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Special Issue / May 1981

ENVIRONMENTAL HEALTH ABSTRACTS & BIBLIOGRAPHY

focus:

MATERNAL AND PERINATAL LEAD POISONING

DEPARTMENT OF HEALTH AND HUMAN SERVICES / PUBLIC HEALTH SERVICE
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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

Exposure to Lead: Sources and Effects

Anonymous. N ENGL J MED 1977 Oct 27; 297(17):943-5.

From authors' discussion: Recent data indicate that the sources of lead for children are multiple, and that body lead burdens below those associated with clinical symptoms can affect biochemical functions and neuropsychologic performance. Anemia is a long recognized effect of lead exposure. Lead, even in low concentrations, affects heme enzymes, notably cytochrome P-450 in the liver and red-cell D-aminolevulinic acid dehydratase. Lead inhibits brain adenyl cyclase at low concentrations in cerebellar preparations and in nigrostriatal preparations. Lead has also been shown to inhibit pancreatic adenyl cyclase. Interference with globin synthesis and collagen synthesis has also been demonstrated at relatively low concentrations of lead. In the heme pathway, lead acts at a number of sites, including the red-cell mitochondrion, where it interferes with the incorporation of iron into the tetrapyrrole ring, resulting in its replacement by zinc. For the young child, the most important target organ is the brain. The catastrophic effects of lead encephalopathy and the protean symptoms of lead poisoning have caused many clinicians to ask whether lesser levels of lead than those producing frank encephalopathy result in subtler forms of brain injury. Lead has been found in the umbilical cord blood of newborns. It has also been shown to be associated with severe reproductive damage in occupationally exposed women, and to be teratogenic in the laboratory animal. Possible sources of lead for children include old house paint, foodstuffs, some newsprint, some ceramic tableware, and water in areas where the mineral content is low, the water acidic, and old leaded pipes still in place. The largest contributor to lead in the atmosphere is automobile emissions.

Lead and Human Behavior

H.A. Walfron. J MENT DEFIC RES 1978 Mar; 22(1):69-78.

Author's abstract: There is little evidence that blood lead levels below about 2.0 μmol, in children cause any untoward neurophychiatric effects. Between 2.0 and 3.0μmol/l, results are conflicting, but those deviations from normality which are noted most likely stem from sub-clinical neuronal damage which has been described by Feldman, Haddow, Kopito and Schwachmann (1973). With blood lead levels in excess of 3.0μmol/l, and particularly with prolonged exposure, neuropsychiatric effects are undoubtedly noted, increasing frequency as the child gets closer to developing clinical signs of frank intoxication and encephalopathy.

Fetal Effects of Lead Exposure (Letter)

J. Scanlon and J.J. Chisolm, Jr. PEDIATRICS 1972 Jan;49(1):145-6.

From authors' discussion: One part of the lead picture which needs a great deal of further study is the fetal effects of exposure to increasing amounts of lead from the environment. It has been demonstrated recently that concentrations of lead found in the "average" child (20 to 40 μg/100 gm whole blood) can inhibit δ-aminolevulinic acid (ALA) dehydratase activity in both blood and brain. That study states that the brain enxyme activity correlated nicely (r = .78) with blood ALA dehydratase activity, suggesting that blood ALA dehydratase may be a useful measure of central nervous system enzyme activity. A small amount of umbilical cord blood from normal newborn infants revealed a mean lead level of 22 μg/100 gm (range 10 to 37 μg). It would be reasonable to expect that ALA dehydratase activity might have been diminished in utero at these lead levels.

Exposure to Lead in Childhood: The Persisting Effects

M.R. Moore. NATURE 1980 Jan 24;283(5745): 334-5.

From author's discussion: Of all the persons in the community, the newborn child is the most prone to injury from overexposure to lead for several reasons. The damage that may be caused will have the greatest long-term social and economic consequences.

In the earliest studies of childhood overexposure to lead, it was clear that classroom performance was poorer in exposed children than in children who had

not been exposed. Thereafter, studies showed that mental retardation could be linked with overexposure to lead in drinking water and with high concentrations of blood lead at or about the time of birth.

In recent studies, a similar degree of diminished learning ability (IQ drop of 4-7 points) and behavioral changes, such as diminished attention span, have been associated with increased concentrations of lead in teeth. These studies by Needleman, et al. and Winnecke are the most convincing evidence to date of low level effects, since the use of tooth lead reflects long-term rather than recent exposure in these children.

Overexposure to lead of young children will have the greatest potential economic effects through increased requirement for care in later life in those most severely affected and by diminution of intellectual potential.

Lead Poisoning

D. Barltrop. ARCH DIS CHILD 1971 Jun;46(247): 233-5.

The difficulty of diagnosing lead poisoning in children because of an initial lack of symptoms, the types of disturbances caused by lead poisoning, and the treatment for lead poisoning are discussed.

Symptoms, which may take 5 to 6 months to develop, may include metabolic disturbances which result in delta-aminolevulinicaciduria, coproporphyrinuria, increased erythrocyte protoporphyrin and a "sideroachrestic" anemia. Disturbance of globin synthesis and mitochondrial abnormalities may also occur.

One disturbance, the inhibition of the enzyme ALA dehydratase at blood lead concentrations hitherto regarded as "normal," may mean a revision of the definition of lead poisoning.

To diagnose lead poisoning, three groups of diagnostic tests may be used: the detection of lead in blood, tests indicating disturbance of metabolism consistent with lead poisoning, and nonspecific tests such as the demonstration of anemia and glycosuria.

Children with pre-encephalopathic lead poisoning and children with encephalopathy should be treated differently. Pre-encephalopathic children should be removed from the source of lead poisoning by admission to the hospital and treated with chelating drugs to remove the lead from soft tissue. The recurrence of lead poisoning should be prevented. Children with early or suspected encephalopathy should be treated with chelators and restriction of fluids to basal needs before the results of the laboratory tests are known.

Environmental Lead and Its Pediatric Significance

D. Barltrop. POSTGRAD MED J 1969 Feb;45(520): 129-34.

Author's abstract: There is evidence that appreciable body burdens of stable and radioactive lead may be acquired by children, and also that part of the maternal intake of lead may influence the fetus. The rapid growth rate, immature metabolic apparatus, and varying dietary patterns which characterize the pediatric age groups suggest that standards for adult males might not be applicable. Numerous environmental sources may contribute to the lead intake of children, but the metabolism of lead in this group is not well understood and deserves further study.

Chronic Lead Intoxication in Children

J.J. Chisolm Jr. DEV MED CHILD NEUROL 1965 Oct;7(5):529-36.

Author's abstract: The serious sequelae of lead intoxication during early childhood are mental retardation, behavior disturbances, convulsive disorders, and nephropathy. The protean symptoms of this chronic disease and the paucity of specific abnormal physical signs make a biochemical approach essential for accurate diagnosis. Fundamentally, the diagnosis of plumbism requires the demonstration of an excessive body burden of lead together with some metabolic evidence of lead's toxic effects in the soft tissues. In children, serial determinations of the concentration of lead in whole blood provide the best means for following trends in total body lead burden and its distribution. Minimal elevations in blood lead concentration are often difficult to evaluate, and the edathamil calcium disodium (EDTA) mobilization test can then be most useful in revealing an increased body lead burden.

The cornerstone of therapy is prompt interruption of abnormal lead exposure. Even so, the excessive intake is halted. In the long-term management of such patients, chelating agents might be used more effectively than they are at present. They are now given mainly for the treatment of obvious acute symptomatic episodes. It is more logical to use these agents to reduce and maintain soft tissue lead concentrations as close to normal as is consistent with safety.

The Susceptibility of the Fetus and Child to Chemical Pollutants. Behavioral Implications of Prenatal and Early Postnatal Exposure to Chemical Pollutants

B. Weiss and J.M. Spyker. PEDIATRICS 1974 May; 53(5):851-9.

From authors' discussion: Perhaps 25% of the children who survive an attack of acute encephalo-

pathy from lead poisoning sustain severe permanent, neurological sequelae. But severe symptoms, because of the current emphasis on early detection, are becoming much less common. Subtle neurological deficits and behavioral impairments are more common developments. Often, however, the handicap is not recognized until after the child enters school. Such children frequently seem to constitute severe behavioral problems, even though they have been diagnosed as completely recovered from the poisoning. They are described as easily distracted, as displaying short attention spans, and as being hyperirritable and aggressive; they often are suffering from sensory and motor impairments demonstrable only with precise testing.

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*Abstracted

EPIDEMIOLOGY AND ETIOLOGY

Occupational Lead Exposure and Women

K. Bridbord. PREV MED 1978 Sep;7(3):311-21.

Author's abstract: The toxicity of lead has been known for approximately 2,000 years, but the issue of women exposed to lead in the workplace has received relatively little attention until recent years. The major thesis of this paper is that the fetus represents an organism which is sensitive to lead and that the fetus is exposed to lead through the mother by the fact that lead crosses the placental barrier. Fetal exposure to lead is, in the author's opinion, the critical issue involved in assessing occupational exposure to lead among women of childbearing age. Multiple studies have demonstrated that concentrations of lead in the mother's blood are comparable to concentrations of lead in umbilical cord blood at birth. Many investigators consider the demonstrated effects of lead upon the hematopoietic system to be the earliest effect associated with lead exposure. Control strategies which prevent significant alterations in the heme synthetic pathway of the mother should prevent such changes in the fetus and thus protect against the more serious adverse effects of fetal lead exposure.

Umbilical Cord Blood Lead Concentration: Relationship to Urban or Suburan Residency during Gestation

J. Scanlon. AM J DIS CHILD Apr 71;121(4): 325-6.

Author's abstract: No statistically significant relationship was shown for umbilical cord blood levels of lead and residency during gestation in either city or suburbs. There was also no significant relationship found between maternal cigarette smoking and cord blood lead levels. These values for cord blood lead are the first noted in the literature. If atmospheric contamination with lead continues at its present rate, further studies of cord blood lead concentration should be undertaken.

Biological Effects of Exposure to Lead in Ambient Air Among Tokyo Inhabitants

K. Tsuchiya, M. Sugita, and C.B. Park. KEIO J MED 1976 Dec;25(4):192-211.

Authors' abstract: The purpose of this study was to examine whether the health of Tokyo inhabitants was affected by lead in the ambient air, on the basis of place of residence, age, and sex. The study came about as a direct result of public concern over a press report that people living near busy traffic intersections were being poisoned by lead in the air. In 1970 and 1971, the laboratories of the Tokyo Metropolitan Institute of Health and the Occupational Health Service Center performed laboratory tests on inhabitants who were concerned about air pollution and presented themselves to their local health departments. The results were then passed on to the Keio University School of Medicine for evaluation. The average lead levels in blood and urine were slightly higher in those persons living in houses which faced a main street than those living on side streets. However, there was no association found to exist according to the distance of the house from the main street. Blood lead levels were higher in males than in females. Lead levels in urine were also higher in males than in females. There was no particular association between age and lead levels in blood or urine. The average lead levels in blood and urine differed by district, but showed no systematic pattern or relationship to the population density. These seem to be due to technical differences between the two laboratories responsible for the testing, as well as to the difficulty in determining such small amounts of lead in blood and urine. In conclusion, according to the available techniques, there was no evidence of an increased level of lead in blood or urine as a result of lead in the ambient air of Tokyo.

Occupational and Environmental Risks in and around a Smelter in Northern Sweden. I. Variations in Birth Weight

S. Nordstrom, L. Beckman, and I. Nordenson. HEREDITAS 1978;88(1):43-6.

Authors' abstract: The Ronnskar smelter in northern Sweden emits a number of potentially toxic substances, of which arsenic, lead, and sulphur dioxide have caused most public concern. Birth weight was studied in the offspring of women working at the Ronnskar smelter and in four populations (A-D) at different distances from the smelter. In the offspring of employees and in two small industrial populations

(A and B) close to the smelter, a significantly decreased birth weight was found. This decrease showed a consistent parity dependence, affecting mainly later pregnancies.

Occupational and Environmental Risks in and around a Smelter in Northern Sweden. III. Frequencies of Spontaneous Abortion

HEREDITAS 1978;88(1):51-4.

Authors' abstract: Frequencies of spontaneous abortion were studied in populations located at different distances from the Ronnskar smelter in northern Sweden. The smelter emits a number of potentially genotoxic substances such as lead, arsenic and suphur dioxide to the environment. In the population located close to the smelter, a significant increase of the abortion frequency was found, compared to more distantly located populations.

Air-Borne Lead as an Environmental Toxin: A review

R.M. Hicks. CHEM BIOL INTERACT 1972 Nov; 5(6):361-90.

From author's conclusion: The evidence reviewed here supports the conclusions that levels of lead in air in urban environments make a significant contribution to the body burden of lead and that the major source of atmospheric lead is combustion of leaded petrol in motor vehicles. There is no doubt that, at high concentrations, lead is a toxin selective for the central and peripheral nervous systems, and that children are more susceptible to lead poisoning than are adults. There is no agreement as to whether the current atmospheric lead levels represent a health hazard. It is a matter of observation that, as more is learned about the side effects of chemical and other environmental pollutants, the lower the accepted "safe" levels become. This is particularly well-exemplified by radiation. The maximum permissible levels of exposures for populations were established and internationally accepted, but, over the years, as knowledge about the biological action of radiation has increased, the permissible levels have had to be progressively reduced until it is now generally accepted that there is no threshold or "safe" dose for radiation effects. The evidence is that attitudes toward environmental lead pollution are following the same pattern, and it is now only a question of time before the legal action already taken in the U.S.A., Germany, Sweden, and Japan is followed by the rest of the world.

Quantities of Lead-Producing Health Effects in Humans: Sources and Bioavailability

K.R. Mahaffey. ENVIRON HEALTH PERSPECT 1977 Aug;19:285-95.

Levels of lead ingestion and inhalation producing increased body burden of lead and clinical toxicity in adults and children are compared with usual levels of exposure. Food, the major source of lead intake, along with air and water, provides the usual exposure to lead. The average intake of lead from these sources apparently produces no adverse health effects. The sources of unusual lead exposure in children are most commonly urban street dirt, house dust, and paint. Several estimates have been made of the common levels of lead exposure for adults, the amount of lead ingested that raises blood lead levels, and the amount of inhaled lead which is absorbed. Children apparently retain a greater percentage of lead than adults, but the normal, tolerable, and toxic levels of lead exposure for children are not clearly established. Organic lead compounds are highly toxic compared to inorganic lead compounds. It has not been determined which inorganic compounds are most likely to have toxic effects nor whether other components in the diet, such as milk, increase or decrease lead absorption in humans. Factors such as minerals, vitamins, fat, and protein content in the diet have been found, however, to influence amounts of lead absorbed and the distribution of lead within the body.

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 diseases 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.

The Biochemistry of Brain Development and Mental Retardation

A.N. Davison. BR J PSYCHIATRY 1977 Dec;131: 565-74.

Author's abstract: Mental retardation may be associated with a number of environmental factors such as undernutrition, lead poisoning, or exposure to neuroactive drugs during a critical period of brain

development. Possible biochemical mechanisms operating in these various conditions and in animal models are reviewed in relation to the vulnerable period hypothesis. Small brains are common in the mentally retarded, and this may be related to a developmental abnormality, particularly at the level of the synapse.

Effects of Lead on the Female and Reproduction: A Review

W.M. Rom. MT SINAI J MED NY 1976 Sep-Oct; 43(5):542-52.

From author's conclusion: Biologic evidence is available indicating that women may be more susceptible to toxic effects of lead. In several animal models, lead exerts a profound noxious effect on pregnancy and fetal development. In addition, the older history of lead's use in the workplace amply documents a deleterious effect on human reproduction. Whether lead is responsible for chromosomal abnormalities in exposed workers remains an unresolved issue. However, there may be no threshold limit at which adverse effects could not occur in the course of development of the human fetus.

The Susceptibility of the Fetus and Child to Chemical Pollutants. Interaction of the Chemical Environment with the Infant and Young Child

L. Finberg. PEDIATRICS 1974 May;53(5):831-7.

From author's discussion: Lead has been an environmental hazard of man for a long time. For children in the United States, the emphasis has properly been on acute and subacute toxicity. The prevalent form of the disorder has come from the ingestion of materials from crumbling surfaces of deteriorated housing–materials containing paint which, in turn, contained lead in the pigment, the drier, or both. The most endangered organ is the brain, and the end result may be death or cerebral dysfunction. Damage to other organs and systems (notably hematopoietic, hepatic, renal, and skeletal) are also seen, but with less devastating results. Sterility may occur in adults with increased lead ingestion. Lead also finds its way into man through the food chain and, in increasing amounts, through the atmosphere from leaded gasline.

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DIAGNOSIS AND SCREENING

Lead Levels in Cord Blood

P. Harris and M.R. Holley. PEDIATRICS 1972 Apr;49(4):606-8.

Authors' summary: Blood lead levels were determined on 24 mothers during labor and on the blood of their newborns. The mean value for the mother's blood lead was 13.2 μg/100 gm and, for the cord blood, was 12.3 μg/100 gm of whole blood. These levels are lower than "normal" blood lead standards usually accepted in the diagnosis and treatment of childhood lead poisoning.

Neonatal Lead Intoxication in a Prenatally Exposed Infant

N. Singh, C.M. Donovan, and J.B. Hanshaw. J PEDIATR 1978 Dec;93(6):1019-21.

From authors' discussion: A presumptive diagnosis of fetal lead intoxication was made on the basis of a positive maternal history of exposure to lead associated with high blood lead and erythrocyte protoporphyrin levels. Exposure to lead occurred during the eighth month of pregnancy, but no treatment was given to the mother because she was asymptomatic, and because of concern for the potential fetal toxicity of calcium EDTA. The infant was born with chemical evidence of lead intoxication, but no neurologic abnormality was detected at birth. The patient's delayed object permanence skills corroborates with the observation of Jenkins and Mellins, who reported that lead-poisoned children had the greatest difficulty with tasks calling for the naming of objects, visual memory, and simple conceptualizing. The delay in language skills of this child could be explained by slightly depressed cognitive skills, particularly her inability to imitate new speech sounds. Cognitive delay can also account for the delay in comprehension. The causative factor may be either the prenatal exposure to high lead or the home environment, which may not be stimulating enough to provide for cognitive and language development. This child appears to be at high risk for later learning problems, which may become demonstrable during early school years.

Congenital Lead Intoxication

A.E. Timpo, J.S. Amin, M.B. Casalino, and A.M. Yuceoglu. J PEDIATR 1979 May;94(5):765-7.

From authors' discussion: We are reporting an infant with fetal lead intoxication, who was also exposed to chelation therapy with calcium EDTA in utero. A diagnosis of lead poisoning was made for a 17-year-old adolescent in her eighth month of pregnancy, who had been eating paint chips from the wall outside of her apartment during the last few months of her pregnancy. Chelation therapy with intravenous calcium EDTA, 1 gm twice a day for 3 days, was instituted. Therapy was well tolerated, without any discernible adverse effects on the fetus. The duration of exposure to lead in the infant is not certain. No obvious congenital malformations have been seen, but bone changes suggest prolonged exposure. Another toxic effect of lead is the alteration of red blood cell membrane permeability, which was observed in this infant, as evidenced by increased osmotic resistance. Although long-term or repeated administration of CaEDTA without zinc supplementation may be harmful to the fetus, the mother was treated, in spite of this concern, because of the dangerously high blood lead level. The treatment, however, did not adequately reduce the lead burden of the infant, who required further chelation therapy postnatally. Exposure of the developing central nervous system to even "subclinical" levels of lead has been reported to cause undesirable developmental consequences such as hyperactivity, learning disabilities, and mental retardation. By 18 months of age, no detectable neurologic or psychomotor developmental abnormalities had been noted in this infant. Nevertheless, the effects of the prolonged exposure to lead, in utero, on optimal brain development and function can only be ascertained by long-term follow-up.

The Human Placenta's Lead Level as a Parameter of Ecological Lead Exposure: Its Validity in Comparison to the Lead Level in Blood, the Acitvity of Delta-Aminolevulinic Acid Dehydratase and the Concentration of Free Erythrocyte Porphyrins of Newborns and Their Mothers (German)

E. Engelhardt, K.H. Schaller, R. Schiele, and H. Valentin. ZENTRALBL BAKTERIOL (Orig B) 1976 Aug;162(5-6):528-43.

English summary: In order to estimate the ecological exposure of lead, placenta and blood investigations were made at four collectives from variously industrialized regions (Ruhr region, Middle Frankonia

Centre, Bavarian Forest). One hundred forty-eight normal births and 19 premature births were listed (in each case, mothers and newborns), as well as 12 abortions. We investigated the lead level in blood, the activity of delta-aminolevulinic acid dehydratase (ALA-D), the concentration of free erythrocyte porphyrin (FEP) and the placentas' lead concentration. Though in the Ruhr region (Dortmund), significantly higher lead levels in blood were found compared to the Bavarian Forest, the total results were in the normal range, less than 35 mug%. On an average, the mothers' blood lead level was around 1.4 times (ca. 5 mug%) above that of their newborns; analyzing this statistically, highly significant correlations were found. However, for the ALA-D activity and the FEP results, no direct dependence on the lead levels in blood could be found. In the placentas, mean lead concentrations between 1.94 mug and 2.23 mug per gram dry-weight (30.6 mug-38.9 mug/100 g wet-weight) were gained. Contrary to the measured results of lead in blood, the average placentas' lead level of the most and least industrialized regions were almost identical. A correlation between the mothers' [blood lead levels], respectively, their children's blood lead levels, and the placental lead concentrations could not be proved. No relation could be found between the results and the gestation ages. Final results: 1. The placenta is not an ideal investigation object concerning the environment's lead exposure. 2. It has no special barrier—or depot—function in lead metabolism. 3. In order to estimate the environment's lead exposure, the determination of the lead level in blood will be, in the future, the optimal method. This investigation is of special value because of the validity of results and the practicability of getting the samples compared to other parameters and biological materials.

A Retrospective Analysis of Blood-Lead in Mentally Retarded Children

M.R. Moore, P.A. Meredith, and A. Goldberg. LANCET 1977 Apr 2; 1(8014):717-9.

Authors' abstract: Blood-lead concentrations were measured retrospectively in the blood contained on cards used for testing for phenylketonuria in the first 2 weeks of life. Cards which belonged to 80 of a group [consisting of] 77 children with mental retardation of unknown etiology and 77 controls, were identified. Of 77 usable cards, 41 were from mentally retarded children and 36 were from controls; 24 mental-retardation/control pairs were found. There was a highly significant trend towards higher blood-lead concentrations in the mentally retarded children. Water-lead concentrations in the maternal home during pregnancy correlated with blood-lead concentrations in the mentally retarded children. These results reinforce the probable association between lead exposure during pregnancy and the development of mental retardation of otherwise unknown etiology.

Lead Levels in Human Placentas from Normal and Malformed Births

D.G. Wibberly, A.K. Khera, J.H. Edwards, and D.I. Rushton. J MED GENET 1977 Oct;14(5):339-45.

Authors' abstract: Placental lead levels were studied in a series of Birmingham births classified by stillbirth, neonatal death, or survival beyond one week. There was an appreciable range of lead levels beyond one week. There was an appreciable range of lead levels even in normal births (0.15-3.56 micrograms/g) but, nevertheless, average results showed a pronounced excess of lead in those who failed to survive both birth and the neonatal period. There was no association of placental lead with impaired birth weight among survivors but, in common with other authors, we noted a seasonal variation. The placentas from Indian women had lead levels similar to those from European women, and lower values were found in the normal sibs of stillbirths and neonatal deaths. The possibility is discussed that, under conditions of impaired fetal health in late pregnancy, the placenta may concentrate lead.

Lead in Umbilical Cord Blood Correlated with the Blood Lead of the Mother in Areas with Low, Medium or High Atmospheric Pollution

B. Zetterlund, J. Winberg, G. Lundgren, and G. Johansson. ACTA PAEDIATR SCAND 1977 Mar; 66(2):169-75.

Authors' abstract: Lead concentrations in 541 samples of umbilical cord blood from different parts of Sweden were determined. The mean concentration was 7.6 mug lead/100 ml (=0.367 mumol/l). The blood lead values were also determined for 297 mothers, and a mean value of 8.7 mug/100 ml (=0.420 mumol/l) was found. There was a significant correlation between the blood lead level of the mother and the infant as studied in 253 pairs. The slope of the regression line was 0.5 (r=0.6). Significantly lower blood values for both mother and infant were found in areas with low pollution as estimated from the lead content in moss. No seasonal variation could be ascertained. Hematocrit versus lead concentration was also studied. A flameless atomic absorption method was used with a standard deviation of 0.9 mug lead/100 ml. The storage time and sample treatment were also studied.

Blood Lead Values in Pregnant Women and Their Offspring

J.J. Gershanik, G.G. Brooks, and J.A. Little. AM J OBSTET GYNECOL 1974 Jun 15;119(4):508-11.

Authors' abstract: Lead levels were determined from maternal and neonatal blood samples collected at a general-care hospital. Ninety-eight cord blood pair samples showed a high correlation of lead levels of mothers and corresponding infants with a product moment correlation coefficient of 0.6377. Thus, neonates are born with lead levels comparable to maternal levels.

Maternal Lead Exposure and Blood Lead Concentration in Infancy

J.E. Ryu, E.E. Ziegler, and S.J. Fomon. J PEDIATR 1978 Sep;93(3):476-8.

Authors' discussion: Infant H., a white girl, was born April 1, 1977, to a 25-year-old primigravida after an uneventful pregnancy of 40 weeks' duration. Birth weight was 2,982 gm; physical and neurologic examinations did not reveal any abnormality. The mother had been employed from March 1974 to February 11, 1977 (i.e., until 7 weeks before delivery) by a manufacturer of electrical storage batteries and, in this occupation, was exposed to considerable amounts of lead dust. Continued observation of both mother and infant indicates that, in the absence of important postnatal exposure to lead, it appears that an infant exposed prenatally can substantially reduce the body burden of lead, at least relative to body mass, during the early months of life.

Effects of Subtoxic Lead Levels on Pregnant Women in the State of Missouri

M. S. Fahim, Z. Fahim, and D. G. Hall. RES COMMUN CHEM PATHOL PHARMACOL 1976 Feb;13(2):309-31.

Authors' abstract: Cords, placentas, placental membranes, and maternal and fetal blood were collected from 249 women delivered in Columbia, Missouri (Region I). The same samples were obtained from 253 women delivered in Rolla, Missouri (Region II), near lead mining areas. The incidence of term pregnancies with early membrane rupture was 0.41% in Region I and 17% in Region II. The incidence of premature deliveries was 3% and 13.4%, respectively. Lead concentration in blood and placental tissues of term pregnancies revealed no significant changes. In term with early membrane rupture, blood concentration of lead was higher, as was the case in placental tissues and cord. Lead concentration was highest in membrane tissues, in mug/100 grams (Regions I and II, respectively): placenta, 6.0+/-0.01 and 7.0+/-0.03; cord, 11.0+/-0.34 and 12.0 +/- 0.18; membrane, 38.9 +/- 2.64 and 45.3 +/- 3.12. A high positive correlation ($r = 0.2941$) between lead concentration in maternal and fetal blood existed. Both were significantly ($P < 0.01$) higher in preterm pregnancies and early membrane ruptures than in term pregnancies. These data suggest that subtoxic levels of lead could increase the incidence of early membrane rupture and premature deliveries.

Free Erythrocyte Porphyrins in Cord Blood

M.A. Gottuso, B.F. Oski, and F.A. Oski, J PEDIATR 1978 May;92(5):810-2.

Authors' abstract: Red cell free erythrocyte porphyrin determinations were performed on cord blood specimens from 236 term infants and on capillary blood specimens from 63 preterm infants weighing less than 1,500 gm, during the first week of life. These results were contrasted with those obtained from 398 normal infants and children aged 1 to 6 years. The mean FEP value for the infants was significantly higher than that observed in the normal control subjects. In 10.5% of the term infants and 15.9% of the preterm infants, values in excess of 120 micrograms/dl RBCs, the highest value recorded in the normal subjects, were observed. Elevations in FEP values were not related to either blood lead concentration or hematocrit levels in the infants. Infants with elevated FEP values were found to have lower serum iron and transferrin saturation values than did infants with low FEP values. These findings suggest that elevations in cord blood FEP values may indicate a state of relative iron deficiency present at birth.

The Susceptibility of the Fetus and Child to Chemical Pollutants. Heavy Metal Exposures: Toxicity from Metal-Metal Interactions, and Behavioral Effects

J.J. Chisolm Jr. PEDIATRICS 1974 May;53(5): 841-3.

From author's discussion: My discussion concerns several possible susceptibility factors to heavy metals that need further investigation. The susceptibility of the young child to heavy metals may be related to diet, or to the intake of protein, calcium or iron. Added to this is his rapid growth, which may be considered a stress factor. In the past, our attention has been directed to the acute and catastrophic effects of grossly increased lead absorption: convulsive disorders, encephalopathy, and the signs of increased intracranial pressure. In the past five years, we seem to have observed fewer children with these acute disorders. Recently, however, a 9-year-old child (considered psychotic and with pica) and a child who de-

veloped the clinical picture of infantile autism after normal development until 3 years of age, have come to my attention. In both instances, blood lead concentrations were elevated and there were other metabolic evidences of lead toxicity; however, the children did not show the classical, clinical signs of acute lead toxicity. Whether or not their increased lead absorption contributed to the observed behavioral disorders is, of course, not known; but the clinical histories are highly suggestive, their cases were chronic, and they did not show any immediate response to chelation therapy. These findings suggest that the role of lead should be considered in a wide variety of central nervous system disorders, even in the absence of classical, clinical syndromes of plumbism.

Placental Transfer of Lead and Its Effects on the Newborn

A. R. Clark. POSTGRAD MED J 1977 Nov;53 (625):674-8.

Author's abstract: Following the baby's delivery, blood was taken from 122 mothers and their infants' cords for estimation of lead, hemoglobin, packed cell volume, and mean corpuscular hemoglobin concentration. All were residents in Kasanda, a township within a radius of 3,000 meters of Broken Hill Lead Mine and Smelter, Zambia, where the annual mean atmospheric lead concentration was 9.6 micrograms/m^3 and the soil lead concentration 100-9400 ppm. Their mean blood levels were high, being 41.2 micrograms and 37 micrograms/dl for mothers and infants, respectively, with a significant correlation ($r = 0.77, P < 0.001$). Thus an infant's blood lead at birth closely follows that of its mother, even at higher values. The increased lead level transfer, however, did not appear to adversely affect the birth weight or red cell values of the newborn. Cord blood lead levels are being used in Broken Hill to monitor a community's exposure to lead.

Lead in Teeth during the Perinatal Period

A.J. Burkitt, G. Nickless, and M.V. Stack. POSTGRAD MED J 1975 Nov;51(601):778-9.

From authors' discussion: This report deals principally with observations of the concentration of lead in 50 developing dentitions. Dentitions prepared for analysis formed a selected population, since it was intended to relate the findings to several arrangements of the data into groupings of comparable size: male/female, urban/rural, stored/recent (50% of these sets of developing teeth had been stored for more than 10 years). The proportion of samples for which the pathologies included "central nervous system and/or other malformations" was increased above the usual frequency encountered in order to be able to note any trend in trace metal analyses which might be related to these pathologies. The mean lead concentration was 5-6 ppm greater in the "recent" group of teeth. The observation of greater lead concentrations in dentitions obtained recently than in those stored for a number of years points toward an environmental change.

Placental Transfer of Lead, Mercury, Cadmium, and Carbon Monoxide in Women. II. Influence of Some Epidemiological Factors on the Frequency Distributions of the Biological Indices in Maternal and Umbilical Cord Blood

J.P. Buchet, H. Roels, G. Hubermont, and R. Lauwerys. ENVIRON RES 1978 Jun;15(3): 494-503.

Authors' abstract: We have investigated the influence of various epidemiological factors (smoking habits, residence, age, occupation, drinking habits, duration of pregnancy, number of previous pregnancies) in the exposure of 474 European pregnant women and their newborns to lead, mercury, cadmium, and carbon monoxide. Smoking has a statistically significant influence on carboxyhemoglobin level in mothers and newborns and on cadmium concentration in maternal blood. The association of smoking with a reduction of fetal weight was confirmed. A slight but statistically significant effect of environmental pollution by lead (urban and industrial > semirural > rural area) on lead intake by the pregnant mothers and its transfer to their fetuses was demonstrated. Some results suggest that, during pregnancy, lead could be mobilized from maternal tissue depots, but further investigations are required to confirm this tentative conclusion. No significant relationships were found between the other epidemiological parameters and the various biological measurements performed on mother and cord blood.

Placental Transfer of Lead, Mercury, Cadmium, and Carbon Monoxide in Women. I. Comparison of the Frequency Distributions of the Biological Indices in Maternal and Umbilical Cord Blood

R. Lauwerys, J.P. Buchet, H. Roels, and G. Hubermont. ENVIRON RES 1978 Apr;15(2):278-89.

Authors' abstract: In 1975 and 1976, we did a survey among 500 pregnant women living in different areas of Belgium in order to evaluate the extent of exposure to heavy metals (lead, mercury, cadmium) during fetal life, their possible biological effects, and the epidemiological factors which may influence the intensity of exposure. Carboxyhemoglobin level was also determined. Comparison of the frequency distri-

butions of the various hematological indices in maternal and umbilical cord blood indicates that the three heavy metals are transferred from the mother to the fetus, but the barrier role of the placenta is different for the three metals. There is no barrier for the transfer of mercury, a slight one for lead, and a more important one for cadmium. This explains that the correlation found between the cadmium concentration in maternal (Cd-B) and fetal blood is much lower (although statistically significant: $r = +0.38$) than that found for lead and mercury ($r > 0.6$). For the range of blood lead concentrations (Pb-B) observed in the mothers and their newborns, there is no significant correlation between Pb-B and erythrocyte porphyrin level. On the contrary, because of its high sensitivity to lead, the erythrocyte enzyme delta-aminolevulinate dehydratase (ALA-D) is negatively correlated with Pb-B in mother and newborn. The correlation is higher when ALA-D activity is expressed in percent of its activity found in the presence of the reactivator dithiothreitol rather than in absolute values. Carboxyhemoglobin levels (HbCO) of mother and newborn are highly correlated ($r = +0.81$, $P < 0.001$). In mother, HbCO is also slightly correlated with Cd-B ($r = +0.29$, $P < 0.001$) which suggests that both pollutants come at least partly from a similar source (smoking). Because of the different barrier effect of the placenta for CO and Cd, no significant correlation between both parameters is found in newborns.

Placental Transfer of Lead, Mercury, Cadmium, and Carbon Monoxide in Women. III. Factors Influencing the Accumulation of Heavy Metals in the Placenta and the Relationship between Metal Concentration in the Placenta and in Maternal and Cord Blood

H. Roels, G. Hubermont, J.P. Buchet, and R. Lauwerys. ENVIRON RES 1978 Jul;16(1-3):236-47.

Authors' abstract: The concentration of lead, mercury, and cadmium was determined in placenta from 474 European women and was compared with the level found in maternal and newborn blood. The influence of some epidemiological factors (residence, smoking, drinking habit, age, occupation, previous pregnancies) on heavy metal accumulation in the placenta was also investigated. The median values of the three heavy metals in placenta were 7.5, 1.06, and 1.08 μg/100 g (wet weight) for lead, mercury, and cadmium, respectively. In comparison with maternal blood, the placenta does not concentrate lead nor mercury, but concentrates cadmium about 10-fold. Cadmium concentration in placenta was significantly correlated with that in maternal blood ($r = +0.38$); for lead, the correlation was lower, although still statistically significant ($r = +0.22$); for mercury, the level in placenta was not significantly correlated with the metal concentration in maternal blood. Among the three heavy metals, only cadmium showed an increased accumulation in placenta of smokers. No significant effect of current residence, maternal age, or occupation on the accumulation of the heavy metals in placenta was observed.

Maternal and Cord Blood Metal Concentrations and Low Birth Weight: A Case Control Study

J.D. Bogden, I.S. Thind, D.B. Louria, and H. Caterini. AM J CLIN NUTR 1978 Jul;31(7):1181-7.

From authors' abstract and discussion: There has been speculation on the possible role of trace metals in contributing to the occurrence of low birth weight, but few data are available for most metals. Twenty-five women giving birth to infants weighing between 1,500 and 2,500 g (cases) and 50 women giving birth to infants weighing more than 2,500 g (controls) were studied. The cases and controls were matched for age (+/- 4 years), race, and socioeconomic status. Cord blood and maternal blood collected at delivery were analyzed by atomic absorption spectrophotometry for calcium, magnesium, copper, lead, and iron. We found no significant differences, for either maternal or cord blood, between lead concentrations of the low birth weight and normal birth weight groups, but it should be noted that all maternal and cord concentrations in the study were below established toxic levels. However, for both groups, the lead concentrations were higher in the maternal blood (15.6 μg/100 ml) than in the cord blood (13.3 μg/100 ml). These differences are statistically significant (paired t test, $t = 4.96$, $P < 0.001$), though the 2.3 μg/100 ml mean difference between maternal and cord blood is just detectable by the method of analysis used. Our data are in agreement with other studies in which slightly higher concentrations were also found in maternal blood than in cord blood. This observation has prompted speculation that fetal tissues might remove lead from blood more efficiently than maternal tissues.

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

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

Authors' abstract: An infant exposed to high levels of lead in utero 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.

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RESEARCH AND EVALUATION

Levels of Lead in Blood and Hematocrit: Implications for the Evaluation of the Newborn and Anemic Patient

J.A. Kochen and Y. Greener. PEDIATR RES 1973 Nov;7(11):937-44.

From authors' speculation: It has been assumed that the clinical evaluation of a given level of lead in blood requires correction for anemia. This was based on the assumption that the intake of lead by the blood is limited by the reduced circulatory erythrocyte volume. This study has shown that the erythrocyte is present in considerable excess in the lead-erythrocyte interaction within the commonly encountered range of hematocrit and levels of lead in blood. This would indicate that hematocrit variation has little influence on intake of lead by blood and that correction of levels of lead in blood for anemia is unnecessary. The presence of similar levels of lead in blood for neonates and mothers indicates that an equilibrium exists between levels of lead in fetal and maternal blood which is unaffected by the difference in fetal and maternal hematocrits. This suggests that the extent of lead exposure and the lead burden in soft tissue may be similar in the mother and fetus.

Transport of Lead 203 and Calcium 47 from Mother to Offspring

K. Kostial and B. Momcilovic. ARCH ENVIRON HEALTH 1974 Jul;29(1):28-30.

Authors' abstract: The transfer of lead 203 and calcium 47 from mother to fetuses and litter was examined 48 hours after a single intravenous application of both radioisotopes to rats on the 18th day of pregnancy and on the fourth and 15th day of lactation. The transplacental transport of lead was eight times lower than that of calcium while the transmammary transport of lead was four times lower. The highest transfer of both radioisotopes from mother to litter was observed during the late lactation period.

Transfer of Lead Via Placenta and Milk

M. Green and N. Gruener. RES COMMUN CHEM PATHOL PHARMACOL 1974 Aug;8(4):735-8.

Authors' abstract: The kinetics of maternal-fetal transfer of lead, as well as through milk, has been investigated in the rat. It was found that lead can be transferred at different stages of gestation. Lead transport is rapid so that the fetus is in equilibrium with the mother 24 hours after injection. Significant amounts of lead are transferred to the nursing rats even a week after a single administration. The lead was found to be concentrated in the head more than in other parts of the body.

Investigations of Factors Influencing Exposure and Response to Lead, Mercury, and Cadmium in Man and in Animals

H.A. Roels, J.P. Buchet, A. Bernard, G. Hubermont, R. R. Lauwerys, and P. Masson, ENVIRON HEALTH PERSPECT 1978 Aug:25:91-6.

Authors' abstract: The susceptibility of the heme biosynthetic pathway to lead, as reflected by increased free erythrocyte porphyrin (FEP) concentration, is in humans, as well as in rats, in the order of the young being either equally or more susceptible than females who are, in turn, more susceptible than males. The difference between adult male and female rats can be explained at least partially by the interaction of estradiol and progesterone with the FEP response to lead; the hormonal influence on FEP does not seem to be mediated through changes in plasma iron. The classical "tubular type" proteinuria in workers chronically exposed to cadmium has two (not necessarily concomitant) components, namely, a tubular-type and a glomerular-type component characterized by increased excretion of low and high molecular weight proteins, respectively. No synergistic effect of cadmium and lead on the proteinuria of workers simultaneously exposed to both metals was observed. Mercury (most likely methylmercury) is freely transferred from the mother to the fetus; there is only a slight placental barrier for lead and a rather strong one for cadmium. Compared to maternal blood, placenta does not accumulate lead or mercury but concentrates cadmium about 10-fold.

Lead-Induced Behavioral Dysfunction: An Animal Model of Hyperactivity

E.K. Silbergeld and A.M. Goldberg. EXP NEUROL 1974 Jan;42(1):146-57.

Authors' abstract: Although clinically, lead poisoning is thought to cause several serious behavioral problems, a causal relationship between lead ingestion and behavioral dysfunction has not been shown. Epidemiological evidence exists for the coincidence of lead exposure and hyperactivity syndromes in children. An animal model of lead poisoning was developed in which suckling mice were exposed to lead acetate from birth indirectly through their mothers and then directly after weaning. For the first 60 days, no deaths of offspring occurred due to lead, but their growth and development were significantly retarded. Activity of offspring was measured between 40 and 60 days of age. Treated mice were more than three times as active as age-matched controls. Treated and control mice were given drugs used in the treatment and diagnosis of minimal brain dysfunction hyperactivity in children: *d*- and *l*-amphetamine, methylphenidate, phenobarbital, and chloral hydrate. Lead-treated hyperactive mice responded paradoxically to all drugs except chloral hydrate: that is, *d*- and *l*-amphetamine and menthylphenidate suppressed hyperactivity, while phenobarbital increased their levels of motor activity. Chloral hydrate was an effective sedative. Implications of these findings are discussed for the study of the central effects of lead poisoning, and for the relationship between lead poisoning and minimal brain dysfunction hyperactivity.

Influence of Sex Hormones on Free Erythrocyte Protoporphyrin Response to Lead in Rats

J.P. Buchet, H. Roels, and R. Lauwerys. TOXICOLOGY 1978 Apr;9(4):361-9.

Authors' abstract: Following oral administration of lead, a difference in free erythrocyte protoporphyrin (FEP) increase was found among adult male, adult female and suckling rats: young animals are more susceptible than adult female rats which, in turn, exhibit a greater FEP increase than adult male animals. This observation parallels that made previously in humans. Possible difference in iron metabolism does not appear to explain the sex-linked difference in FEP response to lead. Sex hormones, mainly progesterone, seem to play a role, but their interaction with lead on the FEP response is restricted to female rats and apparently is not mediated through changes in δ-aminolevulinic acid synthetase activity.

Effect of Chronic Lead Treatment on Renal Function

G.H. Hirsch. TOXICOL APPL PHARMACOL 1973 May;25(1):84-93.

When rats were fed diets containing 1% or 2% lead acetate for 10-40 weeks, the kidney weight:body weight ratio was increased. Renal tissue water content was not changed. Accumulation of PAH and TEA by renal cortical slices from treated rats was not altered, but the capacity of kidney slices to synthesize glucose and metabolize pyruvate was decreased. Doses of 200 ppm lead or less had no effect on these parameters. Rats treated with 1% or 2% lead acetate showed an increase in the percentage of an injected dose of PAH excreted in 2 hours. Treatment of dams at parturition with 2% or 4% lead acetate resulted in an increase in the kidney weight:body weight ratio in the offspring at 30 days of age, an increase in PAH intake by renal cortical slices, and a decrease in renal gluconeogenesis. Histologic examination of kidneys after lead treatment showed varying degrees of vacuolar degeneration and cellular necrosis, and the presence of some lead inclusion bodies.

Copper, Manganese, Zinc, Nickel, Cadium and Lead in Human Fetal Tissues

C.E. Casey and M.F. Robinson. BR J NUTR 1978 May;39(3):639-46.

Authors' abstract: 1. Concentrations of copper, manganese, zinc, nickel, cadmium, and lead were measured in samples of liver, kidney, brain, heart, lung, skeletal muscle and vertebral bone from forty fetuses of 23-43 weeks gestation. 2. Cu concentrations in the liver were up to 100 times those in other tissues, but only those in the brain showed a significant increase with gestational age. 3. Mn concentrations were similar in all tissues; the over-all range was 0.35-9.27 micrograms/g dry matter (DM). 4. Concentrations of Zn in the liver were much higher than in other tissues and decreased with gestational age, whereas levels in skeletal muscle increased. 5. In all tissue, Ni concentrations were within the range 0.04-2.8 micrograms/g DM and levels in kidney and muscle decreased significantly with age. 6. Cd was detected in most of the tissue samples, and concentrations were within the range 0.01-0.58 microgram/g DM. 7. Concentrations of Pb, where it was detected, varied from 0.1 to 2.4 micrograms/g DM in the soft tissues and from 0.4 to 4.3 micrograms/g DM in the bone samples.

Cardiac Effects of Chronic Lead Poisoning

B.J. Williams, W.H. Griffith, C.M. Albrecht, and J.H. Pirch. CLINICAL CHEMISTRY AND CHEMICAL TOXICOLOGY OF METALS (Brown SS ed.) 1977; Amsterdam, Elsevier/North Holland, pp 127-30.

Authors' abstract: Lead exposure of rats during the nursing period results in an increase in the sensitivity of the heart to norepinephrine-induced cardiac arrhythmias. This sensitivity is not accompanied by increased responsiveness to other cardiovascular effects of norepinephrine, such as the vasopressor effect and the stimulation of cyclic AMP accumulation in the heart. The presence of high concentrations of lead in the heart is not required for the expression of cardiotoxicity. The possibility that lead is retained in critical areas within the heart has not, however, been excluded.

It rather appears that early exposure of rats produces effects which develop slowly, and are seen only after maturity. These data suggest the possibility of a relationship between chronic subclinical lead exposure and cardiac abnormalities.

Pharmacological and Neurochemical Investigations of Lead-Induced Hyperactivity

E.K. Silbergeld and A.M. Goldberg. NEUROPHARMACOLOGY 1975 May-Jun;14(5-6):431-44.

Authors' abstract: Mice, chronically exposed to inorganic lead from birth, demonstrate levels of spontaneous motor activity approximately three times higher than coetaneous controls. In addition, their behavioral responses to (+)- and (-)-amphetamine, methylphenidate, and phenobarbital are altered. To further clarify the mechanism of action of lead involved in the induction of hyperactivity and altered pharmacological response, lead-treated mice were administered apomophrine, atropine, neostigmine, physostigmine, *x*-methylparatyrosine, benztropine, chlorpromazine, L-3, 4-dihydroxyphenylalanine (L-DOPA), fenfluramine and 2-dimethylaminoethanol. A comparison of the effects of these compounds on motor activity and reactivity showed significant differences between control and lead-treated hyperactive mice. Neurochemical investigations of lead-induced hyperactivity were undertaken in chronically treated hyperactive mice by measurement of steady state levels and of synaptosomal transport. The so-called high affinity transport systems were studied for the following putative neurotransmitters, precursors, and amino acids: choline, tyrosine, phenylalanine, norepinephrine, dopamine, leucine, glycine, 5-hydroxytryptamine and *y*-aminobutyric acid. Significant changes in high affinity synaptosomal transport were found for choline, dopamine, and tyrosine. The transport systems of other suspected neurotransmitters and the amino acid leucine were not different between lead-treated and coetaneous control mice. In addition, steady-state levels of acetylcholine, dopamine, and norepinephrine were measured in forebrains. Norepinephrine levels were increased, while dopamine and acetylcholine levels were not different in lead-treated animals.

Concentration of Trace Metals in the Blood of Children

H.T. Delves, B.E. Clayton, and J. Bicknell, BR J PREV SOC MED 1973;May 27(2):100-7.

Authors' abstract: Samples of whole blood taken from a control group of children and from a group of children suspected of having lead poisoning have been analyzed, by atomic absorption spectroscopy, for 12 metals–lead, copper, zinc, cadmium, manganese, strontium, chromium, iron, bismuth, lithium, nickel, and cobalt. The main clinical features leading to the laboratory request for a blood lead estimation were severe pica, usually associated with mental retardation, anemia, convulsions, or abdominal pain. Many samples from the patients contained significantly high concentrations, relative to the control group, of the first seven metals listed, whereas other samples from the patients contained significantly low concentrations of iron, copper, and zinc. It was not possible to find any consistent clinical patterns which could be related to these changes.

Effects of Dietary Lead and Zinc on Fetal Organ Growth

P.V. Dilts Jr. and R.A. Ahokas. AM J OBSTET GYNECOL 1980 Apr 1;136(7):889-96.

Authors' abstract: In order to further understand the effects of ingested lead (Pb) on the fetus and the possible interaction of the trace element zinc (Zn) with Pb, groups of rats with dated pregnancies were fed 0, 10, 50, 100, 200, or 500 mg/L of Pb in water throughout pregnancy. Diet was provided ad libitum. A group pair fed with the 200 mg/L of Pb group and a group fed both Zn and Pb, 200 mg/L, were also studied. Placental weight remained constant, but cell division and total protein level in the placenta were decreased, while placental cell size increased markedly. In the fetal carcass and liver, the weight, cell division, and protein were decreased, but cell growth decreased. Organ dry weight varied with wet decreased, while its cell division, growth, and protein were unchanged. The weight, cell division, and protein level of the kidneys were unchanged, but their cell growth decreased. Organ dry weight varied with wet weight, while the percentage of water was unchanged. Whether pair feeding and Zn supplements improve carcass and liver weight is questionable.

Lead, GABA, and Seizures: Effects of Subencephalopathic Lead Exposure on Seizure Sensitivity and GABAergic Function

E.K. Silbergeld, L.P. Miller, S. Kennedy, and N. Eng. ENVIRON RES 1979 Aug;19(2):371-82.

Authors' abstract: Seizures have been described as the endpoint of lead (Pb) intoxication in both humans and animals. Alterations in blood-brain barrier integrity may underlie some cases of Pb-induced seizures, but seizures can also occur in the absence of changes in blood brain barrier. Exposure of rats to two levels of Pb below those producing overt encephalopathy sensitizes them to the behavioral effects of the convulsant agents picrotoxin, isoniazid, mercaptopropionic acid, and strychnine, but not pentylenetetrazol (PTZ). Pb exposure affects several aspects of regional GABAergic function: GABA-transaminase (GABA-T) and glutamic acid decarboxylase (GAD) activities, GABA levels, and apparent rate of GABA synthesis. The results indicated that Pb increased GAD activity, decreased GABA-T activity, and increased the apparent rate of GABA synthesis. However, these changes were not observed consistently in all regions studied. Pb exposure also inhibited the uptake and release (unstimulated and K-stimulated) of (^{14}C) GABA; this effect was observed in both Pb treatment groups and in all brain regions except the cerebellum. The results support an hypothesis of a neurochemical basis for Pb-induced seizures, involving inhibition of GABAergic neurotransmission.

Concentrations of Lead in Capillary Blood of Newborns

N.P. Kubasik and M.T. Volosin. CLIN CHEM 1972 Nov;18(11):1415-6.

Authors' abstract: Lead concentrations in whole blood have been determined for a random sampling of newborns (aged 1-8 days) with the use of a microtechnique involving carbon rod atomization and atomic absorption spectrophotometry. The mean lead concentration for the newborns (13.8 ± 4.5 μg/100 ml of whole blood) differed significantly from that of pediatric populations at low (22.6 ± 6.1) and high lead (32.1 ± 10.4) risk. The concentration of lead in amiotic fluid was less than 20 ng/100 ml of fluid. The significance of the newborn lead values and their role in fetal development remains to be determined.

Effects of Trace Metals on Placental Metabolism

E.B. Dawson, W.D. Cravy, R.R. Clark, and W.J. McGanity. AM J OBSTET GYNECOL 1969 Jan 15;103(2):253-6.

Authors' abstract: The effect of the trace metals, cadmium, lead, and zinc, upon succinic dehydrogenase and cytochrome oxidase activities of mitochondria isolated from human term placentas was determined. Placentas were obtained from both toxemic and nontoxemic patients. All enzyme assays were spectrophotometric and the resultant activities expressed as a ratio to the mitochondrial protein content. The results indicate differences in enzyme activities associated with toxemia and due to the added metals. Increasing concentrations of cadmium ion in the enzyme mixtures resulted in a progressive increase in succinic dehydrogenase activity in both the normal and toxemic mitochondria at levels up to 43.0 mumoles. Lead and zinc ions inhibited succincic dehydrogenase activity at all levels added.

Developmental Effects of Lead

J.P. Bederka, Jr. and J.S. McLellan. SURVIVAL IN TOXIC ENVIRONMENTS. New York, Academic Press, 1974, pp 515-20.

From authors' summary: It appears that relatively high levels of lead entering the fetal and, perhaps, neonatal mouse via the maternal route result in microscopic teratogenic effects and decreased fetal birth weight in mice. Effects on postnatal development in the form of increased mortality, slower rate of body weight gain, and depressed gross motor activity are also seen during the first 35 days of life in mice. Similar effects upon development at present body levels of lead are possible in the more sensitive members of the human and other species. Any contribution of maternal lead toxicity to the neonatal developmental toxicity remains to be elucidated.

The Distribution and Accumulation of CD, Zn, Pb, Cu, Co, Ni, Mn and K in Human Teeth from Five Different Geological Areas of Finland.

R. Lappalainen, and M. Knuuttila, ARCH ORAL BIOL 1979;24(5):363-8.

Authors' abstract: Concentrations of metal were determined in teeth extracted from persons living in areas of Finland where the bedrock is primarily siltstone, orthogeneiss, svecofennidic schist, rapikivi granite or kinzigite. The whole teeth were ground to powder, dissolved in HCl and HNO_3 (2:1 v/v); the metals were analyzed by atomic absorption spectrophotometry. Only the concentration of Zn differed significantly in the various geological areas. Zn and Pb accumulated slightly with age at an average rate of 4.48μg/g and 0.16μg/g per year, respectively. No accumulation of the other trace elements was found.

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