

# *Public Health Threat - A Case of Childhood Lead Poisoning*



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2010

# *Case Presentation*

- A 13 m/o African Female presented for a well child exam on 6/8/07
- Though her father stated during the interview that there was no peeling paint in their apartment, the family lived in low income housing and there was a considerable language barrier, even through a telephone interpreter
- The child was healthy, but seemed subdued and passive and her father states she is not really talking yet

## *Case-Continued*

- A capillary lead level was drawn for routine screening
- Level was reported to be 64 ug/dL a few days later
- A venous lead level was drawn on 6/15/07 to confirm the elevated level
- This level was reported to be 44 (45 is generally accepted as “treatment level”), and anything >10 is considered by Public Health to be of concern
- This case was reported to Polk Co. Public Health by both the lab and the clinic

## *Case-Continued*

- On 6/22/07, a CBC, Iron studies, Peripheral Smear, and repeat lead level were obtained
- Results: Hgb 12.1/Hct 36.6, iron studies normal, peripheral smear no microcytosis or basophilic stippling
- Repeat lead level was now 50, one week later
- After speaking with multiple specialists, including 2 Pediatricians and 3 Hematologists, patient was admitted to the hospital for IV chelation with CaNa<sub>2</sub>EDTA for 5 days

## *Case-Continued*

- Incidentally, the CBC and the Peripheral Smear showed neutropenia of unknown origin
- The WBC was 10.9, but the neutrophil percent was 3% and the absolute neutrophil count was 0.3
- Lymphocytes were high (86% and 9.8), and Atypical lymphs were also reported
- A CBC done in 9/06 was completely normal
- This neutropenia was considered unrelated to the lead poisoning, and most likely of viral origin, however, familial neutropenia was considered

## *Case-Continued*

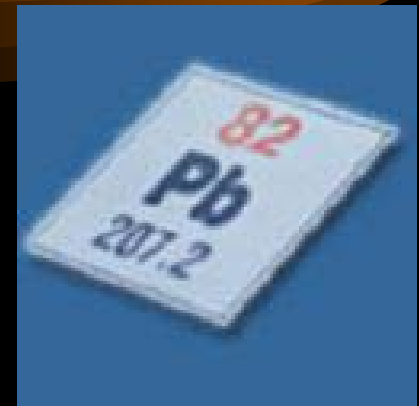
- An abdominal x-ray was obtained prior to admission to look for signs of lead ingestion – it was normal
- A pediatric neurologist was consulted- her exam was reported as normal/without obvious deficits
- Patient was treated in the PICU for 5 days without complications
  - CaNa<sub>2</sub>EDTA can cause ECG changes, hypotension, hypercalcemia, and is nephrotoxic
  - Mercy requires monitoring in a critical care unit

## *Case-Continued*

- Patient was held an additional day following treatment so the family could be relocated to a new apartment
- Not safe for patient to return to building as patients treated with chelation therapy are more susceptible to lead absorption

# *Lead Poisoning-Background*

- Heavy metal
- Found in 3000 BC
- Comes from a naturally occurring metal called Galena
- Once used in wine making as a preservative – sweet taste
- Used in paint because it gave a high quality shine, it is water resistant, it doesn't mold, and it dries quickly



# *Lead Poisoning-Background*

- Gasoline and paint contained lead until the 1970's
- The U.S. government banned the use of lead-based paint in housing in 1978 and in water pipes in 1988
- Still used in many developing countries in gasoline, paint, pottery glaze, solder, and some medications and candy
- Also used in battery production, welding, radiator repair, metal cutting, metal soldering, sand blasting, ammunition, fishing sinkers, and stained glass

# *Lead Poisoning-Classification*

- CDC Classification of Lead Poisoning (plumbism)
  - Class I – Lead level <10 ug/dL
  - Class II – Lead level 10-19 ug/dL
  - Class III – Lead level 20-44 ug/dL
  - Class IV – Lead level 45-69 ug/dL
  - Class V – Lead level >70 ug/dL

Screening capillary lead levels >10 ug/dL are concerning and should be confirmed with a venous level

# *Manifestations of Lead Poisoning*

- Possible effects of mild to moderate toxicity
  - Myalgias, paresthesias, fatigue, irritability, excitability, lethargy, abdominal discomfort, arthralgia, difficulty concentrating, headaches, tremors, vomiting, weight loss, insomnia, depression, and muscular exhaustibility or weakness
  - Long term toxicity can cause a low sperm count and women to have trouble conceiving

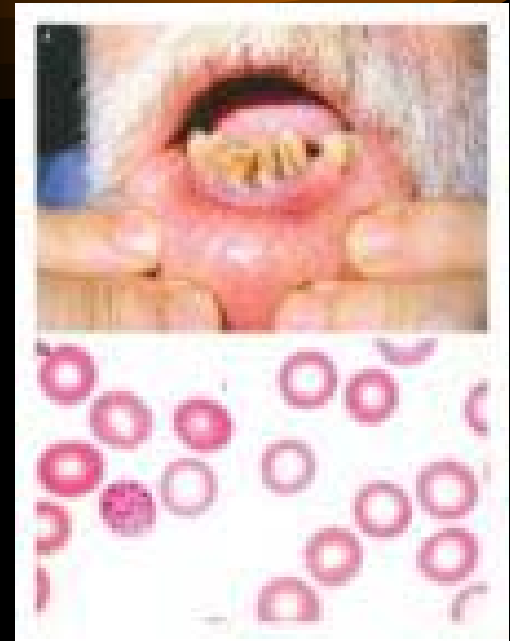
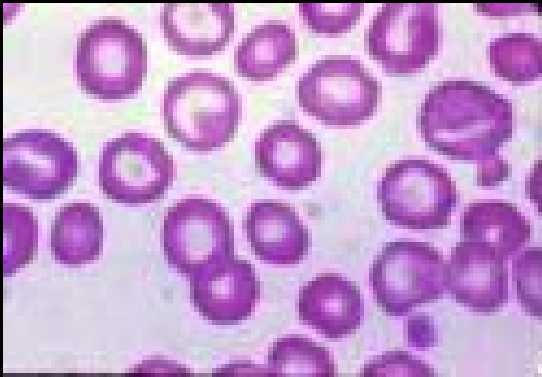
# *Manifestations of Lead Poisoning*

- Severe toxicity leads to 3 major clinical syndromes
  - Alimentary: anorexia, metallic taste, constipation, severe abdominal cramping due to intestinal spasm
  - Neuromuscular: peripheral neuritis, usually painless and limited to extensor muscles
  - Cerebral (lead encephalopathy): seizures, coma, mental retardation, developmental delay, chronic hyperactivity
- Chronic exposure may cause renal failure
- Cognitive and behavioral effects are not reversible

# *Manifestations of Lead Poisoning*

- Lead competes with iron during hemoglobin synthesis, leading to anemia
- Also competes with calcium in bone and nervous tissue, interfering with calcium-dependent intracellular messengers and brain protein kinase c
- Lead has an affinity for cell membranes and mitochondria and interferes with oxidative phosphorylation
- Forms inclusion bodies in cells that are taken into the nucleus and alter gene expression

# *Manifestations of Lead Poisoning*



# *Sources of Exposure*

- Lead dust, ingested or inhaled
  - Can be found on floors, in window sills, in soil or sandboxes, in the air
- Lead paint, chips eaten or window sills chewed on
- Lead fumes, inhaled
- Occupational exposure
- Hobbies, such as stained glass making and ceramics
- Candy and home remedies from other countries
- Food and liquids stored or cooked in lead crystal or lead-glazed pottery
- Water passing through lead pipes or pipes with lead solder

# *Sources of Exposure*

- Many toys made in other countries recently recalled by Mattel and other companies due to lead paint hazard
- Include a lot of popular toys – Elmo, Dora the Explorer, Barbie, Sesame Street, etc.

# *Child vs Adult Exposure*

- Children
  - More common, especially ages <6 - Why?



# *Child vs Adult Exposure*

- Exposure in children under the age of 6 especially important - Why?
  - Encephalopathy more common presentation in children
  - Blood-brain barrier is not fully developed
  - Nervous system still developing
  - Greater prevalence of iron deficiency
  - Smaller bodies, smaller amount needed to become toxic

# *Child vs Adult Exposure*



- Adults
  - Not common
  - Usually exposed through hobbies or occupation
  - Their bodies are better able to get rid of the lead

## *Adult Case*

- In July 2010, 63 y/o male came to PHC c/o feeling lethargic, tired, weak, and dizzy with nausea and vomiting and memory loss
- Stated removed lead paint from front porch 8 wks prior and screened at Polk County 3 wks prior for lead
- Venous level at Polk County – 42
- Patient worried symptoms from lead poisoning

## *Adult Case-continued*

- Patient turned out to have new onset Diabetes with a glucose level of 734, which was most likely responsible for his symptoms
- However, lead level at PHC was 29
- Also one done at hospital next day – 23
- Patient lost to follow up
- No further testing done as of October 2010

# *Lead Toxicology*

- Absorbed from the GI or respiratory tracts
  - Children absorb 50% to 70% of lead from the GI tract, as opposed to 10 to 20% in adults
  - Fasting, iron deficiency, zinc deficiency, and calcium deficiency may increase absorption from the GI tract
  - Lead that is inhaled is almost completely absorbed
  - Cutaneous absorption is minimal
- Distributed in blood, soft tissues (including organs), and mineralized tissues such as bone and teeth

# *Lead Toxicology*

- Lead is mainly excreted via the urine, but can also be found in feces, hair, nails, sweat, saliva, and breast milk
- The half-life of lead depends on where it is in the body
  - Blood - 28 to 36 days
  - Soft tissue - 40 days
  - Bone and teeth - greater than 25 years
    - Can serve as a source of further exposure

# *Lead Poisoning-Work-up*

- Labs
  - Always have elevated capillary levels confirmed with a venous level-may differ considerably due to contamination
  - CBC, retic count, peripheral smear, iron studies to look for anemia and concurrent iron deficiency (lead interferes with heme synthesis and iron deficiency increases the absorption of lead)
  - A free erythrocyte protoporphyrin test can help to confirm a case of lead poisoning - case patient 104 (high)
    - It is high in both lead poisoning and iron deficiency, but to a greater extent with lead (usually >250)
    - EP levels are not elevated until the lead level is over 30 ug/dL

# *Lead Poisoning-Work-Up*

- Notify Public Health so that home can be inspected (CDC recommends inspection for all lead levels over 15)
- Screen all children under the age of 6 living in the same household or with the same exposure
- Children with lead levels  $>20$  automatically qualify for the State of Iowa Early ACCESS System for developmental screening and ongoing monitoring
- All children with elevated lead levels are referred to this agency

# *Lead Poisoning-Treatment*

- The most important intervention in ALL cases is to decrease chances for further exposure by identifying the source
- Children with levels under 45 ug/dL (mild lead poisoning) receive testing for iron deficiency and are monitored closely, but chelation therapy is not typically started
  - 10-14 ug/dL – retest within 3 months (cap or venous)
  - 15-19 ug/dL – retest in 3 months (venous)
  - 20-44 ug/dL – retest in 4 to 6 weeks (venous)

# *Lead Poisoning-Treatment*

- Outpatient treatment (45-69 ug/dL - moderate)
  - Succimer (DMSA)
    - Water soluble analog of dimercaprol
    - Oral agent
    - 10 mg/kg TID x 5 days, then BID x 14 days
    - Increases the urinary excretion of lead
    - Adverse effects: rash, neutropenia, elevated LFTs, GI upset, hemolysis in G6PD deficiency
    - Follow-up with venous Lead level 10 to 14 days after completion of therapy
    - Retreatment should be considered for rebound levels 80% of the original level or >30 ug/dL

# *Lead Poisoning-Treatment*

- IV/IM CaNa<sub>2</sub>EDTA can also be used for moderate lead poisoning
- D-penicillamine is another oral alternative (not FDA approved for lead)
- Inpatient treatment (>70 ug/dL - severe)
  - Any lead level with signs and symptoms of encephalopathy is considered severe lead poisoning
  - Control seizures with diazepam
  - Avoid LP due to possible increase in intracranial pressure
  - IVF and other supportive care

# *Lead Poisoning-Treatment*

## – CaNa<sub>2</sub>EDTA

- IV or IM agent (IV preferred)
- 1000 to 1500 mg/m<sup>2</sup> per day x 5 days continuously or in 2 to 4 divided doses (slowest rate of infusion to avoid precipitation of acute encephalopathy)
- Increases urinary excretion of lead
- Adverse effects: local reaction, fever, hypercalcemia, renal dysfunction, excretion of other essential minerals
- Daily monitoring of renal and hepatic function, frequent UA, EKG ( for arrhythmia)
- Follow-up lead levels 2 days after completion
- Second course if >45 ug/dL (two days between courses)
- Retreatment for rebound 80% of original or >30 ug/dL
- Must be discharged to a lead-free environment

# *Lead Poisoning-Treatment*

- Do NOT use Na<sub>2</sub>EDTA-causes extreme drops in calcium level and can be fatal-two cases reported in MMWR of children aged 2 and 5 years dying following Na<sub>2</sub>EDTA administration
- Another alternative for severe poisoning is dimercaprol (BAL)
  - Deep IM injection, dissolved in peanut oil, pretreatment with Benadryl

# *Lead Poisoning-Treatment*

- Calcium, iron, and zinc help decrease the absorption of lead in the GI tract
- Vitamin C increases renal excretion of lead
- Optimizing nutrition facilitates treatment
- Our patient was treated as an inpatient not just because of level, but reliability of the family was in question, especially with the language barrier.

# *Lead Poisoning-Epidemiology*

- Prevalence of lead poisoning
  - National average - 1.6%
  - Iowa average - 7%
  - Polk county average - 4.8%
  - Zip code 50314 average - 12.41% (Mercy)
  - Zip code 50309 average - 13.11% (Downtown)

There are many rental properties in the 50314 & 50309 zip codes.

**\*\* Lead poisoning is the #1 environmental risk for children nationwide \*\***

# *Adult Epidemiology*

- CDC NIOSH Adult Blood Lead Epidemiology and Surveillance (ABLES) Database reports 272 adult cases with blood lead levels  $\geq 25$  in Iowa in 2008

# *Lead Poisoning-Epidemiology*

- Almost 60% of homes in rural and urban Iowa were built before 1960
- Two-thirds of houses in Des Moines were built before 1978



# *Public Health Side of the Case*

- Family's Background:
  - Immigrants from Africa (speak Neur & some English)
    - Cultural differences: interactions and dynamics of family and friends, foods, spices, etc.
  - Parents have lived in the states since 2000, Des Moines since 2002, and the apartment for 2 years at this time
  - Single family lives in the apartment, but large African community that is very interactive
  - Both parents work for a company that manufactures metal running boards - in the packaging area

# *Public Health Side-Continued*

- The mother of the child was admitted to the hospital for delivery of a baby on 6/25/07
- Mother and infant were tested on 6/26/07, prior to release, and both lead levels were  $<5$  (lead crosses the placenta)
- Incidentally, a neonatologist had been consulted due to a larger than normal anterior fontanelle
- The neonatologist did not find any abnormality of concern
- A cranial US was normal and the newborn screen done at the hospital was later reported as normal

# *Public Health Side-Continued*

- On 6/29/07, the father of the child and the other four siblings were also tested with venous lead levels and CBCs
- Results were as follows:

# *Public Health Side-Continued*

- Dad-30 y/o M
  - Lead <3, Hgb 14.1, MCV 85, WBC 4.0, Neuts 46%
- 3 y/o F
  - Lead 34, Hgb 12.1, MCV 82, WBC 4.9, Neuts 39% (prior CBC 2/06 normal)
- 6 y/o M
  - Lead 24, Hgb 12.3, MCV 80, WBC 4.6, Neuts 42% (prior Lead 5/06 of 5)
- 9 y/o F
  - Lead 19, Hgb 12.2, MCV 83, WBC 4.0, Neut abs 1.6
- 12 y/o F
  - Lead 12, Hgb 12.3, MCV 83, WBC 3.8, Neut abs 1.5

# *Public Health Side-Continued*

- Building background:
  - Owned by company that owns and operates many properties throughout the city
  - Building built in ?, renovated in 1995
  - Public housing with 18 apartments
  - Building is next door to a hispanic grocery store
    - Many Mexican candies found to contain lead

# *Public Health Side-Continued*

- Building stairwells were power-washed in Fall of 2006 by outside company due to peeling paint (cannot have peeling paint in public housing project no matter how old the building is or what kind of paint it is)
- Paint in stairwells was found to be lead-based paint (allegedly unknown to building owner)

# *Public Health Side-Continued*

- Public Health was notified of elevated lead levels right away
- Polk County made four visits to the apartment building and tested many areas:
  - paint, toys, dust, and spices found inside the home
  - paint and dust inside common areas, such as outside the building, stairwells, a room in the basement used as an “art room” for the children, and the playground area
  - Missing metal end of a jump rope of particular interest

# *Public Health Side-Continued*



- Lead dust was found in the apartment and on the floor of the art room
- Lead paint discovered in outside stairwells

## *Public Health Side-Continued*

- Two other families in building were reported to have children with elevated lead levels
- Family 1 – one child at 22, other child at 25
- Family 2 – one child at 14
- Building owner offered free lead screening to all children in the building under the age of 6 at the request of Public Health

# *Proposed Source of Exposure*

- Paint was loosened by the power-washing that took place in Fall 2006
- Paint was crushed into lead dust by walking on it
- Lead dust tracked into other areas on feet of apartment inhabitants
- Lead dust ingested and inhaled by children was the main problem, rather than paint chips

# *Outcome of the Case*

- Public Health had the building owners restrict access to the areas in need of attention immediately
  - Soil access restricted with fencing
  - Occupants restricted from using the rear stairwells
- Families with children under 6 were relocated until proper cleaning and repair could take place
- Some occupants without young children chose to stay

# *Outcome of the Case*

- Lead paint was painted over in common areas, on bare floors, and in rear stairwells
- Bare soil around the periphery of the building was covered up
- Woodchips in the playground area were replaced
- Each apartment was thoroughly cleaned
- The building was re-inspected by Public Health before allowing new families to move in
- With “clearance testing”, every dust sample collected must be at acceptable levels

# *Outcome of the Case*

- As of December 2007 (*six months later*), three of the five children had repeat venous lead levels under 10 ug/dL
- The 13 m/o's lead level was 21 ug/dL
- The 3 y/o's lead level was 22 ug/dL
- The 13 m/o child on subsequent visits seemed more interactive and alert.
- Parents reported she was beginning to talk more.
- Was the initial observation of passivity and her delay in speaking due to lead poisoning, or simply her age and level of development?

# *What Makes This Case Special?*

- Unusual to see clusters of lead poisoning cases
- Exposure could be pinpointed to a specific event and time
- Unusual to have levels high enough to require treatment (especially inpatient with IV chelation)

# *Legal Aspects of Lead Exposure*

- In April 2007, Governor Culver signed into law a requirement for evidence of a blood lead test when any Iowa child enters school (before the age of 6)
  - Polk County states an additional \$275,000 is needed to manage this law
  - Applies to public, private, and home schooling
- This year, Polk County will have a pool of approx. 45,000 children who have to have lead test before entrance
- Polk County will test approximately 7,000 children for lead poisoning in FY 06/07, and estimates 10,000 in FY 07/08, 20,000 in FY 08/09, and 22,000 in FY 09/10

# *Legal Aspects of Lead Exposure*

- Landlords must tell tenants about known lead-based paint hazards before leases are signed
- Leases must include a disclosure unless a certified inspector has checked the property and said in writing that it is lead-free
- Sellers must tell buyers in writing about lead-based paint hazards before entering into a sales contract

# *Cleaning Up The Lead*

- Average cost of abatement is \$20,000 per house
- Training for contractors to become certified is \$1500
- Polk County has a Childhood Lead Poisoning Prevention Program
  - \$80,000 from the State of Iowa
  - \$1,000,000 home repairs grant



# *Cleaning Up The Lead*

- Paint exhibiting an “alligator-like” cracking pattern or that chinks or rubs off in your hands is usually lead-based
- Old varnish that looks cloudy may also contain lead paint
- Public Health recommends a professional clean up the lead, but if done by non-professional an N-100 mask is recommended and dust should be moistened to prevent aerosolization



# *Take Home Points*

- Recommended to test at age 1, age 2, and more frequently if at increased risk
- This is a housing issue, not a behavioral, parenting, or income issue
- **ALWAYS** test for lead!!!



# *Sources for Information*

- <http://www.epa.gov/lead>
- <http://www.polkcountyiowa.gov/health>
- [http://www.idph.state.ia.us/eh/lead\\_poisoning\\_prevention.asp](http://www.idph.state.ia.us/eh/lead_poisoning_prevention.asp)
- <http://www.cdc.gov/nceh/lead>

## *Special Thanks To:*

- Connie Mitchell, Mercy Family Medicine
- Bonnie Murphy, Polk County Public Health
- Chris Frantsvog, Polk County Public Health
- Polk County Lead Coalition
- Edward Bottei, MD, Iowa Statewide Poison Control Center

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*Questions?*

