American College of Preventive Medicine Practice Policy Statement
Screening for Elevated Blood Lead Levels in Children
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Abstract: Based on a review of the current literature and recommendations, the American College of Preventive Medicine presents a practice policy statement on screening for elevated blood lead levels in children.


Burden of Suffering

Lead poisoning is one of the most common diseases of environmental origin among children in the United States today. Children are at particular risk because of their developing nervous systems, increased hand-to-mouth activities, and increased ability to absorb lead. Although average blood lead levels have declined in recent years, nearly 4.4% of children between the ages of 1 and 5 years, or 890,000 children, have blood lead levels at or above the current recommended cut-off level of 10 mcg/dL. The burden of lead exposure is unevenly distributed geographically, economically, and racially/ethnically. For example, about 22% of African-American children and 16% of low-income children aged 1 to 5 years living in houses built before 1946 have elevated blood lead levels. In contrast, 0.6% of children under 6 years of age receiving Medicaid in Alaska and 2% of children aged 1 to 6 years in a California managed care organization have elevated blood lead levels.

Major sources of lead exposure to children include lead-based paint and lead-containing dust, soil, and water. Children may also be exposed to lead contained in ceramics, lead-soldered cans, and folk remedies/cosmetics. Until recently, leaded gasoline was a major source of lead exposure; however, lead was gradually phased out of gasoline beginning in 1975 and removed completely by 1995. Exposure to lead may have significant health effects on children. Acutely, lead has been shown to significantly affect the renal, neurologic, gastrointestinal, and hematopoietic systems, causing anemia, colic, nephropathy, encephalopathy, and death. Chronic low-level exposure may result in cognitive and behavioral changes and learning disabilities. Economic costs of lead poisoning are significant: Costs for inpatient treatment alone of children aged under 5 years totaled over $8 million per year from 1988 to 1992.

Description of Screening and Preventive Measures

Primary prevention, such as removing lead from gasoline, banning lead-based paint, and removal of lead solder in cans, has had a dramatic effect on the lead burden within the pediatric population, and has markedly reduced exposure to and morbidity from lead poisoning. These preventive measures have helped to decrease the geometric mean blood lead levels for children aged 1 to 5 years from 15.0 mcg/dL (1976–1980) to 2.7 mcg/dL (1991–1994). As lead-based paint is now the primary source of lead exposure in the United States, progress toward lead-safe housing is likely to be much more important to continued decreases in lead poisoning than are screening and treatment.

Secondary prevention is based on the identification of chronically exposed children through screening, thereby reducing the duration, intensity, and consequences of exposure. The interventions triggered by elevated blood lead levels depend on the degree of elevation, and are summarized in Table 1.

The principal screening method for detection of elevated lead levels is the blood lead level. This test is performed with accuracy to within 4 mcg/dL. Screening may be performed using either venous or capillary samples. Capillary samples are easier to obtain but they may be less accurate because of contamination by lead present on the skin. Careful cleaning of the skin prior to fingerstick may decrease contamination and increase accuracy. Unfortunately, capillary samples...
may ultimately be more expensive than venous samples because of the need for confirmation of elevated levels using venous blood. Free erythrocyte protoporphyrin (FEP) determinations have been used in the past as a screening test for elevated lead levels. However, FEP has been found to be inaccurate at blood lead levels below 25 mcg/dL, and is not currently recommended for blood lead screening.

Screening questionnaires have also been utilized in order to determine which children are at high risk for lead poisoning, and therefore should be targeted for lead measurement. The 1997 questionnaire presented by the Centers for Disease Control and Prevention (CDC) is included in Table 2. This table also includes two questions from the 1991 CDC questionnaire that were not retained in the 1997 version. In an attempt to increase the sensitivity of the questionnaire, other authors have added questions about behavioral risk factors, such as use of pacifier; eating dirt, paint chips, or other items; use of home remedies; country of origin; and proximity of the home to a busy street.

Evidence of Effectiveness

Accuracy of blood lead screening tests may vary from one laboratory to another. Laboratories that participate in proficiency testing programs, such as that sponsored by the CDC and the Health Resources and Services Administration (HRSA) may provide more accurate results. A 1991 review of commercial labs participating in this program found that most labs could achieve results that were accurate to within 2 mcg/dL. A more recent review of such labs found that sensitivity for blood lead values \( \geq 10 \) mcg/dL was 87.5% and specificity for values \(< 10 \) mcg/dL was 100%. The positive predictive value of blood lead screening is naturally lower in communities where there is a low prevalence of lead poisoning.

### Table 1. Recommended follow-up services according to blood lead level (BLL)

<table>
<thead>
<tr>
<th>BLL (mcg/dl)</th>
<th>Action</th>
</tr>
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<tbody>
<tr>
<td>&lt;10</td>
<td>No action required.</td>
</tr>
<tr>
<td>10–14</td>
<td>Obtain a confirmatory venous BLL within 1 month; if still within this range, provide education to decrease blood lead exposure. Repeat BLL test within 3 months.</td>
</tr>
<tr>
<td>15–19</td>
<td>Obtain a confirmatory venous BLL within 1 month; if still within this range, take a careful environmental history. Provide education to decrease blood lead exposure and to decrease lead absorption. Repeat BLL within 2 months.</td>
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<tr>
<td>20–44</td>
<td>Obtain a confirmatory venous BLL within 1 week; if still within this range, conduct a complete medical history (including an environmental evaluation and nutrition assessment) and physical exam. Provide education to decrease blood lead exposure and to decrease lead absorption. 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. If BLL is ( &gt; 25 ) mcg/dL, consider chelation (not currently recommended for BLLs (&lt; 45 ) mcg/dL), after consultation with clinicians experienced in lead toxicity treatment.</td>
</tr>
<tr>
<td>45–69</td>
<td>Obtain a confirmatory venous BLL within 2 days; if still within this range, conduct a complete medical history (including an environmental evaluation and nutrition assessment) and physical exam. Provide education to decrease blood lead exposure and to decrease lead absorption. 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. Begin chelation therapy in consultation with clinicians experienced in lead toxicity therapy.</td>
</tr>
<tr>
<td>( \geq 70 )</td>
<td>Hospitalize the patient and begin medical treatment immediately in consultation with clinicians experienced in lead toxicity therapy. Obtain a confirmatory BLL immediately. The rest of the management should be as noted for management of children with BLLs between 45 and 69.</td>
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### Table 2. 1997 CDC basic personal risk questionnaire for lead exposure

1. Does your child live in or regularly visit a house that was built before 1950? This question could apply to a facility such as a home daycare center or the home of a babysitter or relative.
2. Does your child live in or regularly visit a house built before 1978 with recent or ongoing renovations or remodeling (within the last 6 months)?
3. Does your child have a sibling or playmate who has or did have lead poisoning?

Screen all children whose parent/guardian responds “yes” or “don’t know” to any question.

*The 1991 CDC Basic Personal Risk Questionnaire for Lead Exposure included the above three questions in addition to the following two questions:

1. Does your child live with an adult whose job or hobby involves exposure to lead?
2. Does your child live near an industry that is likely to release lead (such as a battery plant, lead smelter, or manufacturing plant where lead may be used)?
of elevated lead levels. Targeted screening, in which blood lead levels are measured only in those children determined to be at risk by a screening questionnaire, increases the positive predictive value at the cost of missing children with lead poisoning who have no obvious risk factors. The sensitivity of the 1991 CDC questionnaire has been found to be highly variable, ranging from 30% in a low-prevalence community to 70% to 75% in higher-prevalence communities. Sensitivity of other questionnaires has also been quite variable.

Although its effectiveness has been debated in the pediatric literature in recent years, early detection and treatment for elevated lead levels are important to ensure that lead hazards are removed. Early detection may lead to a number of interventions, including chelation therapy, lead abatement (encapsulation, enclosure, removal, and/or replacement of lead sources within the home), parent education, and/or nutrition management. The effectiveness of counseling families to reduce lead exposure has not been well established. One study employing home visits as a method for counseling families did show declines in blood lead levels; however, no control group was used, and declines could have been caused by regression to the mean, or natural declines in lead levels over time. A more recent study employing a comparison group did show declines in blood lead levels following the intervention, but this study was retrospective and nonrandomized. Clinical trials have not been performed to assess the effectiveness of nutrition interventions in children. However, data from animal trials and from adults suggest that nutrition strategies, such as avoidance of fasting, decreasing fat intake, and increasing iron and calcium intake, may be effective in reducing lead absorption.

Reviews of the effectiveness of abatement provide mixed results. Abatement has been shown to be effective for blood lead levels above 30 mcg/dL and some recent evidence has suggested that abatement may be effective at blood lead levels of less than 20 mcg/dL. Newer techniques for conducting lead abatement, which may involve mechanically blocking rather than removing lead hazards, may be more effective than older methods, but most have not yet been well evaluated. While some methods of lead hazard reduction such as dust control are effective at reducing lead dust exposure and blood lead levels, other methods, such as soil abatement are ineffective.

Chelation therapy has been recommended only for children with blood lead levels at or above 45 mcg/dL. It is never recommended at levels lower than 25 mcg/dL, and usually not indicated at levels from 25 to 44 mcg/dL, except in the context of an approved research study. Evidence has supported the benefit of chelating agents for children with symptomatic lead poisoning, but few studies have compared the benefits of chelation with the adverse effects of treatment in asymptomatic children. While chelation therapy has been shown to decrease blood lead levels, few studies have evaluated cognitive outcomes. Some studies have shown small improvements in cognitive function, but the significance of these findings has been questioned. The effectiveness of chelation therapy must also be balanced by the adverse effects associated with such treatment, which may include renal, hepatic, hematologic, and gastrointestinal toxicity.

Public Policy Considerations

Several public policy issues, including cost-effectiveness and provider compliance, must be considered in developing lead screening policies. A recent cost-effectiveness analysis of lead screening among 1-year-old children found that the cost of universal lead screening exceeded the benefits when the prevalence of elevated lead levels in a community was below 14% (range 11% to 17%). The authors used a societal perspective and conducted a sensitivity analysis using the best- and worst-case scenarios of the effects of education, environmental management, and chelation therapy. However, the study did not account for the costs of determining the initial prevalence of elevated lead levels within a community. Another recent study found that targeted screening incurred both lower costs per child and lower costs per case as compared to universal screening in low- (≤5.9% elevated lead levels) and medium- (6% to 12% elevated lead levels) prevalence communities. Previous studies have shown that even when universal screening was recommended by the CDC, only 27% to 53% of providers complied with universal screening recommendations, and many providers did not believe that universal screening was necessary among their patient population. Furthermore, sufficient laboratories to provide for universal blood lead screening do not currently exist in the United States.

Recommendations of Other Groups

Most major medical and public health organizations currently recommend targeted screening for elevated lead levels. The CDC recently updated its recommendations, and now recommends universal screening among children receiving Medicaid or the Supplemental Food Program for Women, Infants, and Children (WIC), in areas with ≥27% of housing built before 1950 and in populations in which the percentage of 1- and 2-year-olds with elevated blood lead levels is ≥12%. The CDC recommends targeted screening based on risk assessment for all other children. The CDC recommends that states develop specific plans for targeted screening based on local data and an inclusive planning process. Until these plans are developed, the
CDC recommends universal screening of children aged 6 months to 6 years. The American Academy of Pediatrics has concurred with these recommendations. The U.S. Preventive Services Task Force, the Canadian Task Force on the Periodic Health Examination, and the American Academy of Family Physicians support targeted screening policies for children who are at high risk for lead exposure.

Rationale Statement

Targeted screening for elevated lead levels is less costly from a societal perspective than universal screening in all but high-prevalence communities. Furthermore, there is little support among providers for universal lead screening, and sufficient laboratories to provide universal screening do not currently exist. Early detection of elevated lead levels may lead to earlier initiation of treatment. The CDC and AAP recommend assessment and intervention at blood lead levels ≥20 mcg/dL. Chelation has been shown to be effective in treating lead levels ≥45 mcg/dL, while lead abatement has been shown to be effective in treating blood lead levels >30 mcg/dL, and may be effective at lower lead levels. Lead abatement within the home may both help reduce lead levels and prevent further lead exposure to the patient and to family members. Identification of elevated lead levels in high-risk children also allows for the introduction of behavioral and nutrition interventions that may be effective in reducing blood lead levels.

Recommendations of the American College of Preventive Medicine

Screening for elevated lead levels via venous or capillary blood lead testing should be conducted for children aged 1 year only if they are identified as being at high risk for elevated blood lead levels. Criteria for being at high risk include: receipt of Medicaid or WIC, living in a community with ≥12% prevalence of BLLs at ≥10 mcg/dL, living in a community with ≥27% of homes built before 1950, or meeting one or more high-risk criteria of a lead-screening questionnaire. This questionnaire should include both questions suggested by the CDC in their 1997 guidelines, as well as questions developed for and tailored to specific communities. These questions may pertain to use of home remedies and cosmetics, country of origin, and/or behavioral risk factors. Risk assessment for lead exposure should be performed beginning during prenatal visits and continuing until 6 years of age.

Further research is needed to assess the effectiveness of interventions to reduce blood lead levels. Research should be conducted to better elucidate the cognitive effects of chelation therapy, and to evaluate the effectiveness of newer abatement technologies on both blood lead levels and neurocognitive outcomes. More research is also needed to assess the effectiveness of nutrition interventions in children, and of parental education to remove lead from the home. Risk factor assessment tools such as questionnaires should be better evaluated as well, in order to better elucidate their reliability, sensitivity, specificity, and generalizability.

All laboratories that test blood lead levels should participate in blood lead proficiency testing programs such as the collaborative program between CDC and HRSA. Primary prevention strategies, such as progress toward increased lead-safe housing should be continued and encouraged. Recommendations for specific interventions beyond what is indicated in Table 1 are beyond the scope of this statement.

Summary for Practice Guidelines Committee

The U.S. Preventive Services Task Force (USPSTF) recommends that all children at increased risk for lead exposure have blood lead–level screening for children aged 12 months. Children with increased risk are defined by the USPSTF as those with identifiable risk factors or those living in communities with a high or undefined prevalence of elevated lead levels. Screening questionnaires are recommended to identify risk factors for elevated lead levels. The USPSTF does not specify a population prevalence at which to switch from targeted screening to universal screening because the Task Force could not find sufficient evidence to support a specific cut-off level.

Since the publication of the USPSTF’s Guide to Clinical Preventive Services, however, at least two cost-effectiveness analyses have been published that support a switch from targeted to universal blood lead screening at a community prevalence of approximately 12% to 14%. The CDC has recommended a transition from targeted to universal screening at 12% prevalence based on the study by Briss, et al. It is for this reason that we have recommended the switch in screening methods at a community prevalence of 12%. Given the data presented in the CDC guidelines, we also support the CDC recommendation that all children living in communities with ≥27% of homes built before 1950 should be screened for elevated lead levels, although no specific percentages are given in the USPSTF recommendations.

References


Additional References Reviewed But Not Cited


Hanz MN, Gerson M, Ziahska BA. Identification of children at risk for lead poisoning: an evaluation of routine blood lead screening in an HMO-insured population.