# AMERICAN ACADEMY OF PEDIATRICS

Committee on Environmental Health

## Screening for Elevated Blood Lead Levels

**ABSTRACT. Although recent data continue to demonstrate a decline in the prevalence of elevated blood lead levels (BLLs) in children, lead remains a common, preventable, environmental health threat. Because recent epidemiologic data have shown that lead exposure is still common in certain communities in the United States, the Centers for Disease Control and Prevention recently issued new guidelines endorsing universal screening in areas with ≥27% of housing built before 1950 and in populations in which the percentage of 1- and 2-year-olds with elevated BLLs is ≥12%. For children living in other areas, the Centers for Disease Control and Prevention recommends targeted screening based on risk-assessment during specified pediatric visits. In this statement, The American Academy of Pediatrics supports these new guidelines and provides an update on screening for elevated BLLs. The American Academy of Pediatrics recommends that pediatricians continue to provide anticipatory guidance to parents in an effort to prevent lead exposure (primary prevention). Additionally, pediatricians should increase their efforts to screen children at risk for lead exposure to find those with elevated BLLs (secondary prevention).**

ABBREVIATIONS. CDC, Centers for Disease Control and Prevention; BLL, blood lead level; AAP, American Academy of Pediatrics.

In 1991, the Centers for Disease Control and Prevention (CDC) statement *Preventing Lead Poisoning in Young Children*[1] redefined elevated blood lead levels (BLLs) as those ≥10 μg/dL and recommended a new set of guidelines for the treatment of lead levels ≥15 μg/dL. In the 1991 document, universal screening was recommended for children 9 to 72 months of age except in communities with sufficient data to conclude that children would not be at risk of exposure. Because at that time, there were few community-based data, the 1991 CDC statement, in essence, called for universal screening.

In response, the 1987 *Statement on Childhood Lead Poisoning*[2] by the American Academy of Pediatrics (AAP) was replaced in July 1993 by *Lead Poisoning: From Screening to Primary Prevention*.[3] The revised statement supported most of the 1991 CDC recommendations. Specifically, the AAP recommended "blood lead screening as part of routine health supervision for children at about 9 through 12 months of age and, if possible, again at about 24 months of age." Since publication of the 1993 AAP statement, although some areas of the United States have continued to find a high incidence of elevated BLLs,[4–6] epidemiologic investigations have identified many locales where, because of limited exposure to lead, the prevalence of elevated BLLs is so low that targeted (selective) screening is more appropriate than universal screening.[7–12] In consideration of these data, the CDC revised its 1991 guidelines. This policy statement updates the 1993 AAP statement on childhood lead screening.

Significant exposure to lead is a preventable environmental threat to optimal health and developmental outcomes for young children. Many children with elevated BLLs who require individualized management still are not being identified because of inadequate screening efforts in their communities. Conversely, recent data indicate that exposure to lead is so low in some communities that cost-benefit analyses do not justify universal screening in those areas. Against this background, the CDC, after detailed review with its Advisory Committee on Childhood Lead Poisoning Prevention, updated its screening guidelines.[13a] The revised guidelines provide, for the first time, a basis for public health authorities to decide on appropriate screening policy using local BLL data and/or housing data collected by the US Bureau of the Census. This strategy is intended to "increase the screening and follow-up care of children who most need these services, to ensure that prevention approaches are appropriate to local conditions," and to reduce unnecessary testing of children unlikely to be exposed to lead. These new recommendations will have important ramifications on pediatricians' efforts to participate in the early identification, treatment, and eradication of childhood lead poisoning.[14] In areas where universal screening is not warranted, the pediatrician's focus must be to evaluate children who may be at risk and to screen as recommended by state health departments.

### EPIDEMIOLOGY

In the most recent study (1991 to 1994) of the National Health and Nutrition Examination Survey, 2.2% of the US population had BLLs ≥10 μg/dL. The decrease in the overall mean BLL for the general US population from 12.8 to 2.8 to 2.3 μg/dL demonstrated by the three National Health and Nutrition Examination Survey investigations (1976 to 1980,

[a]Copies of this document can be obtained by request to Lead Poisoning Prevention Branch, Centers for Disease Control and Prevention, Mail Stop F 42, 4770 Buford Hwy, NE, Atlanta, GA 30341-3724, or by calling 770-488-7330. The document is also posted on the Internet at http://www.cdc.gov/nceh/programs/lead/guide/1997/guide97.htm.

The recommendations in this statement do not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

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1988 to 1991, 1991 to 1994) is dramatic.[15–18] These declines can be attributed to removal of lead from gasoline, paint, and food cans. The percentage of US children 1 to 5 years of age with BLLs ≥10 μg/dL has decreased from 88.2% to 4.4%. Of children 1 to 2 years of age, however, 5.9% had BLLs ≥10 μg/dL, with the highest rates among African-American, low-income, or urban children.[18] This means that an estimated 890 000 children in the United States have elevated BLLs ≥10 μg/dL.

Lead exposure continues to present a problem for many communities. Although poor, African-American, and urban children are the most exposed, both rural children and those from moderate to high socioeconomic status also may be exposed significantly.[19–21] Approximately 74% of privately owned and occupied housing units are likely to contain lead paint. Age and condition of housing, not geographic location, are the best predictors for the presence of hazards related to lead-based paint;[22] if a home contains lead but is well maintained, risk of exposure to lead is substantially lower compared with the risk from living in a home with chipping paint or window frames and sills in poor condition.

## NEURODEVELOPMENTAL EFFECTS OF LEAD

No threshold for the toxic effects of lead has been identified. The impact of lead exposure on cognition in young children at BLLs ≥10 μg/dL has been amply demonstrated,[23] and the literature is remarkably consistent.[23–25] The magnitude of the effect of blood lead on IQ in young children has been estimated as an average loss of two to three points for BLLs averaging 20 μg/dL, compared with BLLs averaging 10 μg/dL.[23,26–28]

A number of studies recently reviewed by the National Research Council found an association between lead levels and intellectual function in children.[23] In one population, for example, moderately increased body lead burden (defined as a dentine lead level of >24 ppm, corresponding with a peak BLL of >30 μg/dL) was correlated with an increase in the percentage of children with severe deficits (ie, IQ <80) from an expected 4% to 16% and a decrease in the percentage of children with an IQ ≥125 from an expected 5% to 0%.[29,30]

In recent years, research has been directed to other aspects of the developmental neurotoxicity of lead. This research has been aided by the creation of instruments that provide valid, reliable measures of attention, behavior, and other aspects of neurodevelopment. Using these instruments, some investigators have identified associations between lead exposure and weaknesses in attention/vigilance,[31] aggression, somatic complaints, and antisocial or delinquent behaviors.[32,33] Other adverse neurodevelopmental sequelae that have been associated with low to moderate elevated BLLs include reduction in auditory threshold,[34,35] abnormal postural balance,[36] poor eye–hand coordination, longer reaction times,[29] and sleep disturbances.[37] Other studies have failed to confirm many of these results. Although these findings may be statistically significant, in some cases they may not be clinically significant.

## PRIMARY PREVENTION: ABATEMENT, ASSESSMENT, AND ANTICIPATORY GUIDANCE

Primary prevention of lead ingestion through the provision of anticipatory guidance is a major role of pediatricians. It is through education about common sources of lead, such as paint and dust, and less common sources, such as water or contaminated soil, that parents can take measures to minimize their child's exposure to lead. Also, discussions about nutrition and the importance of dietary iron may help prevent elevated BLLs. Educational brochures are available from the AAP to assist in preventive education.

Public health efforts to prevent lead exposure through the removal of environmental lead hazards continue to be a most effective measure. The child's residence and site of routine care are most important, because high lead exposures occur most frequently where children spend the majority of their time. Housing data from the Bureau of the Census, in combination with blood lead data when available from screening, can help prevent lead exposure by identifying neighborhoods in need of abatement. Financing through local, state, and federal loan and grant programs may be available in many communities through health departments or housing offices.

## SECONDARY PREVENTION THROUGH LEAD SCREENING

Lead poisoning and its sequelae can be prevented by blood lead screening followed, when appropriate, by education and case management, as well as by environmental abatement to prevent lead exposure in siblings and playmates. However, a 1994 national telephone survey showed that only one quarter of young children and only one third of poor children, who are at higher risk of lead exposure, had been screened.[38] The AAP surveyed its members and found that slightly more than half stated that they routinely screened their patients younger than 37 months of age.[39] The revised CDC guidelines are a response to poor screening of high-risk children and to concerns about wasting resources by universal screening in low-risk settings.[13] The 1997 CDC publication provides comprehensive guidance to public health authorities for developing a screening policy based on local blood lead and housing age data. The goal of the new CDC screening recommendations remains unchanged: to ensure that children at risk of exposure to lead are tested. Universal screening still is the policy for communities with inadequate data on the prevalence of elevated BLLs and in communities with ≥27% of the housing built before 1950. Targeted screening is recommended in communities where <12% of children have BLLs ≥10 μg/dL or where <27% of houses were built before 1950, based partially on an analysis suggesting that the benefits of universal screening outweigh the costs only when the prevalence of elevated BLLs is in the range of 11% to 14% or higher.[13]

Public health authorities in each state are responsible for setting state and local policy on childhood lead screening. Pediatricians should rely on the pol-



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icies promulgated by their health officials to set practice-specific standards. They also should be involved, both individually and through their AAP chapters, in the development of local screening policies. Areas as large as counties and as small as some determined by ZIP codes or census tracts have practical utility for identifying children appropriate for either universal or targeted screening. In a targeted screening locale, the decision to perform a lead test on a child should be based in part on the responses to a community-specific risk-assessment questionnaire.[1,5,11–13] All questionnaires should include the following three risk assessment questions. Children whose parents respond "yes" or "not sure" to any of these three risk-assessment questions should be considered for screening: 1) Does your child live in or regularly visit a house or child care facility built before 1950?; 2) Does your child live in or regularly visit a house or child care facility built before 1978 that is being or has recently been renovated or remodeled?; 3) Does your child have a sibling or playmate who has or did have lead poisoning?

Other candidates to be considered for targeted screening include children 1 to 2 years of age living in housing built before 1950 situated in an area not designated for universal screening (especially if the housing is not well maintained), children of ethnic or racial minority groups who may be exposed to lead-containing folk remedies, children who have emigrated (or been adopted) from countries where lead poisoning is prevalent, children with iron deficiency, children exposed to contaminated dust or soil, children with developmental delay whose oral behaviors place them at significant risk for lead exposure,[40] victims of abuse or neglect,[41,42] children whose parents are exposed to lead (vocationally, avocationally, or during home renovation), and children of low-income families who are defined as receiving government assistance (Supplemental Feeding Program for Women, Infants, and Children; Supplemental Security Income; welfare; Medicaid; or subsidized child care). According to the CDC, children who receive government assistance and who live in areas where targeted screening is recommended do not require screening if they are at low risk based on the screening questionnaire (see Table 1) and if $<12\%$ of the children have BLLs $\geq 10$ $\mu$g/dL in that community.

In addition to screening of children on the basis of risk questionnaires, screening for lead exposure should be considered in the differential diagnosis of children with unexplained illness such as severe anemia, seizures, lethargy, and abdominal pain.

The standard procedure to determine BLLs requires a blood sample that has been collected properly by venipuncture and analyzed accurately.[1] When feasible, venous blood samples should be used for initial screening. A capillary (fingerstick) blood sample may be a practical screening alternative. When collected properly (Table 2), the capillary specimen can approach the venous blood sample in accuracy.[43] A poorly collected fingerstick sample is contaminated easily by environmental lead, thereby increasing the false-positive rate. Fingerstick values $>10$ $\mu$g/dL should be confirmed with a venous blood sample.

The laboratory technique used to measure BLLs must have a high degree of accuracy. Use of a laboratory that participates in a proficiency testing program is necessary to prevent the misidentification (both false-negative and false-positive findings) of lead exposure.[43,44] Laboratories participating in a proficiency program can be determined by calling the CDC. The CDC blood lead proficiency program allows an error of $\pm 4$ $\mu$g/dL.[45] A recently developed portable machine that reliably measures BLLs may provide a means of rapid, accurate screening.[46] The measurement of erythrocyte protoporphyrin, used formerly as the primary lead screening tool, is insensitive for BLLs $<35$ $\mu$g/dL and should not be used.

## MANAGEMENT OF ELEVATED BLLS

The toxicity of lead is a function of the dose, the duration of exposure, and the developmental and nutritional vulnerability of the child. It is the role of the pediatrician to give realistic reassurance that early detection and source control in children found to have high BLLs can minimize the consequences for the child.

Recommendations by the AAP regarding the urgency and extent of follow-up, which differ slightly from those of the CDC, depend on the risk classification and on confirmed venous BLLs (Table 3). The first step is to perform a confirmatory venous BLL. This should be performed immediately if the screening result is $>70$ $\mu$g/dL; within 48 hours if the result is between 45 and 69 $\mu$g/dL; within 1 week if the result is 20 to 44 $\mu$g/dL; and within 1 month if the result is 10 to 19 $\mu$g/dL.

In children with BLLs of 10 to 14 $\mu$g/dL, a point source of lead exposure is usually not found. Therefore, general education on measures to reduce lead exposure may be useful to parents. If the confirmatory BLL still is between 10 and 14 $\mu$g/dL, BLL

**TABLE 1.** A Basic Personal-Risk Questionnaire*

| | | |
|---|---|---|
| ____Yes | ____No | 1. Does your child live in or regularly visit a house or child care facility built before 1950? |
| ____Yes | ____No | 2. Does your child live in or regularly visit a house or child care facility built before 1978 that is being or has recently been renovated or remodeled (within the last 6 months)? |
| ____Yes | ____No | 3. Does your child have a sibling or playmate who has or did have lead poisoning? |

* Adapted from the Centers for Disease Control and Prevention.[13] The state or local health department may recommend alternative or additional questions based on local conditions. If the answers to the questions are "no," a screening test is not required, although the provider should explain why the questions were asked to reinforce anticipatory guidance. If the answer to either question is "yes" or "not sure," a screening test should be considered.



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**TABLE 2.** Proper Technique for Capillary (Fingerstick) Lead Sampling*

| |
|---|
| Preparing for blood collection |
| Use well-trained personnel |
| Clean work environment, use appropriate waste containers |
| All equipment should be within reach |
| Preparing the finger for puncture |
| Personnel should wear examination gloves throughout the procedure |
| Thoroughly clean the child's finger with soap and water |
| Briefly massage the fleshy portion of the finger gently |
| Clean the finger pad to be punctured with an alcohol swab; dry with sterile gauze or a cotton ball |
| Puncturing the finger† |
| Grasp the finger and quickly puncture it with a sterile lancet |
| Wipe off the first droplet of blood with the sterile gauze or cotton ball |
| Let a well-beaded drop of blood form at the puncture site |
| Do not let blood run down the finger or onto the fingernail |
| Specimen collection |
| Continue to grasp the finger, touch the tip of the collection container to the beaded drop of blood |
| When the container is full, cap or seal the container |
| Agitate the specimen to mix the anticoagulant through the blood |
| Label and store specimen properly |
| Common causes of contaminated (falsely elevated) specimens |
| Inadequate use of gloves by personnel |
| Use of alcohol wipes with lead-based ink |
| Inadequate cleansing of the child's finger |
| Failure to wipe off first drop of blood |

* Adapted from the Centers for Disease Control and Prevention, 1991.[1]

† Use of the heel is advised for infants younger than 1 year.

testing should be repeated within 3 months.[13] For children with BLLs of 15 to 19 μg/dL, the pediatrician should take a careful environmental history. The history should be tailored to the family characteristics and the pediatrician's practice setting; potential questions include those about housing and child care facilities, use of folk remedies and imported pottery, lead testing results among siblings and playmates, and personal habits (eg, hand-washing, hobbies, or occupations that may involve lead). Parents should receive guidance about interventions to reduce BLLs, including environmental hazard reduction as well as optimal nutrition. Nutritional interventions including iron and calcium supplementation, a reduced-fat diet, and frequent meals should be considered because all are associated with reduced gastrointestinal absorption of ingested lead.[13] If the confirmatory BLL is still between 15 and 19 μg/dL, BLL testing should be repeated within 2 months.

Individualized case management, which includes a detailed medical history, nutritional assessment, physical examination, environmental investigation, and hazard reduction, begins at a BLL of ≥20 μg/dL. Chelation therapy may be considered, but is not recommended routinely at BLLs <45 μg/dL.[47] Consultation with clinicians who are experienced in lead chelation is useful in making the decision to chelate an individual child.[48] Support services from other professionals, including visiting nurses and environmental health specialists, are essential in providing assistance with environmental assessment, lead abatement, or alternative housing.

Childhood lead exposure continues to be a public health problem. The following recommendations address the need for more realistic and cost-effective screening methods, follow-up, and environmental abatement programs.

## RECOMMENDATIONS TO PEDIATRICIANS

1. Pediatricians should provide anticipatory guidance to parents of all infants and toddlers. This includes information on potential risk factors for

**TABLE 3.** Recommended Follow-up Services, According to Diagnostic BLL

| BLL (μg/dL) | Action |
|---|---|
| <10 | No action required |
| 10–14 | Obtain a confirmatory venous BLL within 1 month; if still within this range,<br>Provide education to decrease blood lead exposure<br>Repeat BLL test within 3 months |
| 15–19 | Obtain a confirmatory venous BLL within 1 month; if still within this range,<br>Take a careful environmental history<br>Provide education to decrease blood lead exposure and to decrease lead absorption<br>Repeat BLL test within 2 months |
| 20–44 | Obtain a confirmatory venous BLL within 1 week; if still within this range,<br>Conduct a complete medical history (including an environmental evaluation and nutritional assessment) and physical examination<br>Provide education to decrease blood lead exposure and to decrease lead absorption<br>Either refer the patient to the local health department or provide case management that should include a detailed environmental investigation with lead hazard reduction and appropriate referrals for support services<br>If BLL is >25 μg/dL, consider chelation (not currently recommended for BLLs <45 μg/dL), after consultation with clinicians experienced in lead toxicity treatment |
| 45–69 | Obtain a confirmatory venous BLL within 2 days; if still within this range,<br>Conduct a complete medical history (including an environmental evaluation and nutritional assessment) and a physical examination<br>Provide education to decrease blood lead exposure and to decrease lead absorption<br>Either refer the patient to the local health department or provide case management that should include a detailed environmental investigation with lead hazard reduction and appropriate referrals for support services<br>Begin chelation therapy in consultation with clinicians experienced in lead toxicity therapy |
| ≥70 | Hospitalize the patient and begin medical treatment immediately in consultation with clinicians experienced in lead toxicity therapy<br>Obtain a confirmatory BLL immediately<br>The rest of the management should be as noted for management of children with BLLs between 45 and 69 μg/dL |



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lead exposure and specific prevention strategies (Table 4) that should be tailored for the family and for the community in which care is provided.
2. Pediatricians, in conjunction with local health agencies, should help develop risk assessment questionnaires that supplement the standard questions recommended by the CDC (Table 1).
3. Pediatricians should screen children at risk. To prevent lead poisoning, lead screening should begin at 9 to 12 months of age and be considered again at ~24 months of age when BLLs peak. The CDC developed explicit guidance to state health departments for developing community screening policies. In communities where universal screening is recommended, pediatricians should follow this recommendation. In communities where targeted screening is recommended, pediatricians should determined whether each young patient is at risk and screen when necessary. Managed health care organizations and third-party payors should cover fully the costs of screening and follow-up.
4. A history of possible lead exposure should be assessed periodically between 6 months and 6 years of age, using community-specific risk-assessment questions (Table 4). Blood lead testing also should be considered in abused or neglected children and in children who have conditions associated with increased lead exposure.
5. Pediatricians individually and through AAP chapters should be actively involved and provide input in state and local community recommendation development.

## RECOMMENDATIONS TO GOVERNMENT

1. Testing and treating children for lead exposure must be coupled with public health programs to ensure environmental investigation, transitional lead-safe housing assistance, and follow-up for individual cases. Lead screening programs in high-risk areas should be integrated with other housing and public health activities.
2. The AAP supports efforts of environmental and housing agencies to eliminate lead hazards from housing and other areas where children may be exposed. These include financial incentives that can be used to promote environmental abatement. Training and certification of abatement workers are needed to avoid additional lead exposure during deleading activities. Local health authorities should provide oversight of abatement activities to ensure that additional environmental contamination does not occur. Also, less expensive, safe technologies for abatement are needed to make primary prevention efforts more cost-effective.
3. The AAP supports legislation to reduce the entry of lead into the environment and into consumer products with which children may come in contact.
4. Government, like the medical community, should focus its efforts on the children who are most at risk. To do this, more data about the prevalence of elevated BLLs in specific communities are needed. A better understanding of the distribution of lead in the environment would allow more efficient screening efforts.
5. Research is needed to determine the effectiveness of various strategies to prevent and treat lead poisoning, to compare methods for abating lead in households, and to determine the effectiveness of chelating agents with long-term follow-up through controlled trials. Studies to determine the effectiveness and cost of educational interventions also are needed.
6. The CDC should review studies of the efficacy of lead screening and monitor the scientific literature to ensure that screening is being performed in the most public health-protective, least intrusive, and most cost-effective manner possible. In particular, the risk-assessment questions, follow-up recommendations, and models of case management need periodic reevaluation.
7. Federal and state government agencies and legislative bodies should require coverage of lead testing

**TABLE 4.** Risk Factors for Lead Exposure and Prevention Strategies

| Risk Factor | Prevention Strategy |
|---|---|
| Environmental | |
| Paint | Identify and abate |
| Dust | Wet mop, frequent handwashing |
| Soil | Restrict play in area, ground cover, frequent handwashing |
| Drinking water | 2-minute flush of morning water; use of cold water for cooking, drinking |
| Folk remedies | Avoid use |
| Old ceramic or pewter cookware, old urns/kettles | Avoid use |
| Some imported cosmetics, toys, crayons | Avoid use |
| Parental occupations | Remove work clothing at work |
| Hobbies | Proper use, storage, and ventilation |
| Home renovation | Proper containment, ventilation |
| Buying or renting a new home | Inquire about lead hazards |
| Host | |
| Hand-to-mouth activity (or pica) | Frequent handwashing |
| Inadequate nutrition | High iron and calcium, low-fat diet; frequent small meals |
| Developmental disabilities | Frequent screening |



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for at-risk children by all third-party payors, by statute or by regulation.

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