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CDC now uses a blood lead reference value of 5 micrograms per deciliter to identify children with blood lead levels that are much higher than most children's levels. This new level is based on the U.S. population of children ages 1-5 years who are in the highest 2.5% of children when tested for lead in their blood.

This reference value is based on the 97.5th percentile of the National Health and Nutrition Examination Survey (NHANES)'s blood lead distribution in children.

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Screening Young Children for Lead Poisoning:

Guidance for State and Local Public Health Officials

Centers for Disease Control and Prevention
November 1997

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

Screening Young Children for Lead Poisoning:

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Centers for Disease Control and Prevention
David Satcher, M.D., Ph.D., Director

National Center for Environmental Health
Richard J. Jackson, M.D., M.P.H., Director
Division of Environmental Hazards and Health Effects
Henry Falk, M.D., Director
Lead Poisoning Prevention Branch
Jerry Hershovitz, Chief
Nancy Tips, Associate to the Chief for Planning and Evaluation

U.S. Department of Health and Human Services, Public Health Service
November 1997

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Foreword

We find ourselves at a crossroads. On the one hand, blood lead levels in the U.S. population continue to decline, offering the hope that lead poisoning can be eliminated in the not too distant future. On the other hand, children, who are most vulnerable to the harmful effects of lead, continue to be exposed to this toxicant at an unacceptable rate. Some 890,000 U.S. children have lead levels high enough to cause adverse effects on their ability to learn, mainly because of exposure to deteriorating lead-based paint in their homes. To better protect our children, we must step up our efforts to identify those with elevated blood lead levels so that they can receive the care they need.

At present, too many children with elevated lead levels are not being identified. More effective screening is necessary and must be focused where children are most likely to benefit. The policy outlined in this document has two main purposes: to increase screening and follow-up care of children who most need these services, and to help communities pursue the most appropriate approach to the prevention of childhood lead poisoning. In some places, the level of risk for lead exposure may not justify the screening of all children. In many other places, more screening than is currently being done will be necessary.

The process described in the pages that follow will succeed or fail to the extent that it is embraced by state and local health departments, Medicaid agencies, health-care providers,

and other community members. Chapter 3 contains our recommendations for developing screening that is responsive to community situations and needs. We believe that the community should be involved in planning and carrying out screening, and we have tried to outline a process that is easy to follow, even though it involves complex decisions. The Centers for Disease Control and Prevention (CDC) will continue to support state and local public health agencies as they lead the development of statewide screening plans, and our agency stands ready to guide and encourage communities in all facets of lead poisoning prevention. In its effort to combat lead poisoning among children, CDC works with other Federal agencies, especially the Department of Housing and Urban Development (HUD) and the Environmental Protection Agency (EPA), through a combination of regulation, guidance, technical assistance, and funding support.

I want to thank the members of the CDC Advisory Committee, our consultants, and all who have contributed their time and talents to this guidance. I believe that the approach described in these pages will move the nation closer to its goal of eliminating childhood lead poisoning. Certainly, the children of this nation deserve no less.

Richard J. Jackson, M.D., M.P.H.
Director
National Center for Environmental Health

Preface

This guidance on childhood lead screening was developed by CDC in consultation with the members and consultants of the Advisory Committee on Childhood Lead Poisoning Prevention. The committee comprises non-Federal experts drawn from health departments, pediatric practices, managed-care organizations, academia, and non-governmental agencies working on affordable housing and public lead poisoning prevention education. The guidance was also reviewed by childhood lead poisoning prevention program managers and was available during a 6-week period for public comment. The final document is from CDC and does not necessarily reflect the views of all members of the advisory committee.

In 1991, the U.S. Public Health Service (PHS) called for a society-wide effort to eliminate childhood lead poisoning in 20 years (CDC, 1991), and in 1997, PHS remains committed to this goal. Childhood lead screening should be part of a comprehensive program to reach this goal. Chapter 3 of this document discusses the development of statewide plans for childhood blood lead screening. The purpose of these plans is to increase the screening and follow-up care of children who most need these services and to ensure that screening is appropriate for local conditions.

The main intended audience for this guidance is state and local health officials; however, it may also be used by

child health-care providers, managed-care organizations, and others.

Several topics are not covered or are considered only briefly in this document. Some of these topics have been recently considered by other groups:

- Health effects and sources and pathways of exposure (National Research Council, 1993).
- Chelation therapy (American Academy of Pediatrics, 1995).
- Controlling lead hazards in the home (U.S. Department of Housing and Urban Development, 1995).
- National policy for controlling lead hazards in housing (Lead-Based Paint Hazard Reduction and Financing Task Force, 1995).

The continued expansion of knowledge about childhood lead poisoning prevention will be reflected in future changes in CDC guidance.

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Advisory Committee on Childhood Lead Poisoning Prevention

Chairperson
J. Routt Reigart, II, MD
Professor of Pediatrics
Medical University of South Carolina
171 Ashley Avenue
Charleston, SC 29425

Executive Secretary
Henry Falk, MD
Director, Division of Environmental Hazards and Health Effects
National Center for Environmental Health
Centers for Disease Control and Prevention
Atlanta, GA 30341–3724

Members
Isabella J. Clemente, CPNP
Associate Director, Division of Environmental Sciences
Pediatric Clinics
Montefiore Medical Center
Moses 401
111 East 210th Street
Bronx, NY 10467

Cushing N. Dolbeare
Consultant on Housing and Public Policy
215 Eighth Street, NE
Washington, DC 20002–6105

Alvaro Garza, MD, MPH
Health Officer, Stanislaus County
820 Scenic Drive
Modesto, CA 95350

Rita Marie Gergely
Director, Lead Poisoning Prevention Programs
Iowa Department of Public Health
Lucas State Office Building
Des Moines, IA 50319–0075

Andrew K. Goodman, MD
Assistant Commissioner, Division of Community and
Occupational Health
New York City Department of Health
125 Worth Street
New York, NY 10013

Birt Harvey, MD
Pediatrician
101 Alma Street, #1201
Palo Alto, CA 94301–1011

Sanders Francis Hawkins, PhD
Director, Laboratory Services
Connecticut Department of Public Health
10 Clinton Street
Hartford, CT 06106

Patricia L. McLaine, BSN, MPH
Assistant Director for Program Management
National Center for Lead-Safe Housing
10227 Wincopin Circle
Columbia, MD 21044

Janet A. Phoenix, MD, MPH
Manager, Public Health Programs
National Safety Council
National Lead Information Center
1019 19th Street, NW
Washington, DC 20036–5105

Joel D. Schwartz, PhD
Associate Professor, Environmental Epidemiology
Harvard School of Public Health
665 Huntington Avenue
Boston, MA 02115

Roger F. Suchyta, MD
Associate Executive Director
American Academy of Pediatrics
141 Northwest Point Boulevard
Elk Grove Village, IL 60009–0927

Consultants

J. Julian Chisolm, Jr., MD
Director, Lead Poisoning Prevention Program
Kennedy Kreiger Institute
707 North Broadway
Baltimore, MD 21205

Charles G. Copley
Director, Department of Community Health and the Environment
St. Charles County Department of Community Health
305 N. Kings Highway
St. Charles, MO 63301

Andrew M. Davis, MD, MPH
Associate Medical Director, Rush Prudential Health Plans
233 Wacker Drive
Suite 3900
Chicago, IL 60606

Dwala S. Griffin
Administrator, Division of Health Services
Louisville-Jefferson County Health Department
400 East Gray Street
Louisville, KY 40202

Philip J. Landrigan, MD
Chairman, Department of Community Medicine
Director, Division of Environment and Occupational Medicine
Mount Sinai Medical Center
New York, NY 10029

Herbert L. Needleman, MD
Professor of Psychiatry and Pediatrics
Western Psychiatric Institute and Clinic
University of Pittsburgh School of Medicine
3600 Forbes Avenue
Pittsburgh, PA 15213–2593

Patrick Jeremy Parsons, PhD
Director, Lead Poisoning Laboratory
Wadsworth Center for Laboratories and Research
New York State Department of Health
Albany, NY 12201–0509

Sergio Piomelli, MD
Director, Division of Pediatric Hematology and Oncology
Columbia University Babies Hospital
3959 Broadway
New York, NY 10032

Stephanie L. Pollack, JD
Conservation Law Foundation of New England
62 Summer Street
Boston, MA 02110–1008

Lewis Bradford Prenney
Director, Childhood Lead Poisoning Prevention Program
Massachusetts Department of Public Health
470 Atlantic Avenue
Boston, MA 02110

Thomas L. Schlenker, MD
Executive Director
Salt Lake City-County Health Department
2001 South State Street, S–2500
Salt Lake City, UT 84190–2150

Peter Simon, MD, MPH
Assistant Medical Director
Division of Family Health
Rhode Island Department of Health
3 Capitol Hill, Room 302
Providence, RI 02908

Executive Summary

Childhood lead poisoning is a major, preventable environmental health problem. Blood lead levels (BLLs) as low as 10 μg/dL are associated with harmful effects on children's learning and behavior. Very high BLLs (≥70 μg/dL) cause devastating health consequences, including seizures, coma, and death. It is currently estimated that some 890,000 U.S. children have BLLs ≥10 μg/dL (CDC, 1997). Since the virtual elimination of lead from gasoline, lead-based paint hazards in homes are the most important remaining source of lead exposure in U.S. children.

In 1991, the U.S. Department of Health and Human Services called for elimination of childhood lead poisoning and in 1997 retains its commitment to see this effort through. Blood lead screening is an important element of a comprehensive program to eliminate childhood lead poisoning. The goal of such screening is to identify children who need individual interventions to reduce their BLLs. The 1991 edition of *Preventing Lead Poisoning in Young Children* called for virtually universal screening of children 12–72 months of age. Nonetheless, a 1994 national survey showed that *only about one-fourth of young children had been screened and only about one-third of poor children, who are at higher risk of lead exposure than other children, had been screened.*

Some populations of children are heavily exposed to lead while others are not. A recent national estimate

(CDC, 1997) showed that 21.9% of black children living in housing built before 1946 had elevated BLLs (≥10 μg/dL). Studies of other groups of children have shown quite low prevalence of elevated BLLs. For example, a 1994 survey of 967 poor children in Alaska found that none had a BLL above 11 μg/dL (Robin et al., 1997).

Many children, especially those living in older housing or who are poor, need screening and, if necessary, appropriate interventions to lower their BLLs. At the same time, children living where risk for lead exposure has been demonstrated to be extremely low do not all need to be screened. The task for public health agencies, parents, and health-care providers is to identify those children who will benefit from screening and to ensure that they receive the services they need.

CDC Recommendations - Statewide Plan

State health officials should develop a statewide plan for childhood lead screening and convene an inclusive planning committee composed of child health-care providers as well as representatives from local health departments, managed-care organizations, Medicaid, private insurance organizations, and the community.

The plan should address:

- **Division of the state, if necessary, into areas with different recommendations for screening.**
- **Screening recommendations for each area. (A basic targeted-screening recommendation is provided below as an example.)**
- **Dissemination of screening recommendations for each area.**
- **Evaluation.**

A Basic Targeted-Screening Recommendation

State health officials should use this basic recommendation only as an interim measure. A recommendation that is based on assessment of local data and an inclusive planning process is preferred.

Within the state or locale for which this recommendation is made, child health-care providers should use a blood lead test to screen children at ages 1 and 2, and children 36-72 months of age who have not previously been screened, if they meet one of the following criteria:

- Child resides in one of these zip codes: *[place here a list of all zip codes in the state or jurisdiction that have ≥27% of housing built before 1950. This information is available from the U.S. Census Bureau.]*
- Child receives services from public assistance programs for the poor, such as Medicaid or the Supplemental Food Program for Women, Infants, and Children (WIC).
- Child's parent or guardian answers "yes" or "don't know" to any question in a basic personal-risk questionnaire consisting of these three questions:

  -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 day-care center or the home of a babysitter or relative.
  -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)?
  -Does your child have a sibling or playmate who has or did have lead poisoning?

In the absence of a statewide plan or other formal guidance from health officials, universal screening for virtually all young children, as called for in the 1991 edition of *Preventing Lead Poisoning in Young Children* (CDC, 1991), should be carried out.

CDC provides funding and technical advice to assist states and locales in all activities that are called for in this guidance document.

In this document, CDC also provides general guidelines about the roles and responsibilities of child health-care providers in preventing childhood lead poisoning, including anticipatory guidance, screening and follow-up testing, clinical management, chelation therapy, family education about elevated BLLs, and participation in a follow-up team.

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1 Childhood Lead Poisoning in the United States

The problem of childhood lead poisoning. Childhood lead poisoning is a major, preventable environmental health problem in the United States. Blood lead levels (BLLs) as low as 10 μg/dL are associated with harmful effects on children's ability to learn. Very high BLLs (≥70 μg/dL) can cause devastating health consequences, including seizures, coma, and death. It is currently estimated that some 890,000 U.S. children have BLLs ≥10 μg/dL (CDC, 1997).

Lead exposure. Children can be exposed to lead in many ways. Sources of exposure include lead-based paint and industrial sites and smelters that use or produce lead-containing materials. Lead-contaminated dust, soil, and water; lead-containing materials used in parental occupations or hobbies; and lead-containing ceramicware and traditional remedies all contribute to childhood lead exposure. Lead-contaminated house dust, ingested in the course of normal hand-to-mouth activity, is of major significance. House dust is most often contaminated by lead-based paint in the home, when such paint is peeling, deteriorating, or scattered about during home renovation or preparation of painted surfaces for repainting.

Housing with lead-based paint. Lead-based paint in homes is the most important remaining source of lead exposure for U.S. children. Substantial progress has been made in reducing other environmental sources of lead exposure, especially from gasoline and food. But 83% of all homes built in the United States before 1978 still contain some lead-

based paint at a concentration of at least one mg/cm^2 (U.S. Environmental Protection Agency, 1995). The older the house, the more likely it is to contain lead-based paint and to have a higher concentration of lead in the paint. Housing built before 1950 poses the greatest risk of exposure to children. Such housing is present in every state. (Table 1.1.) Even states with low overall rates of older housing have areas that contain predominately older housing.

Temporal trend of elevated BLLs in children. Average BLLs for the population as a whole have declined dramatically since the 1970s. As shown in Figure 1.1., the geometric mean BLLs for children ages 1-5 years declined from 15.0 μg/dL during 1976-1980 (Mahaffey et al., 1982) to 2.7 μg/dL during 1991-1994 (CDC, 1997).

Table 1.1. Quantity and percentage of U.S. housing built before 1950, by state

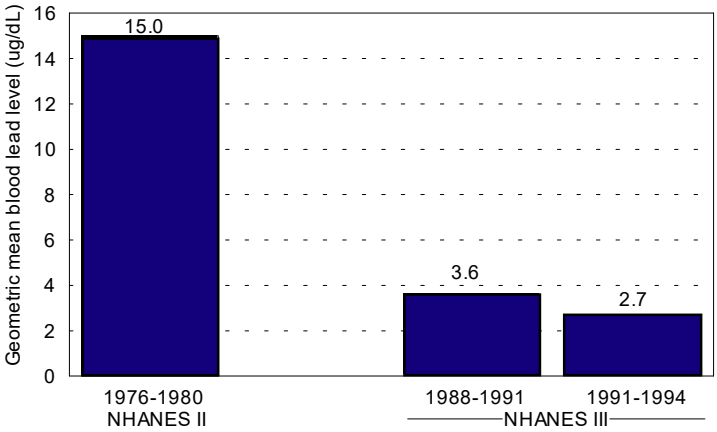
State	Total Housing Units	Housing Units Built Before 1950	Built Before 1950 (%)
Alabama	1,670,379	298,303	17.9
Alaska	232,608	16,248	7.0
Arizona	1,659,430	110,746	6.7
Arkansas	1,000,667	176,662	17.7
California	11,182,882	2,211,243	19.8
Colorado	1,477,349	270,562	18.3
Connecticut	1,320,850	462,808	35.0
Delaware	289,919	64,704	22.3
Dist. of Columbia	278,489	155,194	55.7
Florida	6,100,262	472,481	7.7
Georgia	2,638,418	381,827	14.5
Hawaii	389,810	52,347	13.4
Idaho	413,327	100,738	24.4
Illinois	4,506,275	1,662,888	36.9
Indiana	2,246,046	756,843	33.7
Iowa	1,143,669	490,394	42.9
Kansas	1,044,112	345,564	33.1
Kentucky	1,506,845	364,678	24.2
Louisiana	1,716,241	333,965	19.5
Maine	587,045	242,858	41.1
Maryland	1,891,917	473,984	25.1
Massachusetts	2,472,711	1,157,737	46.8
Michigan	3,847,926	1,228,635	31.9
Minnesota	1,848,445	585,539	31.7
Mississippi	1,010,423	167,685	16.6
Missouri	2,199,129	629,868	28.6

Table 1.1. (Continued)

State	Total Housing Units	Housing Units Built Before 1950	Built Before 1950 (%)
Montana	361,155	108,805	30.1
Nebraska	660,621	249,631	37.8
Nevada	518,858	31,044	6.0
New Hampshire	503,904	162,201	32.2
New Jersey	3,075,310	1,082,081	35.2
New Mexico	632,058	97,750	15.5
New York	7,226,891	3,401,416	47.1
North Carolina	2,818,193	494,675	17.6
North Dakota	276,340	85,128	30.8
Ohio	4,371,945	1,561,695	35.7
Oklahoma	1,406,499	298,347	21.2
Oregon	1,193,567	316,648	26.5
Pennsylvania	4,938,140	2,213,386	44.8
Rhode Island	414,572	181,215	43.7
South Carolina	1,424,155	218,781	15.4
South Dakota	292,436	107,374	36.7
Tennessee	2,026,067	380,068	18.8
Texas	7,008,999	1,008,475	14.4
Utah	598,388	127,266	21.3
Vermont	271,214	109,780	40.5
Virginia	2,496,334	481,679	19.3
Washington	2,032,378	500,808	24.6
West Virginia	781,295	270,441	34.6
Wisconsin	2,055,774	757,204	36.8
Wyoming	203,411	48,254	23.7
United States	**102,263,678**	**27,508,653**	**26.9**

Source: 1990 U.S. census

Figure 1.1. Geometric mean blood lead levels of children ages 1-5 years in the United States: NHANES II and III



Distribution of elevated BLLs among children. Some populations of children are heavily exposed to lead while others are not. For example, a recent national estimate (CDC, 1997) showed that 21.9% of black children living in housing built before 1946 had elevated BLLs (≥10 μg/dL). Studies of other groups of children have shown quite low prevalence of elevated BLLs. For example, a 1994 survey of 967 poor children in Alaska found that none had a BLL above 11 μg/dL (Robin et al., 1997).

Blood-lead screening of children. If we are to eliminate childhood lead poisoning, a comprehensive approach is necessary. (See Chapter 2.) Blood lead screening is an important element of such an approach. The goal of screening is to identify children who need individual interventions to reduce their BLLs. The 1991 edition of *Preventing Lead Poisoning in Young Children* called for virtually universal screening of children 12-72 months of age. Nonetheless, a 1994 national survey showed that many children who are at risk for lead exposure are not being screened (Binder et al., 1996). According to the survey, only about 24% of young children had been screened; fewer than one-third of those at increased risk for lead exposure because of poverty or residence in older housing had been screened.

Current situation. Many children, especially those living in older housing or who are poor, are still being harmed by the effects of lead exposure. These children need screening and, if necessary, appropriate interventions to lower their BLLs. At the same time, children in places with populations that are known to be at extremely low risk for lead exposure do not all need to be screened. The task for public health agencies, parents, and health-care providers is to identify

those children who will benefit from screening and to ensure that they receive the services they need.

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2 A Comprehensive Approach to Childhood Lead Poisoning Prevention

Although lead poisoning among children is a bigger problem in some places than in others, there is potential for lead exposure in nearly all jurisdictions. Public health agencies should develop a comprehensive approach to preventing childhood lead poisoning that is based on the three functions defined in *The Future of Public Health:* assessment, policy development, and assurance (National Academy of Sciences, 1988).

1. Assessing Children's Exposure to Lead

Sources of data for assessment of children's exposure to lead are summarized in Table 2.1. Sources include childhood blood lead surveillance systems (complete data are currently unavailable in most places, but many such systems are being developed); the U.S. Census (widely available data on older housing and young children living in poverty); the Toxic Release Inventory (TRI) from the EPA (widely available data on local industrial sources of lead exposure); and local surveys. Local surveys may be conducted to gather data on industrial sources not included in the TRI; on drinking water that might be contaminated by lead; and on households where lead may be present in traditional remedies, ceramicware, cosmetics, or materials used in hobbies.

Table 2.1. Assessing children's exposure to lead

Exposure Source or Risk Factor	Examples of Sources of Data for Assessment
Pre-1950 housing	Census data, tax-assessor data
Demographic factors (e.g., poverty)	Census data, blood lead surveillance data
Industrial sources, parental occupation (take-home exposure)	Toxic Release Inventory, local surveys, blood lead surveillance data
Drinking water	Local surveys, EPA, local utility companies
Hobbies, traditional remedies, ceramicware, cosmetics	Local surveys, blood lead surveillance data

2. Developing Policies for Childhood Lead Poisoning Prevention

Policies and activities are necessary in three major areas: primary prevention, secondary prevention, and monitoring (surveillance). Activities and associated policies are summarized in Table 2.2.

Primary prevention activities prevent children from being exposed to lead. Especially significant are actions to reduce residential lead hazards before children are born, are sufficiently mobile to be at increased risk for exposure to household lead, or before children move into a home with lead hazards. (Alliance to End Childhood Lead Poisoning, 1994.)

Secondary prevention activities reduce the harmful effects of elevated BLLs after elevations have occurred. Activities include BLL screening and follow-up care.

"Universal" screening is the BLL screening of all children in an area; "targeted" screening is the BLL screening of children who are selected on the basis of: 1) environmental assessment to determine where children are being exposed to lead hazards, or 2) individual risk assessment to identify children who meet certain criteria, which may include place of residence, membership in a high-risk group, or "yes" answers to a personal-risk questionnaire. (See Chapter 3 for more detail on secondary prevention activities.)

Monitoring (surveillance) activities provide information that forms the basis for planning, evaluation, and public support of policies and programs. Activities include development of systems to monitor children's BLLs, sources of exposure,

reduction of lead hazards, and availability of lead-safe housing.

Of particular importance are childhood blood lead surveillance systems containing information on elevated and non-elevated BLL results, demographics, results of environmental investigations, probable sources of exposure, and prescribed medical treatments.

Table 2.2. Childhood lead poisoning prevention activities and associated policies

Activity	Examples of Associated Policies
Primary Prevention	
Evaluation and control of residential lead-based paint hazards	Protective housing codes or statutes
Public lead education	State- or area-wide plan calling for community-wide lead education
Professional lead education and training	State certification for lead-abatement workers
Anticipatory guidance by child health-care providers	State Medicaid policies requiring anticipatory guidance
Identification and control of sources of lead exposure other than lead-based paint	State- or area-wide plan to reduce exposures from industry and drinking water
Secondary Prevention	
Childhood blood lead screening	State- or area-wide screening plan; state Medicaid policies and contracts calling for screening; protocols and policies for providers and managed-care organizations
Follow-up care for children with elevated BLLs	Local policies to establish a follow-up care team; protocols for care coordination, and for medical and environmental management; Medicaid policies and contracts calling for follow-up care
Monitoring (Surveillance)	
Monitoring of children's BLLs	State policy requiring laboratories to report all BLL test results of resident children
Monitoring of targeted (older, deteriorating) housing stock, hazard-reduction activities, and lead-safe housing	State certification and licensing procedures for monitoring safety of lead-hazard reduction activities and occurrence of such activities in areas with targeted housing; procedures for tracking lead-safe housing

3. Assuring the Performance of Activities to Prevent Childhood Lead Poisoning

Health departments should, at a minimum, support, oversee, and monitor the activities necessary to prevent childhood lead poisoning.

In a comprehensive approach, there are roles for many different collaborators in both the public and the private sector. (See, for example, Alliance to End Childhood Lead Poisoning, 1996; and Lead-Based Paint Hazard Reduction and Financing Task Force, 1995.) Examples of activities, collaborating groups, and health department roles are shown in Table 2.3.

Table 2.3. Examples of childhood lead poisoning prevention activities and collaboration

Activity	Collaborators	Roles of public health departments
Primary prevention		
Anticipatory guidance	Health-care providers, medical groups, managed-care organizations	Provide educational materials; publicize, disseminate, and market prevention information
Public education	Health-care providers, medical groups, managed-care organizations, community-based organizations, realtors, contractors, home remodelers, home inspectors, the press	Assess community needs; provide educational materials; convene planning groups; oversee, carry out, or evaluate campaigns; respond to consumer inquiries
Maintenance or improvement of older housing	Property owners, realtors, bankers, community-based organizations, remodelers, housing maintenance staff	Convene policy-development groups; maintain system for monitoring targeted (older, deteriorating) housing; provide training for maintenance staff and remodelers; provide contractor training and certification
Lead hazard evaluation and control	Lead inspectors, risk assessors, lead abatement contractors, trainers, community-based organizations, and licensing agencies	Accredit training providers, certify lead professionals, provide advice and referrals to property owners

Table 2.3. Examples of childhood lead poisoning prevention activities and collaboration (continued)

Activity	Collaborators	Roles of public health departments
Secondary prevention		
Screening	Health-care providers, medical groups, managed-care organizations	Provide patient-education materials and screening protocols; conduct screening
Follow-up care: medical management	Health-care providers, medical groups, managed-care organizations	Provide referrals, protocols, and care coordination; provide medical management.
Follow-up care: environmental investigation	Public and private-sector environmental health specialists	Provide referrals; investigation services; training, licensing, and certification of investigators; laboratory quality controls
Follow-up care: family lead education, home visiting	Visiting nurse associations, community-based organizations	Provide referrals, training, and home-visiting services
Follow-up care: lead-hazard control	Property-owners, bankers, realtors, policy makers, enforcement agencies	Convene policy-making groups; provide referrals, training, licensing, and certification; provide hazard-reduction services

Table 2.3. Examples of childhood lead poisoning prevention activities and collaboration (continued)

Activity	Collaborators	Roles of public health departments
Monitoring (surveillance)		
Using BLL information for program development	Health-care providers, medical groups, managed-care organizations, clinical laboratories	Conduct outreach and policy development to encourage BLL reporting; provide systems to collect, manage, analyze, and disseminate results
Using information on lead-hazard control activities to monitor safety of these activities and lead-safe housing	Environmental sanitarians, lead hazard-reduction contractors	Encourage reporting as part of training, licensing, and certification programs; provide systems to collect, manage, analyze, and disseminate results

References

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3 The Statewide Plan for Childhood Blood Lead Screening

State public health officials should develop a statewide plan for childhood blood lead screening.

The plan should address:

- Division of the state, if necessary, into areas with different recommendations for screening.
- Screening recommendations for each area. (A basic targeted-screening recommendation is provided below as an example.)
- Dissemination of screening recommendations for each area.
- Evaluation.

Screening policy should be based on data that is representative of the entire population. Children should be screened according to state policy.

In the absence of a statewide plan or other formal guidance from health officials, universal screening for virtually all young children, as called for in the 1991 edition of *Preventing Lead Poisoning in Young Children* (CDC, 1991), should be carried out.

A Basic Targeted-Screening Recommendation

State health officials should use this basic recommendation only as an interim measure. A recommendation that is based on assessment of local data and an inclusive planning process is preferred.

Within the state or locale for which this recommendation is made, child health-care providers should use a blood lead test to screen children at ages 1 and 2, and children 36-72 months of age who have not previously been screened, if they meet one of the following criteria:

- Child resides in one of these zip codes: *[place here a list of all zip codes in the state or jurisdiction that have ≥ 27% of housing built before 1950. This information is available from the U.S. Census Bureau.]*
- Child receives services from public assistance programs for the poor, such as Medicaid or the Supplemental Food Program for Women, Infants, and Children (WIC).
- Child's parent or guardian answers "yes" or "don't know" to any question in a basic personal-risk questionnaire consisting of these three questions:

  -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 day-care center or the home of a babysitter or relative.
  -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)?
  -Does your child have a sibling or playmate who has or did have lead poisoning?

There are six steps to developing and implementing the statewide screening plan.

1. Form an advisory committee.

2. Assess lead exposure and screening capacity.

3. Determine the boundaries of recommendation areas.

4. Decide on appropriate screening.

5. Write screening recommendations for areas with universal screening and for those with targeted screening.

6. Implement the statewide plan.

Editor's Note: In the rest of this chapter, we outline (on the left hand pages) the step-by-step process for developing and implementing a statewide screening plan and provide a discussion of those steps on the facing right hand pages.

1. Form an advisory committee.

State health officials should form an advisory committee to develop the statewide plan. The committee should include child health-care providers as well as representatives from local health departments, managed-care organizations, Medicaid, private insurance organizations, and the community.

The advisory committee

The statewide plan for childhood blood lead screening developed by the health department should, at a minimum, have the input of child health-care providers, insurers, and parents.

Involvement of health-care providers, their organizations, and managed-care organizations throughout the process will improve acceptance of screening recommendations. The importance of community collaboration in public health decision-making is underscored by community health research (e.g., Green and Kreuter, 1991). Studies (e.g., Greco and Eisenberg, 1993) also indicate that health-care providers respond well to information and recommendations that come from peers and from their organizations.

Working with insurers, especially the state Medicaid agency, will help ensure that screening is included, as appropriate, in contracts and policies.

2. Assess lead exposure and screening capacity.

2.1. Examine information on children's risk for lead exposure.

2.1.1. Examine BLL data.

Exercise caution in using BLL data to assess risk for lead exposure, because these data may not reflect the risk of the entire population. If BLL data are not thought to be reliable, other data should be used (see following sections) until improved BLL data are available.

Use the following criteria to evaluate BLL data. *Data should meet all of these criteria.* If they do not, they are probably not an adequate basis for screening decisions.

Criteria for evaluating BLL data

1. Laboratory data are available for children who have been screened.
2. Laboratory data are of good quality.
3. Laboratory data are available for individual children.
4. Demographic, socioeconomic, and geographic data are available for individual children.
5. Screening data are representative of the pediatric population of the jurisdiction.
6. Screening data are available for a sample that is large enough to allow for a valid estimate of prevalence to be made.

Evaluating BLL data, additional considerations

- Labs reporting data should be successful participants in an approved proficiency-testing program.

- BLL test results should be maintained in a way that allows identification of duplicate and sequential tests on a single child. It must be possible to distinguish between number of children tested and number of tests performed.

- The results of all tests, regardless of BLL, should be available, so that calculation of rates of elevated BLLs among screened children can take place.

- The data should be representative, i.e., the demographic, socioeconomic, and geographic distribution of children screened should be similar to that of all children in the jurisdiction.

- Screening data that are *not* representative of the entire population, although not ideal, may be useful. For example, data showing low prevalence among those at highest risk would tend to support a targeted-screening recommendation; data showing high prevalence among those at lowest risk would tend to support a universal-screening recommendation (see Step 5).

2.1.2. Examine data on housing.

These data are widely available from the U.S. census and can be used to estimate potential lead-exposure risk in an area. If adequate BLL data are unavailable, housing data can be used alone. Data are available for states, counties, zip codes, census tracts, and census block groups.

The focus should be on housing built before 1950 because it poses the greatest risk for lead exposure.

Age of housing

Housing built before 1950 poses the greatest risk for lead exposure because it is much more likely to contain lead-based paint than is newer housing.

- Paint manufactured before 1950 has more lead than paint manufactured after that year (Lead-Based Paint Hazard Reduction and Financing Task Force, 1995).

- 27% of U.S. housing was built before 1950. Percentages of pre-1950 housing vary widely among states and counties.

- Data from the most recent National Health and Nutrition Examination Survey (NHANES III, Phase 2) confirm the relationship between housing age and BLLs (CDC, 1997).

Table 3.1. Percentage of children ages 1-5 years with BLLs ≥10 μg/dL, by year house built, and geometric mean BLL, by year house built, U.S., 1991-1994

Year house built	% with BLLs ≥10 μg/dL	Geometric mean BLL (μg/dL)
Before 1946	8.6	3.8
1946-1973	4.6	2.8
1973 onward	1.6	2.0

2.1.3. Examine data on demographic characteristics of children.

The focus should be on poor children and children of racial/ethnic minority groups because generally they are at higher risk than other children.

Demographic data on children are widely available from the U.S. census and can be used to identify places with high proportions of children who may be at higher than average risk for lead exposure.

Data on demographic characteristics of children: race/ethnicity and income

Data from NHANES III, Phase 2, show strong relationships between BLL and race/ethnicity and between BLL and income.

Table 3.2. Percentage of children with BLLs ≥10 μg/dL by race/ethnicity and income, U.S., 1991-1994

Characteristic	% children, ages 1-5 with BLLs ≥10 μg/dL
Race/Ethnicity	
Black, non-Hispanic	11.2%
Mexican-American	4.0%
White, non-Hispanic	2.3%
Income	
Low	8.0%
Middle	1.9%
High	1.0%
All children	4.4%

2.1.3. Examine data on demographic characteristics of children (continued).

The focus should be on children between the ages of 12 and 36 months (1- and 2-year-old children) because BLLs tend to be highest in this age group, and more children in this age group have BLLs ≥10 μg/dL.

Examine census and local information to determine whether there are places with high percentages of young children. Estimates generated since the last U.S. census (conducted in 1990) are available to help identify these areas.

Data on demographic characteristics of children: age

Focus on children at ages 1 and 2.
One- and 2-year-old children are at greatest risk for elevated BLLs because of:

- Increasing mobility during the second year of life, resulting in more access to lead hazards.
- Normal hand-to-mouth activity.

In addition, the developing nervous systems of young children are more susceptible to the adverse effects of lead.

Data from NHANES III, Phase 2, reinforce the association between children's age and their risk for elevated BLLs.

Table 3.3. Percentage of children ages 1-11 years with BLLs ≥10 μg/dL by age group, U.S., 1991-1994

Age group (years)	% with BLLs ≥10 μg/dL
1-2	5.9%
3-5	3.5%
6-11	2.0%

2.1.4. Examine data on the presence of other sources of lead.

Examine data from within the state on other sources of lead exposure, such as pottery, traditional remedies and cosmetics, operating or abandoned industrial sources, waste-disposal sites, occupational and take-home exposure, and drinking water. (See National Research Council, 1993, for a comprehensive discussion of sources and pathways of lead exposure.)

Data from local surveys may supply additional information about local sources of lead exposure. BLL surveillance data may also reveal the presence of unusual sources.

Other sources and pathways of lead exposure

Industries, work sites, occupations, and associated materials

Secondary smelting and refining of nonferrous metals
Brass/copper foundries
Firing ranges
Automotive repair shops
Bridge, tunnel, and elevated highway construction
Motor vehicle parts and accessories
Storage batteries (lead batteries)
Valve and pipe fittings
Plumbing fixture fittings and trim
Pottery
Chemical and chemical preparations
Industrial machinery and equipment
Inorganic pigments
Primary batteries, dry and wet

Hobbies and home activities

Recreational use of firing ranges
Home repairs, repainting, or remodeling
Furniture refinishing
Stained glass making
Casting ammunition
Making fishing weights or sinkers, or toy soldiers
Using lead solder (e.g., for electronics)
Using lead-containing artists' paints or ceramic glazes
Burning lead-painted wood
Car or boat repair

2.2. Assess the capacity of local public health systems within the state to oversee and provide lead screening.

This assessment will be one basis for deciding whether to divide the state into areas with different recommended screening.

Examine local information about:

- Health department organization and capacity to oversee screening.
- Current screening activity.
- Capacity to collect and analyze screening data.
- Child health-care delivery systems and patterns.
- Enrollment of children in Medicaid managed care.
- Health department capacity to support private providers of screening.
- Health department capacity to provide screening for children without other access to care.

Information on local health systems

Some locales have long-standing, comprehensive childhood lead poisoning prevention programs with ties to managed-care organizations and support from providers. Other places have less experience, fewer allocated resources, and less provider involvement.

Information about local activities should be used to develop a plan that is responsive to local needs and respectful of local capacities.

3. Determine the boundaries of recommendation areas.

If necessary, subdivide the state into recommendation areas. A recommendation area is a geographic area for which a screening recommendation can be reasonably made.

Efforts should be made to draw boundaries so that recommendation areas are reasonably homogeneous both in magnitude of risk and in health-system capacity to provide screening.

Boundaries of recommendation areas

Some states have relatively widespread and homogeneous risk, while others have less risk or scattered pockets of risk. States also differ with regard to the capacity of local health systems to oversee and provide screening.

Universal screening is appropriate in areas with widespread risk. A state with widespread risk may comprise a single recommendation area with universal screening. Other states with less risk or scattered pockets of risk may be divided into different areas, some with universal screening and others with targeted screening.

Example: A state is divided into two recommendation areas: 1) a large city, designated as a universal-screening area because of its high percentage of older housing, and 2) the rest of the state, throughout which older housing is scattered, which is designated as a targeted-screening area. The large city's health department, with its experienced lead program, will oversee screening in the city; the state health department will oversee screening in the rest of the state.

4. Decide on appropriate screening.

Choose universal or targeted screening for each recommendation area. Use the following table to guide decision making.

Table 3.4. Guidelines for choosing an appropriate screening recommendation

% children, ages 12-36 months, with BLLs ≥10 μg/dL	% housing built before 1950	Recommended screening
≥12%	----	universal
<12%	≥27%	universal (or targeted--see discussion)
3-12%	<27%	targeted
<3%	<27%	see discussion
unknown	≥27%	universal
unknown	<27%	targeted

Cut-off points

These should be used as guides to decision making and should not inhibit, for example, universal screening at prevalences of elevated BLLs or older housing that are slightly lower.

12% prevalence: The vast majority of children in recommendation areas where less than 12% of children have BLLs ≥10 μg/dL will have BLLs below 20 μg/dL, the level requiring medical and environmental intervention. The members of CDC's advisory committee reached substantial, although not unanimous, agreement on the 12% cut-off, which is also supported by a cost-benefit analysis.

27% pre-1950 housing: Housing data can be used as a proxy for BLL data; 27% of U.S. housing was built before 1950. (Bureau of the Census, 1992)

≥27% of housing pre-1950, but prevalence <12%:

- Universal screening should be recommended unless prevalence data are reliable and representative.
- If targeted screening is recommended, the condition of older housing stock should be monitored. Decline in housing conditions should trigger universal screening.

<3% prevalence: Where reliable BLL prevalence estimates are extremely low and exposure sources are demonstrably lacking, methods other than routine screening should be used. Examples of alternatives are periodic focused surveys, routine review of BLL lab data, and public health alerts about newly identified sources of lead exposure.

Note: Whenever a parent or a health-care provider suspects that a child is at risk for lead exposure, a BLL test should be performed regardless of health-department recommendation.

5. Write screening recommendations for areas with universal screening, and for those with targeted screening.

5.1. Write a universal-screening recommendation.

A sample:

Using a blood lead test, screen all children at ages 1 and 2, and screen all children from 36-72 months of age who have not been screened previously.

Implementation of universal screening is discussed in Step 6.

The universal-screening recommendation

In many places, universal screening will be the policy of choice.

In practice, universal screening has often been difficult to achieve. Barriers to screening and how to overcome them are discussed in Step 6.

5.2. Write a targeted-screening recommendation.

A sample:

Using a blood lead test, screen children at ages 1 and 2, and screen children from 36-72 months of age who have not been screened previously if they meet at least one of the health-department criteria.

Usual health-department criteria:

- Residence in a geographic area (e.g., a specified zip code) where there is risk for lead exposure. (See 5.2.1.)
- Membership in a group (e.g., Medicaid recipients) at risk for lead exposure. (See 5.2.2.)
- Parent/guardian answers "yes" or "don't know" to any question in a personal-risk questionnaire. (See 5.2.3.)

The importance of targeted-screening criteria

The criteria established by the health department and its advisors will make it possible for child health-care providers and parents to identify children who need screening. These criteria must be crafted to enable identification of as many at-risk children as possible. The criteria must be tailored to local conditions and easy to use.

Development of these criteria is discussed in detail on the following pages.

5.2.1. Criterion: residence in a geographic area.

This criterion makes it possible to identify children within a recommendation area who live in places where likelihood of lead exposure is increased (e.g., places with older housing).

Effectiveness of screening on the basis of place of residence

An analysis was performed on a state's BLL surveillance data in order to test the effectiveness of screening that is based on residence in zip codes and census tracts with high proportions of older housing.

An analysis of Rhode Island surveillance data - 1995

Rhode Island is a state that requires universal screening and has BLL data on a relatively high proportion of its children. Analysis of 1995 Rhode Island surveillance data shows that:

If, contrary to fact, the state of Rhode Island were to comprise a recommendation area with targeted screening:

- Using the criterion "screen all in zip codes with ≥27% pre-1950 housing" would result in identifying 92% of children with BLLs ≥10 μg/dL.

- Using the criterion "screen all in census tracts with ≥27% pre-1950 housing" would result in identifying 93% of children with BLLs ≥10 μg/dL.

5.2.1. Criterion: residence in a geographic area (continued).

Within a larger recommendation area, smaller places where lead exposure is likely should be pinpointed. Residence in such a place constitutes a screening criterion.

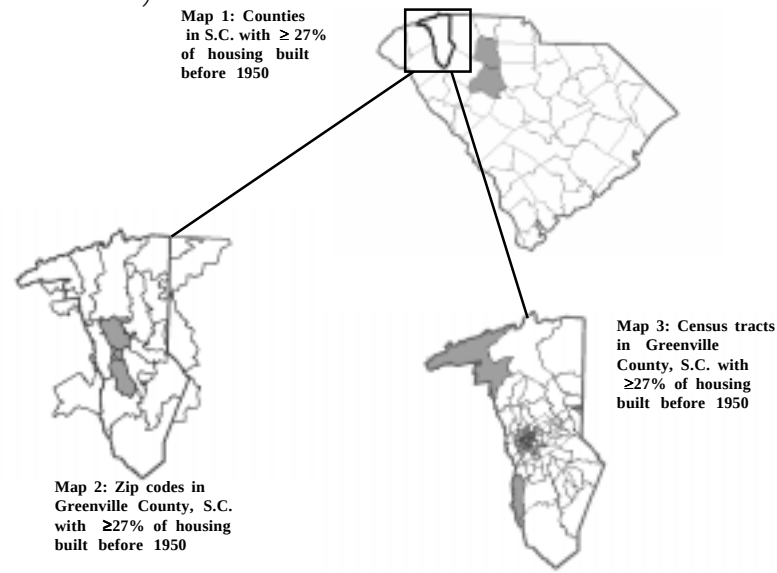
The use of relatively small units of analysis (e.g., census tract, census block group) may reveal "pockets of risk" that would be invisible within a larger unit (e.g., county, zip code). However, small analytic units whose boundaries are not widely recognized will not be useful as screening criteria in a clinical setting, where providers and parents must be easily able to identify children for screening. For example, most people cannot readily identify the census tract in which they live.

Another possible criterion might be residence in a widely recognized neighborhood whose boundaries approximate those of a relatively small analytic unit, such as a census tract, in which increased risk is identified.

Geographic analysis

Computerized mapping software and U.S. census data files make it easy to search recommendation areas for smaller areas with older housing or with high-risk groups. For example, the maps of South Carolina (Map 1), and of Greenville County, S.C. (Maps 2 and 3), below show areas of older housing (shaded areas) for **counties** (Map 1), **zip codes** (Map 2), and **census tracts** (Map 3). The use of smaller units of analysis (zip code or census tract) reveals areas of older housing that are obscured when the larger unit (county) is used. (Note that zip code boundaries do not necessarily coincide with county boundaries.)

Figure 3.1. Housing built before 1950 in South Carolina: geographic analysis at three different levels–county, zip code, and census tract. (Shading indicates ≥ 27% of housing built before 1950.)



5.2.2. Criterion: membership in a high-risk group.

This criterion should make it possible to identify children who may be at risk for reasons other than place of residence.

The focus should be on children who 1) are poor; 2) are members of racial/ethnic minority groups, including black children and some groups of Hispanic and Asian-American children; 3) have occupationally exposed parents; or 4) have some other significant group characteristic that puts them at high risk.

Current (1997) Medicaid policy reflects the assumption that all child beneficiaries are at risk for lead poisoning and requires lead screening for all children who receive Medicaid benefits. Anticipated changes in this policy may give states the responsibility of deciding whether all Medicaid-recipient children should be screened. *In general, children who receive Medicaid benefits should be screened unless there are reliable, representative BLL data that demonstrate the absence of lead exposure in this population.*

Screening among children in a high-risk group

Ways to increase screening of poor children:

- Screen all children who receive Medicaid benefits or vouchers from the Supplemental Food Program for Women, Infants, and Children (WIC).
- Add questions to the personal-risk questionnaire that elicit the poverty status of respondents.
- Increase screening in geographic areas with high percentages of children in poverty.
- Screen in public clinics that serve poor children.
- Improve access to health care for uninsured children.

The importance of membership in a high-risk group: Data from NHANES (CDC, 1997) and other studies (e.g., Rothenberg et al., 1996) demonstrate that children who are poor, are members of racial-ethnic minority groups, or who have occupationally exposed parents are at higher risk of lead exposure than are other children. Membership in a minority group does not predict risk in every community, and children in minority groups who are not exposed to lead do not have elevated BLLs. Traditional remedies and lead-glazed cooking pots and ceramicware used by some Mexican-American and other (e.g., Southeast Asian) families may cause BLL elevations. Children may also be exposed to lead brought home on clothes or persons, or in the car from adults' worksites. Occupations likely to be associated with "take-home" exposures include primary or secondary lead and copper smelting, battery manufacturing, battery recycling, painting and repair of older housing, construction and demolition, pottery work, stained-glass making, radiator repair, electronic components manufacturing, work in gold-assay labs, and gold and silver recovery.

5.2.3. Criterion: response to a personal-risk questionnaire.

This criterion makes it possible to identify children who may be at risk but who do not meet other criteria. CDC recommends a basic three-question questionnaire as a starting point.

A basic personal-risk questionnaire:

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 day-care 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 personal-risk questionnaire

Educational value of questionnaires.
A personal-risk questionnaire stimulates dialogue between the health-care provider and parent about whether or not an individual child should be screened and gives health-care providers the opportunity to educate families about lead hazards.

Predictive value of recommended questions.
Many, but not all, studies* have associated increased risk for elevated BLLs with positive answers to the first two questions. The third question is unlikely to cause a large amount of unnecessary screening, and it may be important in individual situations.

Sensitivity in predicting markedly elevated BLLs.
Results of some studies have suggested that the questionnaire is more sensitive for identifying children with more severe BLL elevations, e.g., ≥15 μg/dL or ≥20 μg/dL, than for identifying children with BLLs in the range of 10-14 μg/dL.

Cut-off date, 1978.
The cut-off date, 1978, is recommended in question 2 because there was some lead in residential paint until this time. Renovations have been shown in many studies to be associated with children's increased risk for elevated BLLs. Lead hazards from unsafe renovations could occur in housing before 1978.

* For a list of studies of personal-risk questionnaires, see Chapter 5, List of Additional Information Available from CDC.

5.2.3. Criterion: response to a personal-risk questionnaire (continued).

Other questions. State health officials and their advisors should tailor the questionnaire to include questions about local sources of exposure in addition to housing, which is covered by the recommended basic three-question questionnaire.

In recommendation areas where exposure to lead from older housing is unlikely, the personal-risk questionnaire could contain questions about other risk factors such as parental occupation or the use of lead-containing ceramicware or traditional remedies.

Examples of additional questions

Personal or family history.

- Have you ever been told that your child has lead poisoning?

Occupational, industrial, or hobby-related exposure.

- Does your child live with an adult whose job or hobby involves exposure to lead?
- Does your child live near an active lead smelter, battery recycling plant, or other industry likely to release lead into the environment?

Other sources.

- Does your child live within one block of a major highway or busy street?
- Do you use hot tap water for cooking or drinking?

Cultural exposures.

- Has your child ever been given home remedies (*e.g., azarcon, greta, pay looah)*?
- Has your child been to Latin America?
- Has your child ever lived outside the U.S.?
- Does your family use pottery or ceramicware for cooking, eating, or drinking?

Poverty.

- Does your family receive medical assistance?
- Do you rent your home?
- Do you or the child's parents perform migrant farm work?
- Have you recently moved?

Behavior.

- Have you seen your child eating paint chips?
- Have you seen your child eat soil or dirt?

Associated medical problems.

- Have you been told that your child has low iron?

6. Implement the statewide plan.

It is up to state health officials and their advisors to ensure that:

1) Staff members of state and local public health agencies understand their roles as established by the statewide plan.

2) Health-care providers, medical groups, managed-care organizations, and parents know what type of screening is recommended for their communities.

3) Other parties affected by the plan, including the state Medicaid agency, private insurers, and policy makers, are involved in the implementation process.

4) The plan is monitored, evaluated, and revised as appropriate.

Implementation

Health-care provider groups and parent groups should educate their members about recommended screening through their newsletters and meetings. Maps of areas of likely exposure are helpful in showing areas of risk.

Health-care provider groups should be made aware of how screening will be monitored and of the importance of their participation in evaluating recommendations.

Providers should receive supportive materials. (For a prototypic provider handbook, see list of additional resources available from CDC in Chapter 5.) These materials include information on background, screening, parent education, referrals, and local sources of lead exposure.

It is important that health departments, Medicaid, and managed-care organizations work closely together to bring about screening of Medicaid enrollees, as recommended. Contracts between the state Medicaid agency and managed-care organizations should include screening, follow-up, and reporting requirements. (For samples of contract language, see list of additional resources available from CDC in Chapter 5.)

6.1. Special considerations in the implementation of a universal-screening recommendation.

The recommendation for universal screening is straightforward, but implementation of such a recommendation has often been inadequate.

Health officials should not assume that making and communicating a universal-screening recommendation are sufficient to bring about such screening. It is critical to involve health-care providers, medical groups, managed-care organizations, Medicaid agencies, and community members in the decision to recommend universal screening and to use the decision-making process to educate these groups about preventing lead poisoning.

In areas where universal screening is recommended, health departments should monitor the effectiveness of the recommendation to ensure that screening rates are high.

Universal screening

Since 1991, when CDC recommended virtually universal screening of U.S. children, barriers to such screening have been identified.

The two most important are:

- Many providers and parents do not believe that lead exposure is a problem in their community.

- Some children who are at high risk for lead exposure because of poverty and residence in deteriorating housing do not receive routine well-child care and thus are not screened for lead.

To address these barriers, health departments have stepped up outreach and lead education for parents and providers and have worked with other agencies and communities to increase rates of well-child care.

Monitoring of screening activity is necessary so that efforts to improve screening rates can be directed to areas where screening is inadequate. See discussion in 6.2.

6.2. Steps to take in implementing recommendations.

Screening recommendations should be based on data. Of particular interest are BLL data. These data should be used to explain and support the recommendations to those who must carry them out, especially child health-care providers, medical groups, managed-care organizations, insurers, and parents. Ongoing collection and dissemination of data are necessary. Public health officials should:

- Collect BLL information.
- Determine the number and location of children with elevated BLLs.
- Determine where screening is taking place and where it is not.
- Compare information about screening activity and BLLs. (Graphics that display both screening and case information are helpful in this comparison.)
- Target education and outreach to areas where more screening is indicated.

Importance of feedback

Research, as well as common sense, suggests that health-care providers are more compliant with clinical practice guidelines when they receive feedback about the effectiveness, importance, and relevance of what they are being asked to do (Elrodt, et al., 1995). Every effort should be made to supply providers with screening data showing BLLs among children in the areas where they practice.

Sources of BLL information

Childhood blood lead surveillance systems that collect results of all BLL tests from all laboratories that serve residents of the area are preferred. Such systems make possible the analysis of screening and case data so that rates of elevated BLLs among screened children can be calculated, trends in BLLs and in service delivery can be detected, and appropriate improvements made.

Alternatively, other monitoring methods can be used, such as serial BLL surveys; surveys of knowledge, attitudes, and behaviors of health-care providers and parents in targeted communities; and studies performed by providers and provider groups using chart-review or other methods to ascertain screening practices.

Public health agencies, Medicaid agencies, and managed-care organizations have a mutual interest in monitoring screening delivered under Medicaid and can share data to achieve this goal.

6.3. Revise screening recommendations as better data become available.

As time passes, screening recommendations may become obsolete. Health officials should periodically evaluate the recommendations and revise them as appropriate.

Pediatric health-care providers, medical groups, managed-care organizations, Medicaid agencies, local health departments, and parents may want to vary from recommendations that have been made. Health officials should develop a review process to explore background and supporting evidence, and to consider the reasons both for retaining and for changing current recommendations.

Revising screening recommendations

Changes in the risk for lead exposure.
Change in the condition of older housing stock in a recommendation area is a reason to revisit a screening recommendation. Such housing may deteriorate or improve, creating a change in the potential risk for exposure to lead.

Additional information for making decisions.
Additional BLL data may become available, making it possible to generate better estimates of elevated BLL prevalence and to use these estimates to refine recommendations, including the recommended personal-risk questionnaire. Better tools for analyzing and presenting data will also be developed, allowing better prediction of risks for lead exposure.

Local input.
Local medical groups and managed-care organizations may perform blood lead surveys of their patient populations. Data from such surveys should be carefully evaluated, since these data can enhance the local decision-making process.

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4 Roles of Child Health-Care Providers in Childhood Lead Poisoning Prevention

Roles of Child Health-Care Providers

1. Use and disseminate information from state and local public health agencies.

2. Give anticipatory guidance.

3. Perform routine blood lead screening, as recommended.

4. Provide family lead education.

5. Provide diagnostic and follow-up testing for children with elevated BLLs.

6. Provide clinical management for children when appropriate.

7. Participate in a follow-up team.

8. Collaborate with public health agencies.

In addition to routine screening and follow-up care, child health-care providers should perform blood lead testing when children have unexplained symptoms or signs that are consistent with lead poisoning.

Children with lead poisoning can present with seizures, other neurological symptoms, abdominal pain, developmental delay, attention deficit, hyperactivity, other behavior disorders, school problems, hearing loss, or anemia.

Editor's Note: In the following discussion of the roles of the child health-care provider, we provide the roles on left hand pages, and discussion on the facing right hand pages.

1. Use and disseminate information from state and local public health agencies.

Utilize information supplied by public health agencies on:

- Recommended screening.
- Educating families about lead.
- Follow-up care.
- Referral sources.

Information from public health agencies

Public health agencies will make recommendations about screening. These recommendations will be based on local risk for exposure to lead.

Screening policy should be based on data that are representative of the entire population, and not limited to a provider practice. Children should be screened according to state and local policy.

In the absence of a statewide plan or other formal guidance from health officials, universal screening for virtually all young children, as called for in the 1991 edition of *Preventing Lead Poisoning in Young Children* (CDC, 1991), should be carried out.

Public health agencies will supply:

- Lead-education materials that reflect local policies and exposure sources.

- Protocols for follow-up care for children with elevated BLLs. Comprehensive follow-up includes in-home assessment, education, environmental investigation, and reduction of lead exposure; supports clinical management; and is discussed in detail in Section 7.

- Referrals to local experts in the treatment of lead-poisoned children, and referrals to additional supportive services for families.

2. Give anticipatory guidance.

During prenatal care and during preventive care at 3-6 months and again at 12 months, provide information about:

- Hazards of deteriorating lead-based paint in older housing.
- Methods of controlling lead hazards safely.
- Hazards associated with repainting and renovation of homes built prior to 1978.
- Other exposure sources, such as traditional remedies.

Anticipatory guidance

Anticipatory guidance should be provided prenatally, when children are 3-6 months of age, and again when they are 12 months of age, because parental guidance at these times might prevent some lead exposure and the resulting increase in BLLs that often occurs during a child's second year of life.

When children are 1-2 years of age, parental guidance should be provided at well-child visits and when the personal-risk questionnaire is administered. (See Section 3.3 below.)

3. Perform routine blood lead screening as recommended.

3.1. Sampling method.

Screening should be done by a blood lead measurement of either a venous or capillary (fingerstick) blood specimen.

3.2 Recommended screening.

Follow health-department recommendations on screening. In the absence of recommendations from the health department, screen all children at ages 1 and 2 and children 36-72 months of age who have not been previously screened.

Choice of sample collection method

The choice of a sample-collection method (venipuncture or fingerstick) should be determined by the accuracy of test results, the availability of trained personnel, convenience, and cost. If children's fingers are cleaned carefully, capillary (fingerstick) sampling can perform well as a screening tool.

Screening recommendations

Universal screening will be recommended where the risk for lead exposure is widespread.

A sample universal screening recommendation:
Using a blood lead test, screen all children at ages 1 and 2 and all children 36-72 months of age who have not been previously screened.

Targeted screening will be recommended where risk is less or is confined to specific geographic areas or to certain subpopulations.

A sample targeted-screening recommendation:
Using a blood lead test, screen children at ages 1 and 2, and children 36-72 months of age who have not previously been screened, if they meet one of the following health-department criteria:

- *Residence in a geographic area (e.g., a specified zip code).*
- *Membership in a high-risk group (e.g., Medicaid recipients).*
- *Answers to a personal-risk questionnaire indicating risk.*

3.3. The personal-risk questionnaire.

In places *with targeted screening,* the health department may recommend routine use of a questionnaire to help identify children who should receive BLL screening.

Such a questionnaire should also be used at times other than the routine screening schedule if it is suspected that a child faces increased risk for lead exposure (e.g., because the family has moved to an older house).

The personal-risk questionnaire

A basic personal-risk questionnaire:

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 day-care 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 re-modeling (within the last 6 months)?

3. Does your child have a sibling or playmate who has or did have lead poisoning?

The health department may recommend additional or different questions for soliciting information about local sources of exposure.

3.4. Additional BLL screening.

In addition to recommended routine screening, BLL screening is also indicated when:

- A child's likelihood of exposure has increased.
- An older child has excessive mouthing behavior or an exposure to lead.
- Parents have knowledge of a child's lead exposure and request screening.

Indications for additional screening

Increased likelihood of exposure. Children's risk for lead exposure may increase, for example, because the family has moved to older housing or to a geographic area with a higher prevalence of older housing, or because the child lives in an older home that has recently been repaired or renovated.

Parental request. Parents may express concern about their children's potential lead exposure because of residence in older housing, nearby construction or renovation, an elevated BLL in a neighbor's child, or unusual household exposures. Such information may be valuable in highlighting potential exposure. A BLL test should be performed if there is reason to suspect that lead exposure has occurred.

4. Provide family lead education.

Provide families of children with capillary or venous BLLs ≥10 μg/dL with prompt and individualized education about the following:

- Their child's BLL, and what it means.
- Potential adverse health effects of the elevated BLL.
- Sources of lead exposure and suggestions on how to reduce exposure.
- Importance of wet cleaning to remove lead dust on floors, window sills, and other surfaces; the ineffectiveness of dry methods of cleaning, such as sweeping.
- Importance of good nutrition in reducing the absorption and effects of lead. If there are poor nutritional patterns, discuss adequate intake of calcium and iron and encourage regular meals.
- Need for follow-up BLL testing to monitor the child's BLL, as appropriate.
- Results of environmental inspection, if applicable.
- Hazards of improper removal of lead-based paint. Particularly hazardous are open-flame burning, power sanding, water blasting, methylene chloride-based stripping, and dry sanding and scraping.

Family lead education

Education should be reinforced during follow-up visits, as needed.

Health departments can often furnish educational materials to the health-care provider, including print materials in various languages.

5. Provide diagnostic and follow-up testing for children with elevated BLLs.

5.1 Diagnostic testing.

The following schedule is recommended.

Table 4.1. Schedule for diagnostic testing of a child with an elevated BLL on a screening test

If result of screening test (μg/dL) is:	Perform diagnostic test on venous blood within:
10-19	3 months
20-44	1 month-1 week*
45-59	48 hours
60-69	24 hours
70 or higher	Immediately as an emergency lab test

* The higher the screening BLL, the more urgent the need for a diagnostic test.

Diagnostic testing

A diagnostic test is the first venous BLL test performed within 6 months on a child with a previously elevated BLL on a screening test. If the diagnostic test is not performed within 6 months, the next test is considered a new screening test, and decisions about follow-up testing should be made on the basis of the new test, and not on the basis of the original screening test.

It is relatively common for children to have slightly elevated screening test results that do not persist on additional testing. For this reason, it is preferable to base interventions on the results of diagnostic testing.

Exception to the recommended schedule

If a child with an elevated screening test result is less than 12 months old, or if there is reason to believe that a child's BLL may be increasing rapidly, consider performing the diagnostic test sooner than indicated in the accompanying schedule.

5.2. Follow-up testing for children with elevated diagnostic BLLs.

- Children with diagnostic BLLs of 10-14 μg/dL should have at least one follow-up test within 3 months.

- Children with diagnostic BLL tests of 15-19 μg/dL should have a follow-up test within 2 months.

- If the result of follow-up testing is ≥20 μg/dL, or if the child has had two or more venous BLLs of 15-19 μg/dL at least 3 months apart, the child should receive clinical management (see next section).

- Children with diagnostic BLLs ≥20 μg/dL should receive clinical management, which includes additional follow-up testing (see next section).

Follow-up testing

A follow-up test is a venous BLL test used to monitor the status of a child with an elevated diagnostic BLL test.

Regular measurement of the BLL of a child with an elevated diagnostic test result is important because the BLL may continue to rise. Rising BLLs are especially likely in children 6 months to 2 years of age because this is the age group in which mouthing behavior is most frequent.

6. Provide clinical management for children when appropriate.

Clinical management includes:

6.1. Clinical evaluation for complications of lead poisoning.

6.2. Family lead education and referrals.

6.3. Chelation therapy, if appropriate.

6.4. Follow-up testing at appropriate intervals.

Clinical management

Clinical management is part of comprehensive follow-up care and is defined as the care that is usually given by a health-care provider to a child with an elevated BLL.

Office visits for clinical management should be complemented by activities that take place in the child's home, such as home visits by a nurse, social worker, or community health worker; environmental investigation; and control of lead hazards identified in the child's environment.

See Table 4.3. for a summary of comprehensive follow-up care.

Note: The accompanying recommendations about clinical management are based on the experience of clinicians who have treated lead-poisoned children. They should not be seen as rigid rules and should be used to guide clinical decisions.

6.1 Perform a clinical evaluation.

Table 4.2. Clinical evaluation

Medical history.
Ask about: • Symptoms. • Developmental history. • Mouthing activities. • Pica. • Previous BLL measurements. • Family history of lead poisoning.
Environmental history.
Ask about: • Age, condition, and ongoing remodeling or repainting of primary residence and other places that the child spends time (including secondary homes and day-care centers). Determine whether the child may be exposed to lead-based paint hazards at any or all of these places. • Occupational and hobby histories of adults with whom the child spends time. Determine whether the child is being exposed to lead from an adult's workplace or hobby. • Other local sources of potential lead exposure.
Nutritional history.
• Take a dietary history. • Evaluate the child's iron status using appropriate laboratory tests. • Ask about history of food stamps or WIC participation.
Physical examination.
Pay particular attention to the neurologic examination and to the child's psychosocial and language development.

Clinical evaluation

Medical history. Developmental progress should be monitored carefully. If there are delays or lags, the child should be referred to an early intervention program for further assessment.

Environmental history. State and local health departments may provide additional questions about local exposure sources.

Nutritional status. Identified nutritional problems should be corrected.

- Deficiencies of calcium and iron may increase lead absorption or toxicity.
- A diet high in fat may result in increased lead absorption.
- Because more absorption of lead may be increased when the stomach is empty, the scheduling of smaller and more frequent meals may be helpful.

Physical examination. Findings of language delay or other neurobehavioral or cognitive problems should prompt referral to appropriate programs. Children may need early intervention programs and further examinations during the early school years to facilitate entry into an appropriate educational program.

6.2. Provide family lead education and referrals.

See Section 4 for topics that should be covered as part of family lead education.

Refer children for appropriate social services if problems such as inadequate housing, lack of routine health care, or need for early intervention educational services are discovered.

Family lead education and referrals

The first opportunity to educate families about the causes and consequences of a child's elevated BLL usually occurs in the health-care provider's office. Health-care providers should discuss both short-term repercussions of elevated BLLs (e.g., the need for follow-up testing and treatment, the need to control lead hazards in the child's environment) and long-term repercussions (e.g., the potential for future learning problems, the availability of early-intervention services).

Health departments may provide printed materials, flipcharts, and videos that can assist in the family-education process.

The health department may also provide referral sources, such as social-service agencies, parent-support groups, and housing services.

6.3. Provide appropriate chelation therapy.

A child with a BLL ≥45 μg/dL should be treated promptly with appropriate chelating agents and be removed from sources of lead exposure.

BLL testing for children undergoing chelation. Before chelation therapy is initiated, a child with a BLL <70 μg/dL should have a second BLL test, performed on a venous specimen, to ensure that therapy is based on the most recent and reliable information possible. Children with screening BLLs of 60-69 μg/dL should have a venous BLL test within 24 hours.

Children with BLLs ≥70 μg/dL should have an urgent repeat BLL test, but chelation therapy should begin immediately, and not be delayed until the test result is available.

A child who is receiving chelation therapy should be tested at least once a month. When chelation is terminated, BLLs should be monitored frequently until sources of lead exposure have been identified and addressed.

Chelation therapy

Chelation therapy should be initiated immediately for all children with an initial screening-test result that is ≥70 μg/dL. If such an elevated BLL is obtained on a fingerstick sample, the health-care provider should order an immediate diagnostic test and consider initiating chelation while that test is being performed, *if there is reason to believe that the results of the screening test are accurate (e.g., if it was obtained by a skilled phlebotomist under controlled conditions).*

6.4. Provide follow-up BLL testing at appropriate intervals.

Children who are receiving clinical management should be tested at 1- to 2-month intervals until these three conditions are met:

1) The BLL has remained <15 μg/dL for at least 6 months, and

2) Lead hazards, e.g., chipping, peeling, lead-based paint, traditional remedies, etc., have been removed, and

3) There are no new exposures.

When these conditions are met, children should be tested approximately every 3 months.

Children for whom these three conditions are met and who have reached 36 months of age no longer need to receive follow-up testing.

Follow-up testing

A follow-up test is a venous BLL test used to monitor the status of a child with an elevated BLL on a diagnostic test.

Children who are receiving clinical management should receive follow-up testing to monitor the effectiveness of services they receive (e.g., lead education, home visitation and environmental investigation, lead-hazard control, chelation therapy).

7. Participate in a follow-up team.

Table 4.3. Comprehensive follow-up services, according to diagnostic* BLL

BLL (μg/dL)	Action
<10	Reassess or rescreen in 1 year. No additional action necessary unless exposure sources change.
10-14	Provide family lead education. Provide follow-up testing. Refer for social services, if necessary.
15-19	Provide family lead education. Provide follow-up testing. Refer for social services, if necessary. If BLLs persist (i.e., 2 venous BLLs in this range at least 3 months apart) or worsen, proceed according to actions for BLLs 20-44.
20-44	Provide coordination of care (case management). Provide clinical management (described in text). Provide environmental investigation. Provide lead-hazard control.
45-69	Within 48 hours, begin coordination of care (case management), clinical management (described in text), environmental investigation, and lead hazard control.
70 or higher	Hospitalize child and begin medical treatment immediately. Begin coordination of care (case management), clinical management (described in text), environmental investigation, and lead-hazard control immediately.

* A diagnostic BLL is the first venous BLL obtained within 6 months of an elevated screening BLL.

The follow-up team and comprehensive follow-up services

Comprehensive services are best provided by a team that includes the health-care provider, care coordinator, community-health nurse or health advisor, environmental specialist, social services liaison, and housing specialist. Coordination of care, environmental services (i.e., identifying and controlling sources of lead exposure) and relocation to safe housing are typically provided or coordinated by the health department.

Because childhood lead exposure is likely to be associated with poor and deteriorating communities, children with elevated BLLs may also have problems such as inadequate housing, lack of routine medical care, and poor nutrition. Children may also need educational services, and the team may be instrumental in ensuring that children with a history of elevated BLLs receives early intervention or special education services for which they are eligible.

8. Collaborate with public health agencies.

Health departments and child health-care providers should interact in a number of ways:

- They should exchange information on local exposures to lead.
- Providers should put complete information on laboratory BLL test-requisition slips and should report children with elevated BLLs to the health department, as required.
- Health departments should collect lab data, analyze it, and prepare reports for providers and the public.
- Providers should encourage health departments to review data and to adjust screening recommendations as necessary.

Working with the health department

Some states require that laboratories report the results of all children's BLL tests, along with demographic and address information. These reports are the foundation of BLL surveillance systems and depend on complete and accurate information being placed on the lab slip by the provider.

On the basis of surveillance information and other information from health-care providers, state and local health departments will be able to review and improve screening recommendations so that they are as effective as possible.

5 CDC Resources and Information for Implementation of Guidance

The guidance in this document calls upon state and local health departments to use data and an inclusive process to develop screening recommendations. Some health departments are already carrying out this process. Others will need support for additional efforts. CDC provides resources and support to health departments to ensure that this guidance is implemented in an effective and timely way.

Statewide plan. CDC gives technical assistance to health departments in the statewide planning process and in the dissemination of screening recommendations.

Census data. U.S. census data are available from many sources. CDC offers assistance in analyzing and displaying these data, and, with other Federal agencies, has future plans to make appropriate parts of the census data files available on the Internet to support lead poisoning prevention activities.

Grant program. CDC provides funding to states and localities through the State and Community-Based Childhood Lead Poisoning Prevention Program grants for screening, for ensuring that follow-up care takes place, and for lead education and monitoring and surveillance activities. In the future, CDC will support grantees in developing and disseminating screening recommendations.

Blood lead surveillance data. CDC assists state and local lead programs in collecting, managing, analyzing, and disseminating surveillance data, and in evaluating the usefulness of these data for statewide planning.

Outreach and communication. CDC provides materials and technical assistance to health departments to aid them in communications with other agencies, child health-care providers, managed-care organizations, and the public. For example, CDC provides a prototype for a handbook for health-care providers. (See Section A)

List of additional information available from CDC.

A. Support for child health-care providers: a prototypic handbook for providers. For use by health departments in preparing materials for health-care providers, this template includes background information and space for additional state and local materials such as state policies, screening recommendations, patient-education brochures, and local referral sources.

B. Developing a statewide plan: materials for examining and analyzing data and making screening recommendations. For use by state and local health officials and epidemiologists, and their advisors in decision making, these materials provide important background.

B.1 *Update: Blood Lead Levels–United States, 1991-1994. Morbidity and Mortality Weekly Report, February 21, 1997.* MMWR article containing data from Phase 2 of the Third National Health and Nutrition Examination Survey

(NHANES III), from 1991 to 1994.

B.2 Brody DJ, Pirkle JL, Kramer RA, et al. *Blood lead levels in the U.S. population: phase 1 of the Third National Health and Nutrition Examination Survey (NHANES III, 1988 to 1991).* JAMA 1994;272:277–83.

B.3 Pirkle JL, Brody DJ, Gunter EW, et al. *The decline in blood lead levels in the United States: the National Health and Nutrition Examination Surveys (NHANES).* JAMA 1994;272:284–91.

B.4 *Costs and benefits of a universal screening program for elevated blood lead levels in 1-year-old children.* Cost-benefit analysis performed by scientists within and outside CDC.

B.5 *Relationship between prevalence of BLLs >10 μg/dL and prevalences above other cut-off levels.* Table of expected proportions of children with BLLs higher than selected thresholds, given different prevalences of elevated BLLs.

B.6 *Exact confidence intervals for some hypothetical estimates of prevalence of BLLs >10 μg/dL, by number of children screened.*

B.7 *Conditions required for a source of lead to be a lead hazard.*

B.8 *Samples of Medicaid contract language on childhood blood lead screening.*

B.9 *List of studies of effectiveness of personal-risk questionnaires for selecting children for blood lead screening.*

C. Materials for Laboratorians

C.1 *The lead laboratory.* A summary of laboratory issues, including quality assurance and accreditation.

C.2 *Capillary blood sampling protocol.*

C.3 *Proficiency testing and quality control.*

Table A: Proficiency Testing Programs for Lead Laboratories

Table B: Quality Control Materials for Use in Blood Lead Testing

Table C: Quality Control Materials for Use in Urine Lead Testing

Table D: Quality Control Materials for Erythrocyte Protoporphyrin Tests

6 Childhood Lead Poisoning Prevention Research Priorities

If we are to improve lead poisoning prevention strategies, we need additional research in the following areas:

1) Effectiveness of interventions aimed at preventing or reducing elevated BLLs and their adverse health effects among children, including studies of:

   - The effectiveness and cost effectiveness of interventions to control lead hazards in housing.

   - The effectiveness of family education about lead poisoning prevention in preventing BLL elevations or in reducing already elevated BLLs.

   - The effectiveness of chelation therapy in preventing or reducing neurobehavioral effects of elevated BLLs, especially among children with modestly elevated BLLs.

2) Barriers to screening and other lead poisoning prevention activities, especially in places with high prevalences of elevated BLLs.

3) Prediction of places with high and low prevalences of elevated BLLs. Such information could be used to allocate resources and target efforts.

4) Methods of identifying individual children with BLLs ≥20 μg/dL including research on the use of the personal-risk questionnaire.

5) The impact of new laboratory methods, including hand-held and clinic-based BLL analyzers, on prevention programs and BLL monitoring.

6) The contribution to elevated BLLs in children of nonpaint sources of lead exposure, including studies of exposure to lead taken home from workplaces of adults.

Glossary

Included below are two sets of definitions. One set is generally used in public health, child health care, and preventive medicine. The second set is specific to this document.

General	Specific to this document
Anticipatory guidance is the education provided to parents or caretakers during a routine prenatal or pediatric visit to prevent or reduce the risk that their fetuses or children will develop a particular health problem.	**Anticipatory guidance** is the education provided to parents or caretakers during a routine prenatal or pediatric visit to prevent or reduce the risk that their fetuses or children will develop lead poisoning. In general, anticipatory guidance for lead should include information about the dangers of deteriorating lead-based paint in homes and of improper renovation or remodeling that disturbs lead-based paint.
Assessment is the process, usually carried out or coordinated by a public health agency, of determining the nature and extent of hazards and health problems within a jurisdiction.	
	A **blood lead level (BLL)** is the concentration of lead in a sample of blood. This concentration is usually expressed in micrograms per deciliter (μg/dL) or micro moles per liter (μmol/L). One μg/dL is equal to 0.048 μmol/L.

General	Specific to this document
	Care coordination is the formal coordination of the care of a child with a BLL that exceeds a specific value—as determined by local or state officials—and the assurance that services needed by that child are provided.
	Clinical management is the care of a child with an elevated BLL that is usually performed by a child health-care provider. It includes 1) clinical evaluation for complications of lead poisoning; 2) family lead education and referrals; 3) chelation therapy, if appropriate; 4) follow-up testing at appropriate intervals.
A **diagnostic test** is a laboratory test used to determine whether a person has a particular health problem.	A **diagnostic test** is the first venous blood lead test performed within 6 months on a child who has previously had an elevated BLL on a screening test.
A **follow-up test** is a laboratory test for the purpose of monitoring the care of a person with a particular health problem.	A **follow-up test** refers to a blood lead test used to monitor the status of a child with a previously elevated diagnostic test for lead.

General	Specific to this document
A **jurisdiction** is the geographic area over which a state or local government has political authority. Counties and incorporated places, such as cities, boroughs, towns, and villages, are examples of jurisdictions. One jurisdiction may lie partially or totally within another, such as a county within a state.	
	A **lead poisoning prevention program** is an organized set of activities, including primary and secondary prevention activities, to prevent childhood lead poisoning.
	A **personal-risk questionnaire** is administered by a child health-care provider to the parents or guardians of a young child to help determine whether that child is at increased risk of having an elevated BLL. The personal-risk questionnaire is one component of an individual risk evaluation.
A **place** is any geographic area.	
Prevalence is the percentage of a population with a particular characteristic.	**Prevalence** is the percentage of a population with an elevated BLL.
Primary prevention is the prevention of an adverse health effect in an individual or population. One method of accomplishing this is reducing or eliminating a hazard in the environment to which an individual or population is exposed.	

General	Specific to this document
	A **recommendation area** is a place for which a public health agency makes a recommendation on how to screen resident children for lead poisoning. A recommendation area can be a country, state, county, city, or other place.
Screening is a method, usually involving a physical examination or a laboratory test, to identify asymptomatic individuals as likely, or unlikely, to have a particular health problem.	**BLL screening** for lead poisoning is the routine measurement of BLLs in asymptomatic children.
A **screening program** consists of screening for a health problem, a diagnostic evaluation for those with positive screening-test results, and treatment for those in whom the health problem is diagnosed.	A **screening program** for lead poisoning is BLL screening, the diagnostic evaluation of children with elevated BLLs, and the provision of educational, environmental, medical, and other services to children found to have elevated BLLs. A screening program is one component of a childhood lead poisoning prevention program.

General	Specific to this document
A **screening test** is a laboratory test to identify asymptomatic individuals as likely or unlikely to have a particular health problem.	A **screening test** for lead poisoning is a laboratory test for lead that is performed on the blood of an asymptomatic child to determine whether the child has an elevated BLL.
Secondary prevention is the prevention or slowing of the progression of a health problem in affected individuals.	**Secondary prevention** is the identification of children with elevated BLLs and the prevention or reduction of further exposure of those children to lead.
	Targeted screening is the BLL screening of some, but not all, children in a recommendation area. The selection of children to be screened is based on the presence of a factor that places these children at increased risk for lead exposure.
	Universal screening is the BLL screening of all children at ages 1 and 2 in a recommendation area.