HOLT'S
DISEASES OF INFANCY AND CHILDHOOD

A TEXTBOOK FOR THE USE OF STUDENTS AND PRACTITIONERS

BY THE LATE

L. EMMETT HOLT, M.D., AND JOHN HOWLAND, M.D.

REVISED BY

L. EMMETT HOLT, JR., M.D.

PROFESSOR OF PEDIATRICS, NEW YORK UNIVERSITY COLLEGE OF MEDICINE; DIRECTOR, CHILDREN'S MEDICAL SERVICE, BELLEVUE HOSPITAL, NEW YORK CITY

AND

RUSTIN McINTOSH, M.D.

CARPENTIER PROFESSOR OF PEDIATRICS, COLUMBIA UNIVERSITY, AND DIRECTOR OF THE PEDIATRIC SERVICE IN THE BABIES HOSPITAL, NEW YORK CITY

ELEVENTH EDITION

APPLETON-CENTURY-CROFTS, INC.

NEW YORK LONDON

Treatment.—This is purely symptomatic. Large amounts of sedatives are often required. Relief from the itching is sometimes obtained by placing the extremities in cold water or sponging with alcohol. If the anorexia is so pronounced that a very insufficient diet is taken, and if there is great loss of flesh and strength, feeding by gavage should be resorted to.

Numerous attempts have been made to overcome a postulated dietary deficiency by superalimentation or parenteral injection of various food factors. Large amounts of vitamins A, B_1, C, D, nicotinic acid and riboflavin have been given with inconstant or negative results. The effect of vitamin B_1 alone has seemed encouraging, but many more observations will be required to establish a definite relationship to the disease.

Bilderback. Group of Cases of Unknown Etiology. Northwest. Med., 19:265, 1920.

Blackfan and McKhann. Acrodynia; a Note on the Pathologic Physiology. J. Pediat., 3:45, 1933.

Byfield. A Polyneuritic Syndrome Resembling Pellagra (Acrodynia?) Seen in Very Young Children. Am. J. Dis. Child., 20:347, 1920.

Day, Smith and Klingman. Tests of Function of Vegetative Nervous System in Acrodynia. Am. J. Dis. Child., 57:265, 1939.

Debré and Névot. Sur le problème de l'étiologie de l'acrodynie infantile. Ann. paediat., 152:253, 1939.

Matzenhofer. Die Akropathien des Kindesalters, mit besonderer Berücksichtigung der infantilen Akrodynie. Ergebn. d. inn. Med. u. Kinderh., 54:269, 1938.

Orton and Bender. Lesions in the Lateral Horns of the Spinal Cord in Acrodynia, Pellagra and Pernicious Anemia. Bull. Neurol. Inst. New York, 1:506, 1931.

Patterson and Greenfield. Erythroedema Polyneuritis. Quart. J. M., 17:6, 1923-4.

Péhu et al. La répartition géographique de l'acrodynie infantile. Rev. franç. de péd., 12:515, 1936.

Swift. Trans. Australasian Med. Cong., 1914, p. 347.

Warton. Acrodynia. Arch. Pediat., 37:513, 1920.

Wood and Wood. Pink Disease. Brit. M. J., 2:527, 1935.

Wyllie and Stern. Pink Disease; Morbid Anatomy with Note on Treatment. Arch. Dis. Child., 6:137, 1931.

LEAD POISONING

Lead poisoning is one of the common and most serious forms of intoxication recognized in childhood. Ingestion is the usual mode of exposure, but some cases of poisoning have followed the inhalation of lead or its absorption through the skin. Most of the children who acquire the disease do so during the first few years of life when it is natural for them to put things into the mouth. The abnormal persistence of this trait, pica, in older children may be followed by lead poisoning. Nursing infants have developed symptoms following the mother's use of a lead nipple shield or lead acetate ointment on the breast. Outbreaks of poisoning in Japan have resulted from the widespread use of a toilet powder containing lead. Other sources of the metal have been food or drink kept in lead vessels or passed through lead pipes. The use of storage battery casings as fuel caused at least forty cases in one epidemic in Baltimore. The most common source of the metal in children is from gnawing lead paint from toys, furniture, railings or sills. Poisoning may follow either a single exposure to a large amount of lead or the repeated ingestion of small quantities, which may proceed for months before producing signs of intoxication.

In one child known to have ingested white lead on only a single occasion the first symptom occurred in ten days and death followed in two weeks. Children as well as industrial workers seem to develop some tolerance to the metal, since a given amount of lead in the blood of one person will be followed by severe symptoms, while in another, particularly one who has had chronic absorption, it will be accompanied by few if any outward signs.

When lead is absorbed into the body it can be found in all the tissues, the greatest concentration being in the bones, liver, pancreas and brain. At the growing ends of bones circulating lead is deposited as phosphate in the cartilaginous matrix. The normal resorption of trabeculae fails to occur and there remains a zone of dense

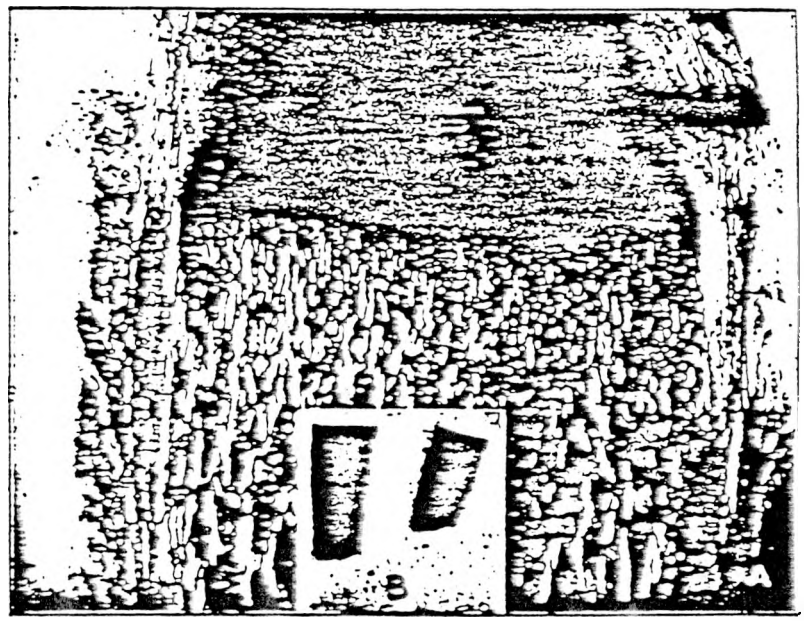

FIG. 161.—TRABECULAR CHANGES IN A RIB IN LEAD POISONING, SHOWING INCREASE IN DENSITY AND THICKNESS OF ZONE OF PROVISIONAL CALCIFICATION.

lead-containing trabeculae proximal to the metaphysis. As the bones grow this dense area tends to disappear, but it may last for years. The width of this zone in a growing bone is some measure of the length of time excess lead has been circulating in the blood, since it is constantly being deposited at the cartilage-shaft junction as long as a high blood level is maintained. In the liver, kidney and pancreas there are intranuclear inclusion bodies which probably indicate that there has been specific cellular damage.

In the brain of an infant dying of lead encephalitis there is found intense edema, many widespread areas of vascular damage with both hemorrhage and seepage of serum into the brain tissue. There is extensive destruction of brain cells, particularly in the cortex and cerebellum, with disintegration of neuroglia. Much of this damage is irreparable. In the neuritis or neuronitis due to lead the whole cell is involved,

and not only the axon but the cell itself may be destroyed. Chronic vascular changes leading to arteriosclerosis sometimes occur. The black stippled line on the gums is due to the precipitation of lead as the sulfide in the loops of end capillaries just back of the gum margin. This line occurs after the teeth have erupted and when oral hygiene is poor.

Symptoms are little affected by race and sex but age influences the form of the disease. The younger the child the more vulnerable the central nervous system to injury by lead. Hence, symptoms of encephalitis usually bring the young child to the hospital. This may happen before anemia, colic and peripheral neuritis occur. Change in disposition, always for the worse, irritability, crying spells and intense restlessness occur. Headache and increasing drowsiness may be the first signs of illness noticed by the parents, and persistent vomiting or convulsions are the most frequent manifestations for which they seek medical aid. The twitching movements tend to persist or to be followed by localized or generalized weakness. When the encephalitis is severe coma is the rule and may persist for weeks. Papilledema is fairly common in these cases. Peripheral neuritis is not one of the usual manifestations, but wrist drop and ankle drop appear occasionally. Once we saw in a child of six years extensive involvement of all the peripheral nerves, both motor and sensory, resulting in complete paralysis and almost total anesthesia. This is rare, particularly the loss of sensation, although numbness and tingling of the fingers and toes is found much more often. Ataxia and coarse tremors accompany the not infrequent cerebellar involvement. Pallor is a common symptom but anemia is seldom severe enough to make the patient ill. Pains in the muscles and joints are of rare occurrence. It is interesting that the onset of symptoms is much more common in the summer months.

Laboratory examinations are of great aid in the diagnosis of lead poisoning, especially the determination of the amount of lead in the circulating blood. Many normal individuals will have from 0.01 to 0.03 milligram of lead in 100 cc. of blood. When the amount reaches 0.1 milligram clinical symptoms usually appear, and if the amount is greater than 0.3 milligram per 100 cc. in a child, severe or fatal encephalitis may be imminent. Either chemical or spectrographic methods may be used to determine the blood lead. The determination of the daily excretion of lead in the urine, normally not more than 0.2 milligram, is an aid in diagnosis.

The blood shows a moderate anemia with a hemoglobin rarely below 50 per cent in uncomplicated cases. The red cells show polychromatophilia and punctate basophilia, which may occur in other conditions but is more characteristic of lead poisoning. These stippled cells appear intermittently but are usually found on repeated careful search. A leukocytosis is frequently present, but there is some question whether this is due to lead itself or to infection which so often antedates the severe symptoms.

Urinalysis shows nothing characteristic. Albuminuria occurs in about a third of severe cases and small amounts of sugar may appear. The blood sugar is not affected, although transient renal glycosuria has been observed.

In lead encephalitis the spinal fluid findings are characteristic. The pressure is high when the symptoms are acute but may be normal during convalescence. The fluid is clear and usually free from pellicle formation. There is nearly always a large

amount of globulin, out of proportion to the increase in cells, which rarely exceed 100 per cu. mm. and are nearly all lymphocytes. We have seen one child with extensive fatal neuritis due to lead and another with marked cerebellar involvement who showed no change in the spinal fluid.

Roentgen examination of the long bones in growing children is of great assistance. The presence of a zone of increased density at the ends of the shaft suggests lead poisoning. It must be remembered that other heavy metals and elementary phosphorus can produce similar zones, and narrower heavy lines are seen in scurvy and healing rickets. In the film, however, these last appear as lines rather than zones. Sometimes far away from the epiphysis are seen fainter bands of increased density indicating previous exposure to the heavy metal. In roentgenograms of the abdomen there are often many fine flecks of metallic density scattered through the intestine. These probably result from the ingestion of paint or other metal-containing substances.

The differential diagnosis of lead poisoning is extensive and includes many diseases which produce encephalitis, neuritis, colic and anemia. Probably the most common confusion is with tuberculous meningitis or some other form of encephalitis.

As long as there is exposure to lead, in fact until the amount of circulating lead in the blood falls toward a normal value, symptoms of poisoning are progressive. Once encephalitis has become manifest there is an even chance that the patient will die. Perhaps the most characteristic feature of the generalized convulsions due to lead encephalitis is their persistence in spite of vigorous efforts at therapy. The less severe symptoms disappear when the metal is removed, and the body seems to be able to repair all the damage except that done to the brain. The prognosis of children who recover from the acute symptoms of lead encephalitis is bad. Only a small proportion of them are normal, a few are idiots and most of them are dull or obviously defective children with a tendency to convulsions. It is difficult in this last group to distinguish cause from effect since pica and hence lead poisoning are more common in defective children.

The treatment of lead poisoning is most unsatisfactory and is largely nonspecific. In a growing child the administration of large amounts of sodium phosphate and vitamin D may aid in the deposition of lead in the bones. In lead encephalitis the usual sedatives have little effect and the agents commonly employed to decrease cerebral edema seem powerless to shrink the badly damaged brain. It is probably wise to use magnesium sulfate, 0.1 gram per kilogram of body weight intramuscularly every four to six hours, during convulsions. Extensive surgical decompression if done early in encephalitis has been of benefit in some instances. Recently the use of large doses of vitamin C, from 200 to 400 milligrams of ascorbic acid daily, has been followed by improvement.

After recovery from the acute manifestations, the question of deleading procedures may be considered. Attempts at deleading by administration of ammonium chloride or fixed acid are unwise because the blood lead level may be raised to such a point as to cause a recurrence of symptoms. Hunter and Aub have shown that a large part of the lead can be removed from the body by means of parathyroid hormone; in their cases the lead did not produce symptoms on its way out. This procedure is not always successful, for children vary considerably in their response to parathyroid hormone; some are refractory and with others there is danger of overdosage. It is important to avoid infections, since they may initiate symptoms in latent poisoning; the acidosis which may

accompany them tends to promote the solution of calcium and lead salts which normally would remain fixed in the bones.

It is obvious then that prevention of exposure is the main point of attack. Parents should be educated to recognize the possible harm of pica, paint chewing and other common methods of acquiring lead. In spite of the rather high incidence of cases of lead poisoning there are no laws in this country to prevent the use of lead paint in children's toys and furniture. In only three states is it necessary to label paint so that one may ascertain that lead is an ingredient.

T. C. G.

Aub. The Biochemical Behavior of Lead in the Body. J. Am. M. Ass., *104*:87, 1935.

Aub et al. Lead Poisoning. Medicine, *4*:1, 1925.

Blackman. Lesions of Lead Encephalitis in Children. Bull. Johns Hopkins Hosp., *61*:1, 1937.

——— Intranuclear Inclusion Bodies in the Kidney and Liver Caused by Lead Poisoning. Bull. Johns Hopkins Hosp., *58*:384, 1936.

Cattey. Clinical and Experimental Lead Poisoning. Radiology, *17*:957, 1931.

Gottlieb and Mason. Glycosuria in Lead Poisoning. Am. J. Dis. Child., *59*:115, 1940.

Holmes, Campbell and Ambrae. Effect of Vitamin C on Lead Poisoning. J. Lab. & Clin. Med., *24*:1115, 1939.

Holt. Lead Poisoning in Infancy. Am. J. Dis. Child., *25*:125, 1923.

Hunter and Aub. Effect of Parathyroid Hormone on Excretion of Lead and of Calcium in Patients Suffering from Lead Poisoning. Quart. J. Med., *20*:123, 1927.

Kato. Lead Meningitis in Infants. Am. J. Dis. Child., *44*:565, 1932.

McKhann. Lead Poisoning. In Brennemann's Practice of Pediatrics. Prior, Hagerstown, 1937.

——— Lead Poisoning in Children. Am. J. Dis. Child., *32*:516, 1926.

Park, Jackson, Goodwin and Kajdi. X-ray Shadows in Growing Bones Produced by Lead. J. Pediat., *3*:265, 1933.

Schmidt et al. Bleivergiftung. Ergebn. d. ges. Med., *13*:321, 1929.

Sobel et al. Influence of Calcium, Phosphorus and Vitamin D on Lead in Blood and Bone. J. Biol. Chem., *132*:235, 1940.

Tanquerel des Planches. Lead Diseases. (Translated by Dana.) Bixby, Lowell, 1841.