INCREASED LEAD ABSORPTION AND LEAD POISONING IN YOUNG CHILDREN

A STATEMENT BY THE

CENTER FOR DISEASE CONTROL

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3 years of age who are at risk should be screened every 2 to 3 months during this period.

Screening tests for undue lead absorption and lead toxicity are essentially limited to various methods of blood lead determination and measurement of erythrocyte protoporphyrins.[14,15,16,17] Blood lead may be determined by a macro method or by one of many micro methods.

The blood lead level is the result of many factors and a single determination cannot indicate whether the observed level is increasing, decreasing, or stable. By any method, blood lead determination is an exacting laboratory procedure requiring constant attention to quality control. A micro test is usually employed in children since it requires only a sample of blood taken by finger stick. Blood lead determinations by a micro method are highly sensitive to contamination from lead on the skin during collection by finger stick. Thus, a blood lead test should be repeated on children whose initial blood lead levels are determined to be "elevated." If possible, an erythrocyte protoporphyrin test should be performed before further action is taken.

The erythrocyte protoporphyrin level can also be determined on a micro specimen. It is a simpler laboratory procedure, is not influenced by contamination of the specimen with lead, and is less subject to physiological fluctuation. More important, EP is a better index of potential toxicity from the body's lead burden and is usually elevated before clinical symptoms begin.[14,15,16,17]

Significant numbers of children with blood lead levels of 30 to 39 μg/100 ml have shown evidence of metabolic impairment as detected by EP testing. Recent evidence suggests that when blood lead levels and EP levels disagree, the EP level most reliably reflects a child's true clinical status. The EP provides a better estimate of soft tissue lead, adverse metabolic response and, hence, risk.[17,18]

However, tests for both EP and blood lead are acceptable as primary screening tests, because a negative result usually excludes lead intoxication. A positive result of either test cannot by itself establish the risk of lead poisoning. It must be realized that a percentage of elevated EP levels may be due to iron deficiency anemia and a percentage of elevated blood lead levels may be due either to external contamination of the sample by lead or to a transitory elevation from lead ingestion.

Both blood lead, a test of lead absorption, and erythrocyte protoporphyrin tests, a test of metabolic effect of lead, are necessary to fully evaluate and monitor children who are positive on screening by either method. This allows three possibilities for screening:

1. Initial screening with EP – all positive children tested for blood lead level.
2. Initial screening for blood lead level – all positive children tested for EP and repeat blood lead level.
3. Initial testing with both tests simultaneously.

The Center recommends that an EP test be used for screening for lead poisoning followed by blood lead level tests for all children with positive EP. This recommendation is made because of the greater ease and reproducibility of EP measurement and the added benefit of detecting children who may have iron deficiency. Laboratories performing these tests should participate in the Center's Proficiency Testing Program or an equivalent program to help insure accurate test results.

For uniformity, it is recommended that the results of blood lead be expressed in μg/100 ml of whole blood and the results of EP be expressed as equivalents of Free Erythrocyte Protoporphyrin (FEP) μg/100 ml of whole blood by the ethyl acetate-acetic acid HCl extraction method. The results of both EP and blood lead can be graded to establish a degree of hazard of lead intoxication.

It must be noted that, in the case of EP, elevated levels (60-189 μg/100 ml) may be due to iron deficiency anemia, but extremely elevated levels (≥190 μg/100 ml) are due almost exclusively to lead intoxication. The only exception is the rare genetic disorder, erythropoietic protoporphyria, which is characterized by severe cutaneous photosensitivity.

Interpretation of Results

The children tested may be divided into four major lead poisoning categories, or classes, by combining the results of these two tests, as shown in the table. These categories indicate the degree of risk and, therefore, urgency of medical and environmental management based on both blood lead and EP measurement (μg/100 ml whole blood).

Test	Class I Normal	Class II Minimally Elevated	Class III Moderately Elevated	Class IV Extremely Elevated
Pb	≤29	30–49	50–79	≥80
EP	≤59	60–109	110–189	≥190

The ranges of blood lead and EP were chosen to represent an approximation of the equivalent degree of risk to the child and to predict the probability of need for medical management. Presently available experience indicates that in the majority of cases, the results of EP and blood lead will fall in the corresponding range. However, in a minority of cases, there will be discrepancy between the results of the blood lead and of the EP. In these cases, the result of the EP is most likely

the basis of their screening test results are given in the following section.

V. Pediatric Management

Screening, pediatric management, and hazard control are equally important in caring for children at risk of lead poisoning. Pediatric management must include treating the child with undue lead absorption, in addition to following him until the risk of further damage is minimal. Guidelines for the management of children in various risk categories are outlined in this section.

Class IV

Class IV children, regardless of the presence or absence of clinical symptoms or of other laboratory findings, should be considered an unequivocal case of lead poisoning. Since the risk of acute lead encephalopathy is great, its onset unpredictable, and its course fulminant, these children should be hospitalized immediately for evaluation and chelation therapy. Severe and permanent brain damage may occur in as many as 80 percent of the children that develop acute encephalopathy.[25] Treatment before onset of encephalopathy will improve this grim prognosis.

Children in this group who are symptomatic, have intercurrent fever or dehydration, or are detected during summer months are at extremely high risk. This group of children, and in particular the younger child, should be given highest priority.

Lumbar puncture is unwise due to the risk of increased intracranial pressure. If lumbar puncture is necessary to rule out meningitis or other serious disease, it should be performed cautiously and only after a careful search for signs and symptoms of increased intracranial pressure.

Chisolm, Coffin, and others[26,27,28] have described appropriate protocols for inpatient chelation therapy of children with lead poisoning. It is essential to consult such references before treating children in order to properly appreciate the inherent dangers, precautions, and rationale for such treatment.

The chronicity of lead poisoning and undue lead absorption as a medical problem for the individual child must be emphasized. Children who require chelation therapy will also require long-term medical surveillance and care. "Rebound" of blood lead levels resulting from release of lead from tissue pools after an apparently successful course of chelation therapy should be anticipated. The need for repeated courses of chelation in some children — even after lead ingestion has ceased — should be recognized.

Penicillamine, though receiving increasing attention for the treatment of lead poisoning in children, is not licensed by the Food and Drug Administration (FDA) for this purpose. Therefore, any physician or program wishing to use this drug as a chelating agent for lead-poisoned children should use it in accordance with current FDA policy. In this manner, careful usage of the drug will be encouraged and useful data regarding its efficacy and safety may be obtained. In no case should it be used in children without, or in lieu of, control of lead hazard in their homes.

Reduction of lead intake is necessary for all children in Class IV, both as part of immediate therapy and as a part of the follow-up procedure. Children receiving chelation therapy should not be released from the hospital until lead hazards in their homes and elsewhere in their environment are controlled or suitable alternative housing arranged.

After hospitalization and removal of lead from their environments, children in Class IV are still at high risk and should be followed with blood lead and/or erythrocyte protoporphyrin determinations at 1-2 week intervals until those levels stabilize or show a continual decline for at least 6 months. Thereafter, they should be followed at 1-3 month intervals (at least 6-week intervals in summer months) until 6 years of age, or longer, to prevent repeated poisoning. Neurological and psychological assessment should be obtained at the time of diagnosis and in following years to detect any neurological or behavioral deviation so that proper therapy and school placement can be instituted. Additional clinical and laboratory evaluation should be conducted when indicated to assess other sequelae of lead poisoning, such as renal, myocardial, and metabolic disorders.

Class III

Class III children who have compatible symptoms which cannot be explained otherwise or who have abnormal ALA-d, urinary ALA, or urinary coproporphyrin levels should be considered as having lead poisoning and recognized as candidates for urgent inpatient medical management. All children in this class should be further evaluated by history for otherwise unexplained symptoms or signs (pica, anorexia, vomiting, abdominal pain, behavioral change, irritability, speech disturbance, ataxia, seizures) with *selected* laboratory tests (complete blood count, radiography of long bones and intestinal tract, repeat EP and blood lead, semi-quantitative urine coproporphyrin, ALA-d quantitative urinary ALA, or coproporphyrin). A thorough physical and neurological examination is particularly indicated to exclude other illnesses in symptomatic children in this category.

As noted before, lumbar puncture is unwise due to the risk of increased intracranial pressure. If lumbar puncture is necessary to rule out meningitis or other

Summary of Recommended Follow-Up

Frequency	Diagnostic Category						
	IV**	III*	II	Ia	Ib	I Age 12 – 36 months	I Age > 36 months
1 – 2 weeks	XX						
4 weeks		XX			XX		
6 weeks	X (in summer)	X (in summer)					
3 months	X (after six mos. stable)		XX	Arrange treatment of iron deficiency	X (until blood lead normal)	XX	
1 year		X (after 1st yr. of follow-up)		Follow as Group I		X	XX

* Symptomatic or treated patients in Group III should be followed as Group IV.
** After hospitalization has been completed.
X Minimal
XX Optimal

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