EXHIBIT 13

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...ata, who states that excessive or pathologic contraction, occasionally induced by solution of pituitary, is potentially active of pathologic states. There is an obvious reason solution of pituitary, given immediately after the delivery e baby, does not frequently cause trouble. It requires from to twenty minutes to produce a hard contraction of the by this means, and in the majority of instances the ...ta will have been delivered before the expiration of that It seems unnecessary to give solution of pituitary immeely after delivery of the baby, when 700 out of 1,000 ...ts are delivered with less than 200 cc. of blood loss, and some 2 per cent develop hemorrhage. I hope that Dr. ...ell will substantiate his routine by presenting his figures ...ss of blood.

LEAD POISONING IN CHILDREN

CHARLES F. McKHANN, M.D.
AND
EDWARD C. VOGT, M.D.
BOSTON

The continued occurrence of lead poisoning in ...ldren, despite the efforts of physicians, health ...encies and insurance companies to disseminate ...rmation concerning this preventable disease, war...nts the presentation of a review of certain phases of ...condition and a further report of the cases observed this clinic.

SOURCES OF LEAD

Lead poisoning in infants may follow the prolonged ... of lead nipple shields;[1] in Japan poisoning has ...urred frequently from the use by the mother of face ...der containing lead.[2] In infants and older children ... ingestion, over a period of time, of water containing ...en small amounts of lead may result in intoxication. ...ecently there was reported an extensive series of cases ...f lead poisoning following the inhalation of fumes in ...nes where storage battery casings were used as ...l.[3] However, most frequently the ingestion of lead ...a result of the habit observed in small children of ...ting unusual substances.[4]

Perversions of appetite, designated pica, leading to ...e ingestion of foreign substances such as sand, coal, ...oth, hair or paint are observed in mentally defective ...nd neurotic children, in those suffering from anemia ...nd in those harboring intestinal parasites. In the ...ajority of cases of lead poisoning due to ingestion of ...aint, the pica has apparently been merely a pernicious ...abit, unrelated to any underlying abnormal condition. The incidence of lead poisoning (table 1) is highest in ...nfants and small children in whom teeth are erupting ...nd in whom there is a great tendency to put things ...into the mouth.

...From the Department of Pediatrics, Harvard Medical School, and the ...nfants' and Children's Hospitals.

...Read before the Section on Pediatrics at the Eighty-Fourth Annual ...ession of the American Medical Association, Milwaukee, June 15, 1933.

1. Wilcox, H. B., and Caffey, J. P.: Lead Poisoning in Nursing ...abies: Report of Two Cases Due to Use of Lead Nipple Shields, ...A. M. A. 86: 1514 (May 15) 1926.

2. (a) Hirai, I.: Meningism in Sucklings in Japan from Lead Poisoning, Arch. Pediat. 44: 137, 1927. (b) Fukushima, M., and Matsumoto, ...: Statistics of Two Hundred and Ninety-Eight Cases of Infantile Lead ...oisoning, Orient. J. Dis. Infants 3: 27, 1928. (c) Kato, Katsuji: Lead ...eningitis in Infants: Résumé of Japanese Contributions on the Diag...osis of Lead Poisoning in Nursings, Am. J. Dis. Child. 44: 569 ...Sept.) 1932.

3. Williams, E.; Schulze, W. H.; Rothchild, H. B.; Brown, A. P., ...nd Smith, F. R., Jr.: Lead Poisoning from the Burning of Battery ...asings, J. A. M. A. 100: 1485 (May 13) 1933.

4. Thomas, H. M., and Blackfan, K. D.: Recurrent Meningitis Due ...o Lead in a Child of Five Years, Am. J. Dis. Child. 8: 377 (Nov.) 1914. ...cKhann, C. F.: Lead Poisoning in Children, ibid. 32: 386 (Sept.) ...926. Strong, R. A.: Meningitis Caused by Lead Poisoning in a Child ...f Nineteen Months, Arch. Pediat. 37: 532, 1920. Ruddock, J. C.: Lead ...oisoning in Children with Special Reference to Pica, J. A. M. A. 82: ...1583 (May 24) 1924.

and toys, informed of the danger to small children from the ingestion of lead paint, have cooperated by substituting other types of pigments for the lead pigments formerly used. New cribs are seldom painted with lead paint, and the better grades of toys are largely free from lead pigment.[5] Painted woodwork and painted furniture continue to present sources of lead available to the child.

Intoxication following the ingestion or inhalation of lead appears to be dependent on a number of factors. Of primary importance are the amount of lead ingested and the period of time over which it is taken in. The absorption of small amounts of lead by all persons, whether in urban or in rural populations, seems to be of normal occurrence and is said to be unaccompanied by danger.[6] An increase in the amount of lead ingested, or the continuation of absorption over a period of time, may lead to intoxication. Age is a third factor of importance. Children appear more susceptible to severe intoxication than adults. A similar observation is made in experimental animals, for likewise the young animals seem more susceptible to lead poisoning than do the adults of the same species. In addition to the influence of age on susceptibility to lead, there is observed considerable individual variation in tolerance to the metal. Some children, after the ingestion of moderate amounts of the metal, rapidly develop encephalitis. Others are capable of tolerating quite large amounts with the minimal development of symptoms but with, however, the deposition of abnormal amounts of lead in the body, a condition which we designate latent lead poisoning, for under certain circumstances such patients may mobilize the lead deposited in apparently inert form and thereafter develop serious manifestations.

TABLE 1.—*Age Incidence of Lead Poisoning in Infants' and Children's Hospitals, Boston, 1924-1933*

Age	No. Cases
Under 1 year	7
1 to 2 years	39
2 to 3 years	34
3 to 4 years	5
4 to 5 years	4
Over 5 years	3
Total	92

SYMPTOMS

Usually the ingestion of lead in small amounts has taken place over a period of weeks or months before symptoms are noted. The early manifestations are traceable to disturbed function of the gastro-intestinal tract. Anorexia, constipation, vomiting and abdominal cramps are commonly observed, associated with a variable degree of anemia. More serious symptoms are those referable to the central nervous system. Peripheral neuritis, the usual accompaniment of lead intoxication in adults, is observed infrequently in children, particularly in the younger age groups where the development of encephalitis is more common.[7]

5. Personal communication to the authors of a survey of crib and toy manufacturers made by the Lead Industries Association, secretary, E. L. Wormser.

6. Kehoe, R. A.; Edgar, Graham; Thamann, Fred, and Sanders, Lester: The Excretion of Lead by Normal Persons, J. A. M. A. 87: 2081 (Dec. 18) 1926. Kehoe, R. A.; Thamann, F., and Cholak, J.: On the Normal Absorption and Excretion of Lead: I. Lead Absorption and Excretion in Primitive Life; II. Lead Absorption and Excretion in Modern American Life; IV. Lead Absorption and Excretion in Children, J. Indust. Hyg., to be published.

7. McKhann, C. F.: Lead Poisoning in Children: The Cerebral Manifestations, Arch. Neurol. & Psychiat. 32: 294 (Feb.) 1932.

Evidences of the onset of encephalitis are a change in the mental state of the child and more persistent vomiting, frequently of projectile character. Visual disturbances, alteration in rates of pulse and respiration, delirium, stupor, coma or convulsions may ensue. These manifestations often are accompanied by an elevation of the blood pressure, choking of the optic disks and, in extreme cases, separation of the cranial sutures. When death occurs it follows a period of coma or convulsions and appears to be due to central respiratory failure, as the heart continues to beat for some time after respirations cease.

TABLE 2.—*Additional Data on Lead Poisoning from the Infants' and Children's Hospitals, 1924-1933*

Number of patients with lead intoxication		77
Number of patients with encephalitic symptoms	45	
Deaths from lead encephalitis	11	
Number of patients with neuritis without encephalitis	4	
Permanent sequelae in 12 patients, as follows:		
Convulsions persisted in	4	
Cerebral atrophy	4	
Tremors	2	
Mental retardation	6	
Muscular weakness	2	
Blindness	3	
Speech defect	1	
Number of patients with roentgen evidences of lead, but with minimal symptoms, "latent lead poisoning"		12
Total number of cases of plumbism		94

Although localized lesions such as minute hemorrhages and cellular infiltrations have been found in the brains of patients who have succumbed to lead encephalitis,[8] it is possible to attribute the train of symptoms observed in the disease to the rapid development of generalized, increased intracranial tension due to intense cerebral edema.

Cerebral edema in a child with lead poisoning presenting cerebral symptoms was observed by Chvostek in 1897. A young girl with lead poisoning developed headache, vomiting, a slow pulse rate, coma, choked disks and vasomotor disturbances. At necropsy the meninges were clear. The whole brain appeared swollen, the convolutions were flattened, the medulla was pressed into the foramen magnum, and the ventricles were very small. This description of the gross appearance of the brain in children succumbing to lead encephalitis has been confirmed repeatedly.

Weller[9] studied the pathology of lead encephalitis in experimental animals and observed a similar intense cerebral edema. We also have produced lead encephalitis in animals and in the course of our experiments have confirmed Weller's observations.

If a child survives severe lead encephalitis there frequently remain sequelae indicating cerebral injury of a permanent nature. Cerebral atrophy or degeneration may become manifest in cerebral palsy, epileptiform seizures or mental deficiency. By encephalography the extensive nature of the injury may be demonstrated. Although lead is known to be deposited in the brain and may directly injure or kill the nerve cells, the destruction of brain tissue which is observed need not be explained by a specific action of the metal but may be attributed to degenerative processes resulting from impaired circulation to the brain during the prolonged state of intense cerebral edema.

While an encephalopathy is the usual form of lead poisoning seen in infants and children, milder types of intoxication are encountered which, although not dangerous to life, are of great importance in that their recognition may result in the prevention of the more serious and frequently fatal encephalitis. Neuritis has been mentioned. Gastro-intestinal disturbances are present in almost all cases. In addition to those symptoms and signs which have been mentioned, the ingestion suddenly of large amounts of lead may, by local irritation, induce bleeding into the lower intestinal tract with the passage of fresh or changed blood in the stools. Occasionally also the kidneys are irritated so that a transient albuminuria or hematuria is observed. Glycosuria was seen frequently in our more severe cases, especially those with encephalitis. There was considerable doubt as to whether the elevated blood sugar level and glycosuria were due to injury to the pancreas, or whether they were of the type designated as cerebral and observed in other forms of encephalitis.

The incidence of lead encephalitis in the series of cases of lead poisoning observed since 1924 in this clinic is shown in table 2. The relatively high fatality rate and the frequency of permanent sequelae are to be noted.

DIAGNOSIS

Lead encephalitis must be distinguished from other types of disease with cerebral involvement, notably various forms of encephalitis and meningitis. The history of ingestion of lead and the presence of symptoms of gastro-intestinal disturbance preceding the development of cerebral manifestations suggest lead poisoning. In our opinion the cerebral manifestations are evidences only of the cerebral edema and are not pathognomonic of lead intoxication. Nor are the changes in the cerebrospinal fluid of diagnostic importance in distinguishing lead intoxication from other forms of encephalitis. In cases of lead encephalitis the spinal fluid escapes under increased pressure, oftentimes as high as from 600 to 700 mm. of water pressure. The fluid is clear and colorless, contains usually a trace of globulin and shows an elevation of the total protein. Occasionally a slight pleocytosis is observed.

TABLE 3.—*Determinations of Lead and Calcium in the Cortex of the Shaft of the Femur and in the Lead Line at the Growing End of the Femur* *

	Calcium, Mg. per Gm. of Bone	Lead, Mg. per Gm. of Bone	Lead, Mg. Calcium, Gm.
Cortex of shaft	209.0	0.114	0.546
Lead line	83.5	0.602	7.210

* By chemical examination the lead line was found in this case to contain over five times as much lead per gram of bone as did the cortex of the shaft, while the lead/calcium ratio (column 3) was thirteen times as great in the lead line as in the shaft. Chemical examinations were made through the courtesy of Dr. L. T. Fairhall.

Examination of the blood for basophilic stippling of the red cells is of diagnostic aid. Stippling of the red blood cells is not, however, peculiar to lead poisoning, nor is it found even with constancy in cases of the disease. Particularly it is likely to be absent in cases of so-called latent lead poisoning, and it may be absent even in children showing definite symptoms of intoxication. In patients and experimental animals the numbers of stippled cells in the circulating blood vary from

8. Okubo, A., and Tanaka, H.: Histo-Pathological Changes in Lead Poisoning, J. Pediat. (Tokyo), no. 304, p. 1325, 1925.
9. Weller, C. V., and Christensen, A. D.: The Cerebrospinal Fluid in Lead Poisoning, Arch. Neurol. & Psychiat. 14:327 (Sept.) 1925; The Cerebrospinal Fluid in Lead Poisoning, chap. 29 in The Human Cerebrospinal Fluid, The Association for Research in Nervous and Mental Disease, New York, Paul B. Hoeber, Inc., 1924.

and reflect perhaps more accurately the level rt of lead in the blood than the total amount ly or the amount deposited in certain organs icing symptoms referable to these organs.

d line observed in the gums of adults suffer- lead intoxication is found rarely in children. w of our patients had a lead line in the mar- he gums. When present the lead line is a sign, although it must be distinguished from nes produced by other heavy metals, notably

the most useful aids in the diagnosis of in children are the recently recognized in the bones demonstrable by roentgenogram. hanges, recognized independently by Park,[10] and one of us (E. C. V.)[12] in this country arious foreign investigators,[13] consist of zones ased density at the growing ends of the long d at the margins of the flat bones. The devel- of these changes appears to be dependent on eased deposition of lead in place of calcium in wing ends of the long bones, as well as on a abnormality in the microscopic structure of e formation. The results of chemical analysis one substance of the dense band as compared at of similar material taken from the shaft are in table 3 and indicate that there is a definite in lead in the dense bands observed at the yseal margins of the long bones. Microscopic ation shows further that in cases of plumbism beculae in these rapidly growing parts of the re more numerous and are more closely packed[9] r than in normal bone.

change in the bones has proved to be one of st constant observations in lead poisoning in n, and has led to the discovery of numerous vith minimal symptoms or with unusual clinical stations. Rarely has the lead line in the bones bsent. In one patient, 20 months of age, a diag- of lead encephalitis was made and confirmed by al analysis of the excreta for lead, but the diag- lead line in the bones was absent. The child ved gradually and within a few weeks had devel- the definite dense band found in lead poisoning. lines in the ends of the long bones are not ar to lead poisoning, as the ingestion of phos- s and other substances may produce similar [4] Narrow lines of sufficient density to be con- with a lead line may be found at the ends of the bones in healing rickets and in infants with in A deficiency. Occasionally in the normally ing child there may be a zone of increased density e metaphyseal margins of the long bones, owing to a heavy deposit of calcium. These lines should e confused with the lines observed in lead poison- which are of greater density and width (fig. 1). rther confirmation of the presence of lead in the rospinal fluid or blood may be obtained by spec- troscopic examination.[15] This determination is said to permit an exact diagnosis of the presence of lead within twenty-four hours after blood is withdrawn from the vein of the patient.

The demonstration of lead in the excreta of children by chemical examination is not adequate evidence of intoxication, as it has been shown by Kehoe[8] and confirmed in this clinic that normal children excrete small amounts of lead in the urine and stools. However, patients with lead poisoning excrete much larger amounts of the metal than do normal children, so that quantitative determinations of lead in the excreta, properly appraised, may be accepted as satisfactory evidence of plumbism.

TREATMENT

Although it is impossible within the scope of this paper to discuss the chemistry of lead in the body, a brief statement may aid in the understanding of the suggested methods of treatment.

Aub and his co-workers [16] have pointed out that lead in the body is absorbed, transported, deposited and excreted much as is calcium, so that, in general, factors

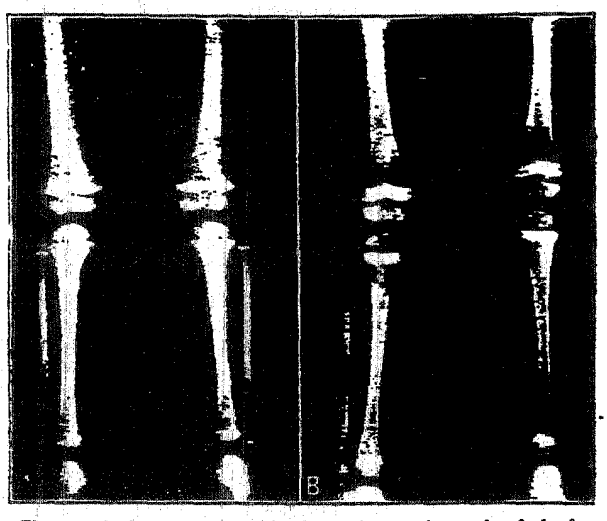

Fig. 1.—*A*, dense transverse bands at the growing ends of the long bones observed in a child with lead poisoning. *B*, roentgenogram of the long bones of the same patient four months later. Note the greater breadth of the bands.

which influence calcium metabolism might be expected to have an influence on lead. Lead is absorbed through the lungs or intestinal tract and, in rare instances, through the skin. It is carried in the blood stream presumably as the phosphate and is deposited in various organs, especially the brain, liver, pancreas and bones. Lead deposited in the organs of the body may induce the symptoms referable to the various systems, but lead deposited in the bones is in an inert form. Thus in relieving lead poisoning measures are usually recommended which tend to hasten the removal of lead from the circulation and the deposition of the metal in the bones. To this end calcium salts [16] or phosphates [17] are administered to diminish the solubility of lead in the blood, and viosterol is given to hasten the growth

Park, E. A., in discussion of McLean, Stafford: The Bone Lesions ogenital Syphilis, Am. J. Dis. Child. 39: 899 (April) 1930. Park, ; Jackson, Deborah, and Reidi, Lasle: Shadows Produced by Lead e X-Ray Pictures of the Growing Skeleton, ibid. 41: 685 (March)

Caffey, J. P.: Clinical and Experimental Lead Poisoning: Some genologic and Anatomic Changes in Growing Bones, Radiology 17: 1931.

Vogt, E. C.: A Roentgen Sign of Plumbism, Am. J. Roentgenol. 350, 1930; Roentgenologic Diagnosis of Lead Poisoning in Infants Children, J. A. M. A. 98: 125 (Jan. 9) 1932.

Koga, Sato and Kashahara, cited by Kato, K., and Kraft, E.: genbefunde bei Bleivergiftungen im Kindesalter, Fortschr. a. d. Geb. ntgenstrahlen 46: 269, 1932.

Phemister, D. B.: The Effect of Phosphorus on Growing, Normal Diseased Bones, J. A. M. A. 70: 1787 (June 8) 1918.

15. Kimura and Uchida, cited by Kato.[2c] Shipley, P. G.; Scott, T. F. M., and Blumberg, H.: The Spectrographic Detection of Lead in the Blood as an Aid to the Clinical Diagnoses of Plumbism, Bull. Johns Hopkins Hosp. 51: 327, 1932.

16. Aub, J. C.; Fairhall, L. T.; Minot, A. J., and Reznikoff, P.: Lead Poisoning, Medicine 4: 1, 1925 (a comprehensive discussion of the chemistry, physiology and other aspects of lead poisoning).

17. Shelling, D. H.: Effect of Dietary Calcium and Phosphorus on Toxicity of Lead in the Rat: Rationale of Phosphate Therapy, Proc. Soc. Exper. Biol. & Med. 30: 248, 1932.

of bone. The efficacy of these therapeutic measures is difficult to evaluate, as the milder cases of intoxication show prompt improvement if the ingestion of lead is prohibited and if the child remains free from infection and in a good state of nutrition.

Removal of lead from the body, or deleading, may be accomplished by inducing an acidosis or an alkalosis, by deprivation of calcium or by the administration of parathyroid extract-Collip.[18] In view of the fact that acute infection or the development of acidosis may induce symptoms in a child who harbors lead in the bones but who has been symptom-free for a period of time, and furthermore because efforts at deleading have resulted in the recurrence of cerebral symptoms, we have given up the attempt to delead our patients.

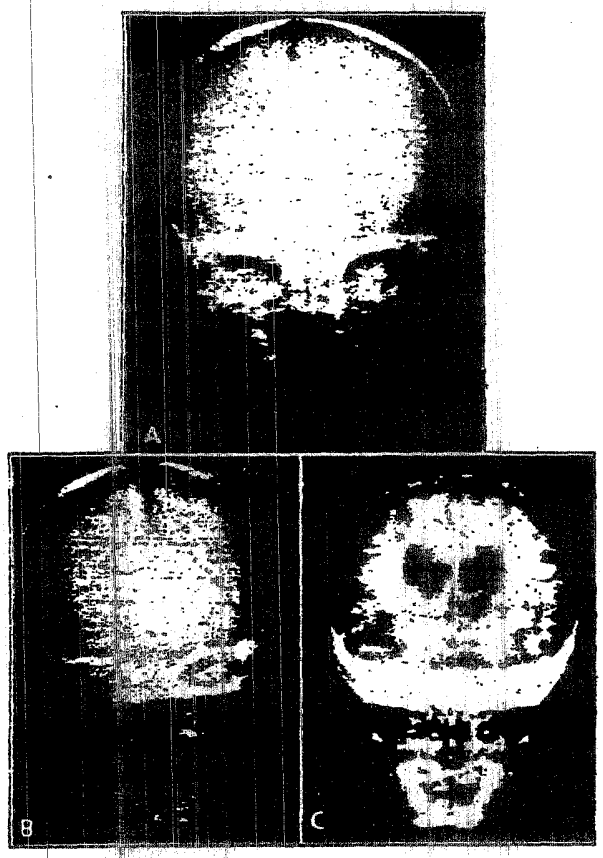

Fig. 2.—A, roentgenogram of the skull of R. M. on her admission to the hospital. No abnormality is noted. *B*, roentgenogram of the skull three weeks after admission, showing the sutures widely separated. *C*, encephalogram seven weeks after the onset and three weeks after the subsidence of symptoms of lead encephalitis. Cerebral atrophy is evidenced in the markedly enlarged ventricles and the excess of air over the cortex of the brain.

Although danger of return of the symptoms of lead poisoning persists for some time, it gradually subsides owing to the spontaneous elimination of the metal.

The treatment of children who have already developed lead encephalitis is not satisfactory. Lead deposited in the brain appears to induce intense cerebral edema which is highly resistant to the ordinary methods of combating cerebral edema. Intravenous injections of magnesium sulphate or of hypertonic solutions of salt or dextrose have had only temporary effects. It would appear that life can be prolonged or maintained by the use of drugs which control the convulsive seizures, but the unfortunate sequelae cannot be prevented by these substances. In the more severe cases separation of the sutures of the skull has occurred, resulting in relief to the patient through spontaneous cerebral decompression. The pressure required to accomplish this decompression is great and may account for the permanent cerebral injury that is so common among the children who survive the acute encephalitic stage. The following case illustrates the course of severe but nonfatal lead encephalitis:

REPORT OF A CASE

R. M., a girl, aged 2½ years, was admitted to the hospital because of anorexia, drowsiness and tremors of three days' duration. For three months she had vomited, suffered from abdominal cramps and been constipated. The history revealed that for four and a half months she had been chewing paint from the woodwork and furniture of the house. After admission to the hospital she remained in a stuporous state, refused food, continued to vomit almost everything taken, had constant tremors of the extremities and periodically suffered from generalized convulsions.

Examination of the blood showed a moderately severe anemia, with numerous stippled cells present in the smears. Roentgenograms of the long bones showed definite lead lines. The blood pressure was elevated. Severe papilledema developed rapidly, and over a period of three weeks the sutures of the skull gradually separated (fig. 2 *A* and *B*). The spinal fluid was found to be under greatly increased pressure; globulin was present, the sugar content was normal and the cell count was elevated, ranging in various examinations from 19 to 31 mononuclear cells. Therapy directed toward hastening the deposition of lead in the bones as well as measures designed to relieve increased intracranial tension were apparently without effect on the course of the disease. An operative procedure, in the nature of a widespread flap decompression, was contemplated but was not performed. Following the spontaneous decompression, whether or not because of it we cannot say, she began gradually to improve. The tremors subsided and the vomiting ceased. As she became less stuporous it was apparent that she had become mentally defective and that she was almost totally blind. With the disappearance of papilledema the optic disks became very pale. Encephalograms made seven weeks after admission and three weeks after the subsidence of symptoms of increased intracranial pressure showed considerable cerebral atrophy as evidenced by markedly enlarged lateral ventricles and an excess of air over the cortex (fig. 2 *C*). Further observation of the child over a period of several months indicated that her mental condition gradually improved and fortunately her vision returned at least in part, but she remained obviously and probably permanently retarded mentally.

In view of the failure of therapy in children with cerebral manifestations of lead poisoning, we have been prompted to undertake the experimental investigation of lead encephalitis. By means of organic lead salts given by mouth it was found to be possible to induce with great regularity a fatal type of lead encephalitis in rats, guinea-pigs and rabbits. After a few days the animals developed tremors which were followed by generalized clonic convulsions. After a variable period of convulsions death ensued from respiratory failure. Measurements of the blood pressure of guinea-pigs in the stage of tremors or convulsions of lead encephalitis showed an elevation almost 50 per cent above the normal level established by similar determinations in control animals of the same ages and weights. The brains of animals succumbing to lead encephalitis showed the intense edema described by Weller.

Thus lead encephalitis induced experimentally in guinea-pigs resembled in many aspects the disease as

18. Aub, J. C., and Hunter, D.: Lead Studies: XV. The Effect of the Parathyroid Hormone on the Excretion of Lead and of Calcium in Patients Suffering from Lead Poisoning, Quart. J. Med. 20: 123, 1927.

observed in infants and children. After producing and studying the manifestations of lead encephalitis in upward of twenty guinea-pigs, we undertook to test the efficacy of various therapeutic agents. Thus far in a series of over fifty animals we have been unable to influence the course of the disease if treatment has been delayed until the animal is in a state of convulsions. Control of the convulsive seizures has been accomplished by the use of magnesium sulphate, phenobarbital, pentobarbital-sodium, amytal or paraldehyde, with considerable prolongation of life but without effect on the final outcome. The parenteral administration of calcium salts, sodium salts, including phosphates, iodide, thiosulphate, ferricyanide and thiocyanate, and other drugs which theoretically might have some effect on the solubility of lead in the blood or the deposition of the metal in the body, has been tried without influence on the course of the disease. Other means of combating lead encephalitis in experimental animals are now under investigation.

SUMMARY

A diagnosis of plumbism can be made in children in the early stages of intoxication by the correlation of the history, physical signs and laboratory data in conjunction with the roentgenologic findings. Cerebral manifestations seldom occur in patients who receive, at this stage of the disease, treatment directed toward hastening the deposition of lead in the bones. Although progress has been made and is being made in the understanding of lead encephalitis, the treatment of patients with lead encephalitis remains in an unsatisfactory state.

The attack on lead poisoning in children must be made largely through prophylactic measures. Realization by physicians of the dangers to children of the continued ingestion of lead and the dissemination to mothers of information on the subject should result in prevention of the disease.

ABSTRACT OF DISCUSSION

DR. R. A. KEHOE, Cincinnati: I shall emphasize a few points made by the authors and speak briefly on lead excretion. Although lead encephalitis occurs in adults, it is relatively rare, occurring only when massive doses of lead have been absorbed. In children, on the other hand, it is not infrequent. It is of particular interest and importance that in children with lead poisoning there is a striking tendency for symptoms of the central nervous system to develop, indicating the fundamental difference in the disease in children and adults. Encephalitis in children, as in adults, has a bad prognosis. From available figures one concludes that the prognosis in children and the outlook for complete recovery are even somewhat worse than in adults. The preventive aspect of this problem should therefore be greatly stressed. Since the authors' figures have shown that this condition occurs at the period when children are most likely to eat abnormal things and to chew various objects in their environment, pediatricians should be alert to note abnormal appetite and behavior. Pica being the most frequent cause of lead poisoning in children, strenuous efforts must be devoted to eliminating lead from their environment. This situation is very serious in Queensland. A large number of cases have been reported, presumably because children play on weathered, lead-painted verandas where the lead pigments have dusted out to the surface. The contributions of the roentgenologist to the diagnosis of lead poisoning are among the most significant in our day, and it is an unfortunate limitation that they are applicable only to children. This sign of the line in the bones is extremely important. Recognizing, however, that it may not always be possible to differentiate this line from certain other densities that occur on the epiphyseal end, it is of some consequence to stress the diagnostic importance of lead in the excreta. It has been shown beyond any reasonable doubt that lead occurs normally in the excreta of children, as of adults. The quantity of lead that may be found under normal conditions is small. The levels of lead in the excreta that can be demonstrated to have clinical significance are comparatively well defined. It is thus possible, with accurate analytic methods, to recognize the probable existence not only of lead poisoning but also of lead exposure in unusual amounts, both in children and in adults. This method, as an adjunct to the much quicker and much more convenient x-ray method, will aid materially the correct diagnosis of lead poisoning in children.

DR. ROBERT A. STRONG, New Orleans: In 1914 I reported a case of lead encephalitis in a child 18 months old and at the time I could find only six other reports in young children, although the literature at the time seemed to indicate that it prevailed extensively among adult workers in the lead industry in France. As the authors have stated, physicians must be lead conscious in order to be able to elicit lead poisoning. A considerable amount of lead poisoning has been overlooked in these little patients. Since hearing papers such as Drs. McKhann and Vogt have presented, I have been more alert. I have seen three cases in New Orleans during the past winter in which the lead line was demonstrable. Unfortunately, the cases had advanced until the central nervous system was involved and consequently the cases were not amenable to treatment. The authors have called attention to the fact that stippling of the cells is by no means common to lead. Dr. Foster Johns, of the department of clinical medicine at Tulane, had his attention called to a widespread mortality among wild ducks around the hunting grounds on the Gulf Coast of Louisiana. An examination of the blood of these ducks revealed the cause of the mortality. His observations were similar to those made by Dr. McGrath of the Mayo Clinic a few years ago. When the gizzards of the ducks were opened, it was found that they were filled with lead shots such as are used in hunting ducks. The shot removed from the gizzards were about one-third the size of shot that have never been used. These ducks died from lead poisoning as a result of mistaking the shot in the bottom of the lagoons for the small stones they usually ingest. The authors have informed me that they have received the cooperation of some of the manufacturers of toys and other articles which find their way into the hands of children and have received reasonable assurance that they will use something other than lead in the paints used in coloring these articles.

DR. KATSUJI KATO, Chicago: This presentation on lead poisoning reminds me of conditions in Japan. It is rather unusual in this country to see so many cases as Drs. McKhann and Vogt have experienced in Boston in a period of nine or ten years, for even in Japan there is an average annual figure of about ten cases of lead poisoning in the larger pediatric clinics. I am anxious to point out that among various forms of lead poisoning there is one particular type to which but little attention has been paid in the past; namely, congenital saturnism, or lead poisoning. In Japan the source of lead has been chiefly in the form of face powders. At present the government requires the use of titanium instead of lead in the manufacture of cosmetics. In spite of this, lead is still being used in a certain percentage of face powders, because lead seems to give a better spreading effect on the skin. The authors informed me that the pregnant mother has a greater tolerance for lead, owing to the fact that the metal is taken up in the rapidly growing bones of the fetus. The Japanese mothers continuously use lead-containing cosmetics on their necks, faces, shoulders and breasts during pregnancy, often to the extent of veritably whitewashing the exposed parts of the body. This would strongly suggest the possibility of congenital origin of lead poisoning in new-born infants. In certain cases of congenital hydrocephalus, may it not be reasonable to suspect intra-uterine lead poisoning as its cause? Again, in some cases of spastic paralysis of the limbs, with or without convulsive seizures, which are usually thought to be due to intracranial hemorrhage, congenital lead poisoning may be a possible cause. This suggests at once that the so-called lead lines at the metaphyses of long bones in the new-born infant presenting suggestive symptoms should be looked for by making roentgenograms. This is important both in diagnosis and in treatment.