is more biologically plausible than others. There is, however, little evidence to make any definitive statement even on these elements, let alone draw any conclusion about their role in the pathogenesis of coronary heart disease. From a purely epidemiological point of view, the observations on the association between the levels of these trace elements and coronary heart disease lack strength and consistency. Further, these findings do not possess specificity and, in most instances, cannot be explained on the basis of a biologically plausible hypothesis. Thus, neither their association with the disease nor the mechanism of action of these trace elements in the pathogenesis of cardiovascular diseases, especially coronary heart disease, is determined at present. There is an urgent need to design and conduct, perhaps in a national collaborative manner, a prospective epidemiological study aimed at delineating the possible influence of trace elements in the incidence of cardiovascular diseases and coronary heart disease. The future direction of research efforts will depend on the consistent demonstration of a dose-effect relationship between trace elements and specific cardiovascular diseases. It is important that further research in this field include autopsy and clinical studies of special groups of patients selected to maximize environmental exposure effects and minimize, or control for, effects of established disease or genetic influences. Additionally, there is an important need for further basic investigation of the role of trace elements in metabolic and regulatory processes. Clinical, epidemiological, and laboratory research hold considerable promise.

Blood Lead Concentrations in a Remote Himalayan Population

S. Piomelli, L. Corash, M.B. Corash, C. Seaman, P. Mushak, B. Glover, and R. Padgett. SCIENCE 1980 Dec;210(4474):1135-7.

Authors' abstract: The lead content in the air at the foothills of the Himalayas in Nepal was found to be negligible. The concentration of lead in the blood of 103 children and adults living in this region was found to average 3.4 μg/dl, a level substantially lower than that found in industrialized populations.

Public Health Aspects of Toxic Heavy Metals in Animal Feeds

R.P. Sharma and J.C. Street. J AM VET MED ASSOC 1980 Jul 15;177(2):149-53.

Authors' abstract: Studies involving animals of three species (dairy cattle, growing swine, and laying chickens) indicated that residues of lead and cadmium do not increase appreciably in major food products obtained from the animals during long-term exposure to subtoxic dietary concentrations of these heavy metals. Human risk would not be expected by the consumption of milk, meat, or eggs from animals similarly exposed. Both metals accumulate in liver and kidney, and lead accumulates in bone. A moderate intake of liver and kidney from lead-exposed animals appears to present little or no health hazard. Utilization of these organs from cadmium-exposed animals, however, should be avoided.

Lead Modelling—A Decision-Making Tool

J.E. McEvoy. SCI TOTAL ENVIRON 1980 Dec;16(3):231-7.

Author's abstract: The difficulties of decision-making in a state of ignorance regarding the problem area, [a situation which is] true for many questions of environmental pollution, are discussed with reference to lead. Before irrevocably committing a considerable amount of both capital and material resources, the policy-maker would like to make a prediction about the potential effectiveness of any control measure. To this end, a mathematical model is suggested which represents the transport of lead within a standard man. It may be used at two discrete levels, either to analyze a number of control strategies in terms of their relative effectiveness in reducing blood lead concentrations, or, dependent upon the model's accuracy and the availability of data concerning the exposure to, and metabolism of, lead by a specific population, to select between two or more directly competing strategies for the control of that population's lead exposure, the selection of the optimum strategy being based on the model's output. Modelling may be seen, therefore, to satisfy, at least in part, the need for decision-making information in an area where time may not permit the acquisition of appropriate, unequivocal scientific evidence.

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