Environmental Medicine Grand Rounds

Lead Toxicity

Lead

Medical Grand Rounds Seminar
Learning Objectives

• Explain what lead is
• Identify where lead is most commonly found in the United States today
• Identify the most important routes of exposure to lead
• Identify the populations most heavily exposed to lead
• State the CDC’s level of concern for lead in children’s blood and recommendations for screening
• State the OSHA level for intervention for occupational exposure to lead
Learning Objectives (cont’d)

• Describe the way lead is taken up, distributed, and stored throughout the body
• Describe at least three major physiologic effects of lead
• Name three symptoms of mild lead toxicity
• Name three symptoms of acute lead toxicity
• Name the most useful test for lead toxicity
Learning Objectives (cont’d)

• List three steps that should be taken at blood lead levels between 10 and 19 mcg/dL
• Describe additional steps that should be taken for BLL 20-44 mcg/dL, 45-69 mcg/dL and 70 mcg/dL and above
• List steps patients with domestic exposures can take to reduce lead exposure
• List steps patients with occupational exposures should take
What is Lead?

- Soft blue-gray metal
- Found in the natural environment
- Was added to paint and gasoline in past
- Still used in consumer products

_the natural ore galena_
How Does Lead Get Into the Environment?

- Deterioration of lead-based paint
- Leaded gasoline
- Businesses that involve lead
- Lead mines or smelters
How Are People Exposed to Lead?

- Dust, paint, and/or soil
- Contaminated food, water, or alcohol
- Some imported home remedies and cosmetics
- Endogenous exposure
Lead in Home Environments

- Pre-1978 homes with deteriorated leaded paint
- Children at greatest risk
- Most exposure through leaded dust in home
- Lead dust levels have been directly correlated with children’s BLL
How Are People Exposed to Lead in Work Environments?

- Swallowing lead dust
- Breathing contaminated air
- Lead contacting skin
- Workers can expose their families if they bring lead home on their clothes or skin
What Jobs Involve Lead?

- Lead smelting or mining
- Construction/remodeling
- Automobile repair
- Plumbing
- Police officers/military
- Many others
What Hobbies Involve Lead?

- Car repair
- Artistic painting
- Stained glass
- Pottery glazing
- Soldering
- Target shooting
- Making bullets, slugs or fishing sinkers
Lead in Drinking Water

• Lead can enter water by leaching from
  – Lead-containing pipes
  – Brass faucets
  – Solder
• Boiling does not get rid of lead
• Running cold water before use may reduce exposure
Lead in Commercial Products

• Lead is still used in products such as:
  – Bridge paint
  – Computers
  – Solder
  – Pewter
  – Ceramic glazes
  – Jewelry
  – Automotive batteries

• Imported or older pre-regulation products
Lead in Food Products

• Food or beverages may be contaminated through
  – Production
  – Packaging
  – Storage
Lead in Ethnic Products

- **Mexican**: azarcon, greta, liga, Maria Luisa, alarcon, coral, rueda

- **Asian**: chuifong, tokuwan, ghasard, bali goli, kandu, surma, ba-baw-san

- **Middle Eastern**: alkohl, saoott, cebagin

- **For more examples, see Appendix 1 of**: http://www.cdc.gov/nceh/lead/CaseManagement
Lead in the Environment

- Varies from place to place
- Soil near roadways (pre-1976 gasoline)
- Elevated in soil, water, or air near lead mining or smelting facilities
- Near smaller businesses and industries that involve lead
Who is Most at Risk of Lead Exposure?

• Children living in older housing

• Pregnant women and developing fetus
Biologic Fate

• Most lead is excreted
• Children and pregnant women absorb more lead than others
• Exchanged between blood, soft tissues, and mineralizing tissues
Physiologic Effects of lead

- No known threshold for effects of lead
- Affects all organ systems
- Developmental neurologic effects of greatest concern
Neurologic Effects of Lead

- Neurologic effects on children documented at levels below 10 mcg/dL
- Low exposure effects: lowered IQ, attention deficits, and impaired hearing
- High exposure effects: irritability, convulsions, coma, or death
- Similar effects in adults at higher exposure levels
Renal Effects of Lead

• Acute exposure: reversible effects
• Chronic exposure: nephropathy (chronic interstitial nephritis)
• Childhood exposures → adult renal disease
Hematologic Effects of Lead

- Interferes with production of hemoglobin
- Can induce two kinds of anemia:
  - Acute exposure → hemolytic
  - Chronic exposure → synthetic
- Threshold for adults: 50 mcg/dL
- Threshold for children: 40 mcg/dL
Endocrine Effects of Lead

- Inverse correlation between BLLs and vitamin D levels
- Chronic exposure may affect thyroid function
Cardiovascular Effects of Lead

• Increases risk of hypertension
Developmental Effects of Lead

• Crosses the placental barrier
• Affects fetal viability, and fetal and early childhood development
• Maternal lead may affect child’s neurologic development
Clinical Evaluation

- Preventive screening
- Exposure History
- Physical evaluation
- Signs and symptoms
Preventive Screening

- See state or local guidance for blood lead screening
- CDC guidelines
  - Test children at ages one and two
  - Test children annually to age six if high-risk
- For adults, see OSHA guidelines
- Lead exposure risk questions
Environmental Exposure History

- Age and condition of residences
- Home remodeling activities
- Occupations and hobbies of family
- Family history
  - Maternal exposure
  - Unusual medicines or home remedies.
- Imported or glazed ceramics or lead crystal
- Siblings or playmates with lead poisoning
Physical Examination

• Neurologic
• Hematologic
• Cardiovascular
• Gastrointestinal
• Renal
• For children: hearing and nutritional status
Signs and Symptoms

• Patient may appear asymptomatic
• Impaired abilities may include
  – Decreased learning and memory
  – Lowered IQ
  – Decreased verbal ability
  – Impaired speech and hearing functions
  – Early signs of hyperactivity or ADHD
• Symptoms vary by exposure level
Signs and Symptoms: Low Toxicity

- Myalgia or paresthesia
- Mild fatigue
- Irritability
- Lethargy
- Occasional abdominal discomfort
Signs and Symptoms: Moderate Toxicity

- Arthralgia
- General fatigue
- Difficulty concentrating/Muscular exhaustibility
- Tremor
- Headache
- Diffuse abdominal pain
- Vomiting
- Weight loss
- Constipation
Signs and Symptoms: Severe Toxicity

- Paresis or paralysis
- Encephalopathy—may abruptly lead to seizures, changes in consciousness, coma, and death
- Lead line (blue-black) on gingival tissue
- Colic (intermittent, severe abdominal cramps)
Laboratory Tests

- Venous blood sample
- Confirm elevated finger-stick
- Erythrocyte protoporphyrin (EP) is no longer considered useful
Complete Blood Count

• May show basophilic stippling* in patients with extended significant exposure

* Also seen in arsenic poisoning
Abdominal Radiograph

Lead charm found in child’s stomach
Longbone radiographs

“Lead Lines” in five year old male with radiological growth retardation and blood lead level of 37.7µg/dl

(Photo courtesy of Dr. Celsa López Campos, Clinical Epidemiologic Research Unit, IMSS, Torreón, México)
“Lead Lines” in three-year-two-month-old girl with Blood lead level of 10.6 µg/dl

Notice the increased density on the metaphysis growth plate of the knee.

(Photo courtesy of Dr. Celsa López Campos, Clinical Epidemiologic Research Unit, IMSS, Torreón, México)
U.S. Standards for Lead

Blood:
- CDC level of concern for children: 10 mcg/dL
- OSHA workplace standard:
  - 50 mcg/dL for removal from the job
  - 40 mcg/dL for mandatory notification

Environmental:
- Agencies have set standards for lead in water, air, and soil
Clinical Management

• Most important step is removal of lead exposure
  – Referral to health department
  – Environmental Investigations
  – Other potential sources of lead
  – Education about prevention
Chelation Therapy

• At very high blood lead levels (over 40 mcg/dL for children), chelation may be indicated

• Consult with physicians or medical centers with chelation therapy experience
Instructions to Patients

• Reduce source(s) of lead exposure
• Maintain a diet high in calcium and iron
• Continue to monitor blood lead levels
• If workplace exposure suspected, contact:
  • Workplace health and safety officer
  • Occupational Safety and Health Administration (OSHA)
Instructions to Patients with Pre-1978 Homes

• Test for lead hazards
• Assume paint has lead
• Make sure all paint is in good condition
• Fix lead paint hazards safely
Instructions to Patients with Pre-1978 Homes

- Use “lead-safe” work practices when disturbing paint
  - Work wet
  - Contain dust and debris
  - Keep children away
  - Use proper equipment and materials
  - Specialized clean-up and testing after work is done
Instructions to Patients with Pre-1978 Homes

- Avoid exposure to sources of lead
- Do not let children chew painted surfaces
- Wet-clean surfaces weekly
- Clean window sills and wells
- Do not let children play in bare soil
- Cover bare soil in the yard with
  - Grass
  - 6 inches of mulch
Instructions to Patients with Pre-1978 Homes

- Run cold water for 1 to 2 minutes before using
- Wash children’s hands and faces
- Wash toys with soap and water
- Feed children plenty of calcium and iron rich foods
Summary

- Primary sources: deteriorated paint, contaminated dust or soil, and some products
- Lead is very dangerous to young children and the developing fetus
- Certain workers may be exposed
- Focus on preventing exposure/removing source
Summary

Diet
Drinking water
Paint
Soil / Dust
Outdoor
Indoor

Air

Other sources
How can I get more Information?

- Regional poison control center
- Your local or state health department
- National Lead Information Center: 1-800-424-LEAD
  www.epa.gov/lead/nlic.htm
- Information on lead safe work practices:
  www.epa.gov/lead/epahudrrmodel.htm
- Alliance for Healthy Homes: (202) 543-1147
  www.afhh.org
Additional Information

- Agency for Toxic Substances and Disease Registry (ATSDR)  www.atsdr.cdc.gov
- Association of Occupational and Environmental Clinics (AOEC)  www.aoec.org
- Pediatric Environmental Health Specialty Units (PEHSUs)  www.aoec.org/PEHSU.htm
- American College of Occupational and Environmental Medicine  www.acoem.org
- American College of Medical Toxicologists  www.acmt.net
- American College of Preventive Medicine  www.acpm.org