

Lead Guidelines for Primary Care Providers Caring for the Adult Migrant Worker

Introduction

This guideline is intended to provide useful advice to primary care clinicians caring for adult migrant patients who have been exposed to lead, whether at work, at home, in their country of origin, through hobbies, in the community, or through consumer products, retained bullets, or other sources. These guidelines have been adapted to the migrant population from the California Department of Public Health Occupational Lead Poisoning Prevention Program Medical Guidelines for the Lead-Exposed Worker, updated April 2009, and are intended to provide management guidelines appropriate for the primary care setting. For additional treatment information appropriate to the occupational health setting, consult the guidelines at <http://www.cdph.ca.gov/programs/olppp/Documents/medgdln.pdf> or other resources cited in this guideline. In attending a migrant patient with possible lead exposure or toxicity, consider the following points:

- Clinicians who evaluate patients with potential lead exposure should have appropriate public health and occupational health referral mechanisms in place for medical management and evaluation of the workplace. Although a primary goal of health care is to remove the patient from exposure, the social consequences of potential disruption of housing or of income are particularly relevant to farmworkers and must be considered by the clinician.
- Although the federal Occupational Safety and Health Administration's (OSHA) lead standards have provided guidance that has been beneficial for lead-exposed workers, these regulations have not been substantially changed since the late 1970s, and thus are primarily based on health effects studies that are well over three decades old. Nor do they adequately address long-term effects. There is an urgent need to revise them.
- The clinical guidelines presented here are appropriate for adults. They are not targeted to younger adults. Many "adult" farmworkers are adolescents who may be at greater neurodevelopmental risk than their older counterparts. See the MCN publication "Lead Guidelines for Primary Care Providers Caring for Migrant Children".
- Adult workers may include pregnant women and reproductive health risks and effects are addressed in this guideline. More detailed information relevant to the management of lead exposure in pregnant women, however, is treated as a separate problem because the guidelines differ from those for the general adult population. See the MCN publication "Lead Guidelines for the Pregnant Migrant Woman".

Background

Lead exposure may occur in more than 100 industries in the United States (Table 1). Although the toxic effects of lead have been known for centuries, harmful lead exposures are still widespread. Adults are primarily exposed in the workplace. Lead affects multiple body systems and can cause permanent damage. Lead exposure, if undetected, often results in misdiagnosis and costly care. Many workers with lead toxicity do not receive medical attention and, for those who do, follow-up may not be adequate to prevent future lead poisoning.¹ Studies have shown that only a small percentage of employers in some lead industries provide routine blood lead testing for lead-exposed employees in spite of regulatory requirements.^{2,3}

Adult migrant workers are generally not recognized as particularly at risk for lead exposure. Yet they experience a host of risk factors: frequent mobility with residential stays in substandard housing; intermittent work in hazardous occupations such as construction; work within the farm that includes lead exposure; dependence on day labor and avoidance of reporting illness; environmental exposures related to country of origin; self-importation of ethnic products that contain lead; and linguistic, cultural, and access barriers to health education and prevention efforts related to lead.

Lead is not an essential element and serves no useful purpose in the body. Acute, high-dose lead poisoning with findings such as headache, malaise, and crampy abdominal pain is now relatively uncommon. However, low exposures that in the past were without recognized harm are now considered hazardous as new information continues to emerge about

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TABLE 1. JOBS AND INDUSTRIES WITH POTENTIAL LEAD EXPOSURE

Industry Type	Work Activities
General Industry	Lead production or smelting Battery manufacturing or recycling Brass, bronze, or lead foundries Metal radiator repair Scrap metal handling Recycling of lead-sheathed cables Lead soldering Firing ranges Ceramics manufacturing Machining or grinding metal alloys containing lead Plastics manufacturing
Construction Industry	Sanding, scraping, burning, or disturbing lead paint Demolition of old structures Welding or torch cutting lead painted metal Abrasive blasting Construction or repair of bridges, water towers, tanks, roofing Lead abatement Painting—residential or commercial Renovation or remodeling structures built before 1978 Welding on metal structures

in the geometric mean blood lead level (BLL) for adults in the United States from more than 12 micrograms of lead per deciliter of blood (mcg or $\mu\text{g}/\text{dL}$) in 1980 to less than 2 $\mu\text{g}/\text{dL}$ in 2002.⁴ However, even though the average BLL in the general population has markedly declined, many workers with high-risk jobs are still overexposed to lead. Exposures in the U.S. are primarily to the inorganic form of lead.

Sources of Lead

Routes of exposure for inorganic lead are inhalation and ingestion. Lead fumes and soluble lead dust are nearly completely (~80%) absorbed by inhalation. In general, adults absorb about 10-15% of an ingested dose through the gastrointestinal tract, in contrast to 50% absorption for children. Once absorbed, lead is found in all tissues but eventually 90% or more of the body burden is accumulated (or redistributed) into bone. Lead does not remain in the bone permanently; rather, it is slowly released back into the blood with a half-life of years to decades. Lead is excreted primarily through the urine with smaller amounts in feces, sweat, hair, and nails.

Job activities known to involve the use or disturbance of lead include: handling of lead-containing powders, liquids, or pastes; production of dust or fumes by melting, burning, cutting, drilling, machining, sanding, scraping, grinding, polishing, etching, blasting, torching, or welding lead-containing solids; and dry sweeping of lead-containing dust and debris. Adults also encounter lead in environmental settings and through activities such as home remodeling, particularly in homes built before 1978 that contain lead-based paint, lead-contaminated consumer products, traditional remedies, moonshine whiskey, hobbies, such as melting lead sinkers or use of target ranges, from retained bullets, and through other sources.

Agricultural work may involve machinery repair, construction, blasting, welding, renovation, and cleaning of lead-based materials. Farmworker housing is typically substandard and even if freshly painted, may contain lead dust in the dirt surrounding the dwelling. Cooking materials, from spices to pottery to pots and pans, may contain lead if they were not manufactured in the US. Many migrant workers are not responsible for their own cooking, so the source of the crew's food preparation must be noted.

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TABLE 2. SOME COMMON NON-OCCUPATIONAL AND ENVIRONMENTAL SOURCES OF LEAD EXPOSURE

Immigration should be recognized as an environmental risk: Asia, Mexico and Central America have particularly high levels of lead still present in everyday products. Industrial pollution in Asia is a well-known source.

Remodeling or painting pre-1978 housing	Melting lead for fishing weights, bullets or toys	Leaded crystal tableware
Peeling paint	Lead solder in stained-glass artwork	Mine tailings
Ethnic medicines or folk remedies (e.g. azarcón, greta, pay-loo-ah, kandu, some Ayurvedics)	Lead-soldered cans	Beauty products such as Kohl eye make-up, certain hair dyes
Ethnic foods such as fried grasshoppers, self-imported spices, and candies. The wrappers of these foods may also contain lead, as has been shown with candies.	Lead-contaminated candies	Imported toys
Pica (ingestion of lead-containing nonfood items, e.g., soil or ceramics, plaster, or paint chips)	Backyard scrap metal recycling	Imported vinyl mini blinds
Retained lead bullet or fragments	Moonshine (liquor from a homemade still)	Recreational target shooting
	Antique pewter plates, mugs, utensils, toys	Lead-contaminated drinking water supply
	Imported brass or bronze kettles, cookware	Using lead glazes for ceramics, food dishes, and cookware. Acidic foods like salsa can leach even more lead from these containers.
	Lead-glazed tableware or cooking vessels	Painting/stripping cars, boats, bicycles

TABLE 3. SYMPTOMS ASSOCIATED WITH LEAD TOXICITY

Mild Toxicity:	Mild fatigue or exhaustion; emotional irritability or lability; difficulty concentrating; sleep disturbances
Moderate Toxicity:	Headache; general fatigue or somnolence; myalgia, arthralgia, tremor; nausea; decreased appetite; abdominal cramps, constipation or diarrhea; decreased libido
Severe Toxicity:	Colic (intermittent, severe abdominal cramps); peripheral neuropathy; encephalopathy

There are some well documented exposures related to ethnic foods and treats. Grasshoppers are considered a delicacy by people from the area of Oaxaca, Mexico. Both the grasshoppers, and the spices they are cooked in, have been found to have very high lead levels. Public health campaigns have tried to remove these items from local tiendas, but the practice continues and is not regulated. Some candies brought from Central America and Mexico have been found to contain lead, as have the wrappers. Many medicines are sent to migrants from family members in their home countries, and it is unclear how many of these traditional and prescription medicines contain lead. Recently, large levels of lead were found in vitamins imported from India. Environmental exposures that occurred in immigrants' countries of origin can result in long-term bone storage with ongoing release into the bloodstream.

See Tables 1 and 2 for additional information about high-risk occupations and other sources of lead exposure.

Effects of Lead Poisoning

Lead adversely affects multiple organ systems and can cause permanent damage. In addition to the symptoms associated with acute, high-dose exposures, there is increasing concern with regard to the sometimes subclinical health effects linked to chronic, lower-dose exposures including hypertension, effects on renal function, cognitive dysfunction,



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and adverse female reproductive outcomes. Current concern over the adverse health risks associated with lead exposure in adults starts at a BLL of 5 µg/dL for adverse female reproductive outcomes and at 10 µg/dL for the other health effects listed above.⁵

In general, the number and severity of overt symptoms worsen with increasing BLL (Table 3). Early symptoms are often subtle and nonspecific, involving the nervous system (fatigue, irritability, sleep disturbance, headache, difficulty concentrating, decreased libido), the gastrointestinal system (abdominal cramps, anorexia, nausea, constipation, diarrhea), or the musculoskeletal system (arthralgia, myalgia). A high level of intoxication can result in delirium, seizures, and coma associated with lead encephalopathy, a life-threatening condition. Symptoms may lag physiological changes. Some individuals may be unaware of any symptoms even though they are experiencing lead toxicity.

Research shows multiple health effects at BLLs once thought to be without recognized harm (Table 4).⁵ A recent review concluded that evidence is now sufficient to infer a causal relationship of lead exposure with hypertension.⁶ Since hypertension is a significant risk factor for heart disease, stroke, and renal insufficiency, lead exposure may exert an important influence on cardiovascular, cerebrovascular, and renovascular mortality.

Early kidney damage is difficult to detect. However, a 10 µg/dL increase in BLL has been associated with a 10.4 mL/minute decrease in creatinine clearance.⁷ In a population of older men with a mean BLL of 8.6 µg/dL (range 0.2-54.1), a 10-fold increase in BLL predicted an increase of 0.08 mg/dL in serum creatinine concentration, roughly equivalent to 20 years of aging.⁸ Another recent review concluded that there is an association between BLLs and decrements in cognitive function in adults.⁹ A study of currently exposed lead workers (mean age 40.4 years) showed that a 5 µg/dL increase in BLL had the same negative influence on cognitive function as an increase of 1.05 years of age.¹⁰ Subclinical slowing of nerve conduction velocity has been seen at BLLs as low as 30 µg/dL.¹¹ Because of the blood-brain barrier, lead and other heavy metals are slow to enter and leave the brain tissue. Central nervous system effects may sometimes persist well after the BLL has dropped. These effects may negatively impact job performance and safety.

While a decrease in hemoglobin was previously associated with BLLs above 50 µg/dL, a study using K-shell X-ray fluorescence measurement of lead in bone has found that bone lead levels were significantly correlated with a decrease in hemoglobin and hematocrit even though BLLs were low (mean 8.3 µg/dL); this may reflect a subclinical effect of bone lead stores on hematopoiesis.¹²

Abnormal sperm morphology and decreased sperm count have been observed at approximately 40 µg/dL.^{13,14} In a cohort of 668 pregnant women seeking prenatal care in Mexico City, it was found that women whose BLLs were 5-9, 10-14, and > 15 µg/dL had elevated odds ratios for spontaneous abortion of 2.3, 5.4, and 12.2, respectively, as compared with the reference category of women with < 5 µg/dL of blood lead.¹⁵ Lead readily crosses the placenta and is present in breast milk.¹⁶ Lead exposure during pregnancy affects children's physical development measured during the neonatal period and in early childhood.^{17,18,19} Elevated maternal BLLs have also been associated with poorer infant mental development and adverse impacts on postnatal neurobehavioral development.^{20,21,22}

Household members of workers with lead exposure are at increased risk for lead poisoning if lead is carried home on the worker's body, clothes, shoes, or in the personal vehicle (called "take-home" exposure). Children under six years old and the fetus are especially sensitive to neurological damage. Available evidence suggests there is no BLL without risk of health effects in these populations.²³

Medical Evaluation Screening

Taking a detailed medical and environmental/occupational history is a fundamental step in both determining whether a patient should receive BLL testing and for the assessment of a person with lead exposure. It is important to ask about exposure to lead in current and previous jobs (Table I), protections used, biological and air monitoring data, hygiene practices, knowledge and training, hobbies, traditional medications and foods, imported, cookware and cosmetics, moonshine use and other non-occupational sources (Table 2). Immigration from Asia, Central America, or Mexico is an

independent risk factor. A medical and reproductive history is essential in identifying individuals at increased risk of adverse health effects from lead exposure. Physical exam findings in lead poisoning are frequently lacking. Gingival lead lines and wrist or foot drop, manifestations of high lead exposures, are rarely seen.

Medical Management of Pregnant Women Based on Blood Lead Levels

TABLE 4. HEALTH-BASED MANAGEMENT RECOMMENDATIONS FOR LEAD-EXPOSED ADULTS

Blood Lead Level (BLL) µg/dL	Short Term Risks Lead exposure < 1 year	Long Term Risks Lead exposure ≥ 1 year	Management
< 5	None documented	None documented	
5 – 9	Possible spontaneous abortion Possible postnatal developmental delay	Possible spontaneous abortion Possible postnatal developmental delay Possible hypertension and kidney dysfunction	Discuss health risks Reduce lead exposure for women who are or may become pregnant
10 – 19	Possible spontaneous abortion Possible postnatal developmental delay Reduced birth weight	Possible spontaneous abortion Possible postnatal developmental delay Reduced birth weight Hypertension and kidney dysfunction Possible subclinical neurocognitive deficits	As above for BLL 5-9 µg/dL, plus: Decrease lead exposure Increase biological monitoring Consider removal from lead exposure to avoid long term risks if exposure control over an extended period does not decrease BLL below 10 µg/dL, or if medical condition present that increases risk with continued exposure*
20-29	Possible spontaneous abortion Possible postnatal developmental delay Reduced birth weight	Possible spontaneous abortion Possible postnatal developmental delay Reduced birth weight Hypertension and kidney dysfunction Possible subclinical neurocognitive deficits	Remove from lead exposure if repeat BLL measured in 4 weeks remains ≥ 20 µg/dL
30-39	Spontaneous abortion Possible postnatal developmental delay Reduced birth weight	Spontaneous abortion Possible postnatal developmental delay Reduced birth weight Hypertension and kidney dysfunction Possible neurocognitive deficits Possible non-specific symptoms**	Remove from lead exposure
40-79	Spontaneous abortion Possible postnatal developmental delay Reduced birth weight Non-specific symptoms** Neurocognitive deficits Sperm abnormalities	Spontaneous abortion Possible postnatal developmental delay Reduced birth weight Non-specific symptoms** Hypertension Kidney dysfunction/nephropathy Subclinical peripheral neuropathy Neurocognitive deficits Sperm abnormalities Anemia Colic Possible gout	Remove from lead exposure Refer for prompt medical evaluation Consider chelation therapy for BLL over 50 µg/dL with significant symptoms or signs of lead toxicity
≥ 80	Spontaneous abortion Possible postnatal developmental delay Reduced birth weight Non-specific symptoms** Neurocognitive deficits Encephalopathy Sperm abnormalities Anemia Colic	Spontaneous abortion Possible postnatal developmental delay Reduced birth weight Non-specific symptoms** Hypertension Nephropathy Peripheral neuropathy Neurocognitive deficits Sperm abnormalities Anemia Colic Gout	Remove from lead exposure Refer for immediate/urgent medical evaluation Probable chelation therapy

* Medical conditions that may increase the risk of continued exposure include chronic renal dysfunction (serum creatinine > 1.5 mg/dL for men, > 1.3 mg/dL for women, or proteinuria), hypertension, neurological disorders, and cognitive dysfunction.

** Headache, fatigue, sleep disturbance, anorexia, constipation, arthralgia, myalgia, decreased libido, etc.

See Figure 1 for a suggested set of environmental and occupational health screening questions for the primary care setting. This tool was developed by the Migrant Clinicians Network with guidance from the Environmental and Occupational Medicine Residency Directors Association and endorsed by the Association for Occupational and Environmental Clinics. As a first line of screening, it is likely to reveal individuals who are at risk for lead exposure.

Testing

The single best diagnostic test for lead exposure is the blood lead level. It reflects the amount of lead currently found in the blood and soft tissues (and hence key target organs). The BLL alone is not a reliable indicator of prior or current exposure, or total body burden. BLLs reflect the contributions of recent external exposure to lead as well as the release of internal bone lead stores into the blood. As such, BLLs represent a mixture of both external exposure and internal lead stores.²⁴ When interpreting a person's blood lead level, three key questions to keep in mind are whether the exposure history has been:

- acute or chronic?
- recent or remote?
- high or low?

Periodic testing of BLL is called biological monitoring. This provides valuable information to assess lead exposure for individuals as well as groups of workers. Note that a detailed exposure history is an essential part of evaluating and interpreting biological monitoring information.

While the Cal/OSHA lead standards require zinc protoporphyrin (ZPP) testing, this is an indirect and insensitive biomarker of lead absorption. An elevated ZPP may indicate that lead is affecting the heme synthesis pathway. This effect can begin at a BLL as low as 20 µg/dL in some adults but is not greater than 90% sensitive until the BLL exceeds 50 µg/dL. An increase in ZPP usually lags an increase in BLL by two to six weeks. Therefore, a normal EP or ZPP in the presence of an elevated BLL suggests recent exposure. OLPPP recommends that routine measurement of ZPP be undertaken only when necessary to comply with the Cal/OSHA lead standards. Other medical conditions can cause an elevated ZPP, the most common being iron deficiency anemia, porphyria, and inflammatory conditions.^{25,26} The upper limit of normal for ZPP varies some between labs but is usually between 35 and 40 µg/dL.

It is important to check BLLs of household members, particularly children, of lead-exposed individuals. Lead workers may unwittingly expose their families to lead dust brought home on clothes, shoes and in cars. Farmworker housing that is situated at the worksite may increase possibilities for exposure.

Patient Education

Individuals at risk of lead exposure should receive education on the following points:

1. Wear protective clothing at work
2. Meals eaten at work should be eaten in a clean area

Figure 1. Environmental and Occupational Health Screening Questions for the Primary Care Setting.

1. (Occupation) Describe what you do for work.
2. (Activities and Cause) Are there any physical activities that you do – at work or away from work – that you feel are harmful to you?
3. (Substances/Physical Hazards and Cause) Are you exposed to chemicals, fumes, dusts, noise, and/or high heat at your work or away from work? Do you think these are harming you?

Figura 1. Preguntas para sondear en los lugares de atención a la salud

- 1 (Ocupación) Describa lo que hace en su trabajo.
2. (Actividades y causa) ¿Qué actividades físicas hace usted –en su trabajo o en otro lugar- que usted cree que le hacen daño?
3. (Sustancias/peligros físicos y causa) ¿Usted está expuesto en su trabajo o en otro lugar a químicos, humos, polvos, ruido, o altas temperaturas? ¿Usted cree que esas actividades le están haciendo daño?

Developed by MCN with guidance from the Occupational and Environmental Medical Residency Directors Association and endorsed by the Association for Occupational and Environmental Clinics, 2007.

3. Wash hands before eating
4. Shower and change clothing before touching household members
5. Maintain as much separation of home from workplace as possible, i.e., wash work clothes separately, do not allow children to play in or near work areas.

The Migrant Clinicians Network offers resources and educational materials particularly suited to those who serve migrant workers and the mobile poor: www.migrantclinician.org

Diagnosis and Management

The primary therapy for lead poisoning is cessation of exposure.

For any BLL $\geq 10 \mu\text{g}/\text{dl}$, treatment should be initiated. Recent research findings, as noted above, have prompted revised health-based management recommendations for lead-exposed adults. These recommendations and the adverse health risks associated with short-term and long-term exposures at different BLLs are summarized in Table 4. The table presents recommendations for a broad range of BLLs.

Primary care providers should enlist the assistance of an environmental/occupational health specialist for management and ongoing surveillance of lead toxicity in adults. To locate an Environmental Occupational Health Clinic in your area, consult www.aoc.org.

The clinician, with the patient's permission, should contact the employer for further workplace exposure information, such as air level monitoring, biologic monitoring and Material Safety Data Sheets (MSDSs). Work-related exposure measurements should be readily available to the clinician. The federal OSHA standards are available at <https://www.osha.gov/SLTC/lead>. Small businesses can obtain information at <http://www.osha.gov/dosp/smallbusiness/index.html>.

Assistance, especially for non-occupational problems such as herbal remedies, candy, moonshine, etc. is available from local and/or state health departments

Chelation Therapy

In adults, the use of chelation therapy is generally reserved for those with symptoms or signs of severe toxicity and/or very high BLLs. While uncommon, adults may have a very high BLL (e.g., 80 - 99 $\mu\text{g}/\text{dL}$) and have no overt symptoms. These patients should be removed from exposure and followed carefully.

Patients with BLLs of 80-99 $\mu\text{g}/\text{dL}$, with or without symptoms, as well as some symptomatic individuals with BLLs of 50-79, can be considered for chelation. Levels above 100 $\mu\text{g}/\text{dL}$ usually warrant chelation as they are often associated with significant symptoms and may be associated with an incipient risk of encephalopathy or seizures.⁵

Chelation therapy primarily reduces lead in the blood and soft tissues, such as liver and kidneys, and has a relatively smaller impact on the fraction of lead stored in bone. In patients with substantial bone lead stores who are chelated, re-equilibration of lead from bone back into blood and soft tissues may result in a rebound effect with a rise in the BLL after an initial drop. Symptoms associated with lead toxicity may recur.

Chelation guidelines are controversial and may change as new agents and information are introduced. Although chelation has been associated with improvement in symptoms and decreased mortality, controlled clinical trials demonstrating efficacy are lacking, and treatment recommendations have been largely empirical.²⁷

Chelation therapy should not be initiated until after the individual has been removed from exposure and should not be continued if the individual returns to a lead exposure job. Chelation should be considered only on an individual case basis and in consultation with medical providers who are knowledgeable about treatment of adult lead poisoning.²⁸

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