This event is the first of a 4-part webinar series developed as part of the American Academy of Pediatrics (AAP) project, *Increasing Capacity for Blood Lead Testing and Interpretive Guidance for Blood Lead Results*.

The webinar materials are developed and presented by pediatric lead experts from the AAP to educate primary care providers on various aspects of lead exposure prevention, testing, treatment, and follow up care.
It Starts with Testing: Identifying Children with Elevated Blood Lead Levels

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Disclosures

• *In the past 12 months, the presenter had no relevant financial relationships with the manufacturer(s) of any commercial product(s) and/or provider(s) of commercial services discussed in this CME activity.*

• *The presenter intends to discuss unapproved/investigative uses of a commercial product/device in this presentation.*
At the end of this webinar, participants will be able to:

1. Cite potential sources of lead exposure
2. Identify vulnerable populations of children eligible for lead exposure monitoring
3. Describe health consequences of childhood lead exposure
4. Cite barriers/strategies to improve testing in office practice
## PEHSU Consultative Topics - 2007-2014

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1. I pose a set of pictures and a scenario.

2. And then I will provide the back story of how the child was poisoned.
Scenario #1

- 18 month old BLL 97 mcg/dL, Hgb 9.6 gm%, MCV 69;
- Poor appetite, repeated spitting up food, little weight gain in past month, and irritability;
Scenario #2

- 7 year old child with mild autism during WCC  BLL 19 mcg/Dl;
- His mother, a realtor, takes him with her when showing 1800’s vintage homes in older Boston neighborhoods;
Scenario #3

• 2 year old with autism and ADHD was referred to the ED to rule out leukemia: extreme pallor, Hgb 5.5 gm%, and lethargy;
• BLL 139 mcg/dL;
Growing List of Sources of Lead Contamination

- Fishing weights
- Pots & pans
- Jewelry
- Glazed pottery
- Herbs & botanicals
- Marksmanship
- Religious powders
- Ethnic Medicines (Ayurvedics, Greta, Azarcon)
- Breast creams
- Baby powder
- Spices
- Dietary supplements
- Toys
- Antique cribs
- Cosmetics (Kohl, Sindoor)
- African & Middle Eastern infant eye cosmetics (Tiro)
Children Are Different – Lead Poisoning
Vulnerability of Children

- Immature detox: liver, kidneys, lungs
- Nutritional Differences; 7x Increased Water Intake
  - Smaller size and wt; Longer life spans
  - Oral exploratory habits
  - Poor cognitive discrimination
  - Pica
  - Mimicry
  - Curiosity

- Sensitive forming brain tissue
- Immature immune system
- Breathing zone closer to ground
- Rely on others for safety, protection or escape
- Mobility: crawling, cruising, toddler gait

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Absorption: 10-90%

Nutrition: Fe, Ca, vit D deficiencies

Distribution: 40-50% soft tissues

Blood-brain barrier

Deep Reservoirs: <70% bone

Targets: brain, blood, bone, immune, kidneys
Factors Influencing Toxicity

- Duration of exposure
- Age at exposure
- Amount entering body
  - Amount absorbed (bioavailable dose)
  - Fe status [4x risk eBLL in deficiency]
  - (+ Ca, Mg, Vitamin D status)
- Genetics
Clinical Findings – Lead Poisoning
Clinical Toxicity

- Headache
- Irritability
- Distractible
- Vomiting
- Constipation
- Stomachache
- Poor appetite
- Trouble sleeping

A ‘Neurotoxic Signature’?

‘Settled Science’: Multiple studies of lead’s developmental, motor, cognitive, behavioral damage in vulnerable childhood populations

- Attention
- Executive Function
- Visual-Spatial Skills
- Behavioral Challenges
- Hearing, Speech & Language
- Fine & Gross Motor Skills
IQ Studies  N=1333

- 2.4 to 10 µg/dL → ↓ 3.9 IQ points
- 10 to 20 µg/dL → ↓ 1.9 IQ points
- 20 to 30 µg/dL → ↓ 1.1 IQ points

Reading Readiness  N=3406 R.I. kindergarteners

mBLL 14 ugm/dL (5-31 ug/dL)
mFSIQ 87 (56-105)
Age: 20-23 years old
fMRI measured during verb generation

Diminished Activation: Left Frontal Cortex & Left Middle Temporal Gyrus
Enhanced Compensatory Right Hemisphere Homolog – Wernicke’s area

High Lifetime Mean Blood Lead (26 µg/dL)

Low Lifetime Mean Blood Lead (7.6 µg/dL)

Yuan et al, 2006
Negative associations: BLLs 2-10 ug/dL vs... tests of academic performance, class rank, end of grade testing

Multiple studies (America, Europe, Africa):
- Al-Saleh et al 2001
- Wang et al 2002
- Surkan et al 2007
- Min et al 2009
- Chandramouli et al., 2009
- Miranda 2010 & 2011  N=57,000
- Strayhorn & Strayhorn 2012  BLL explains 8-16% of variance reading/math
- Ann Evens 2013 Chicago  N=48,000
- Zhang 2013 Detroit
- Amato et al 2013 Milwaukee
- Pat McLaine et al 2013 Providence RI
- Magzeman et al 2013 lower BLL savings $28 billion
Lead & Behavior

• Learning disabilities
• Executive function
• Hearing & speech
• Hyperactivity
• Aggression, other behavior problems
• Police reports, delinquency
• School drop-out
Testing & Screening
**Definition: Screening vs Testing**

- **SCREENING** – families are surveyed as to the risk factors known to be associated with elevated BLLs

- **TESTING** – performance of a finger-stick or a venous blood lead level in the office to determine whether a child has been exposed.
Screening: Vulnerable Children

- Medicaid? WIC? Fe deficiency?
- Pre-1978 home? Renovations?
- Visits pre-1978 home or day care
- Job or hobby Pb?
- Sibling/playmate with eBLL?
- Products from other countries?
Foster Care Children

- All prospective foster care parents with pre-1978 housing should have home screened for lead hazards and, if necessary, remediated prior to placement.
- Prospective foster care families should qualify for those local grants and loans necessary to bring their housing into compliance.
- All preschool children in foster care should be tested BLL at ages 6-12 and 24 months, and then at ages 3 and 4 yrs.
- If preschool child living in a foster care residence has eBLL, then all children ≤5 years living in same home should also be tested with a BLL.
- Foster children with eBLL should be monitored according to CDC guidance and have their foster care home environments assessed for sources of lead contamination.

Children with Autism Spectrum Disorder (ASD)

• All preschool-aged children diagnosed with ASD should be screened

• Children with ASD should be periodically monitored as long as they continue to have pica behaviors, even into school-aged years
• All immigrant/refugee/intl adopted children should have one BLL.
• All immigrant/refugee families & intl adoptees living in pre-1978 housing should have home screened for lead hazards and, if necessary, remediated.
• All preschool immigrant/refugee/intl adoptee children should have BLL at ages 6-12 and 24 months, and then at ages 3 and 4 yrs.
• Families should be queried:
  – Use of foreign cookware
  – Use of imported foods/candies
  – Use of ethnic remedies
  – Use of imported herbs, botanicals, dietary supplements
  – Use of religious powders
  – Use of imported cosmetics
State-Specific Compliance
Population-based 97.5\textsuperscript{th}% tile of 2 NHANES cycles

Trends: Reference Blood Lead Levels

National Health and Nutrition Examination Survey (NHANES)
New population data used to re-calculate screening rates

- Screening lower for 3 year olds in many communities
- ~20% of first incident cases are at age 3

Source: Massachusetts Department of Environmental Services (MASSDEP)
Texas Testing Children <6 yr - 2016

- 8% Texas housing stock pre-1950
- <14% eligible Texas children tested
- State Pb intervention level 10 ug/dL

Source: Texas Department of State Health Services (DSHS)
New Hampshire Testing Children <6 yr - 2010-2015

- 58% NH housing stock pre-1978
- <17% eligible NH children tested
- Annually >800 NH preschoolers found to have eBLL

Source: NH 2015 Lead Exposure Surveillance Report
Finger-Stick or Venous?
Triage: eBLL Results

- **<5.0 ug/dL**
  - Repeat BLL 6-12 mos

- **5-14 ug/dL**
  - Repeat BLL within 1-3 mos

- **15-19 ug/dL**
  - Repeat BLL within 4 weeks

- **20-24 ug/dL**
  - Repeat BLL within 2-4 weeks

- **25-44 ug/dL**
  - Repeat BLL within 1-2 weeks

- **45-69 ug/dL**
  - Medical Emergency – ASAP

- **>70 ug/dL**
  - CCU

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Office Take-Homes: Screening & Testing
Roles for Healthcare Providers

- Case-finding
- Prevent further exposure (inspection)
- Dietary counseling
- Hazard reduction
- Neurodevelopmental assessment
- EIP/Head Start referral
- Social management (loans? relocation? legal?)
Barriers

- Time Pressures/ forgetfulness
- Confusion about community risk
- Confusion about eligibility
- Too many steps
- Complacency
- Poor staff compliance
- Poor family compliance
Strategies for Testing

- Audit office performance
- Offer point-of-service testing
- Change office patterns to facilitate screening – cut down steps
- Electronic tickler file for follow-up & scheduling
- Improve parental education and local resources
• **Pediatric Vulnerabilities:** Kinetic differences, immaturity, behaviors, diet, built environment

• **Novel Hazards:** Ethic remedies, religious powders, cosmetics, etc.

• **Special Populations:** Foster children, international adoptees, immigrants, refugees, children with ASD & Pica

• **Lead:** Dose, neurotoxicity

• **Solutions:** Test; manage the patient; support kids & families; fix the environment
Resources

• CDC’s Childhood Lead Poisoning Prevention Program: https://www.cdc.gov/nceh/lead/about/program.htm
• Massachusetts CLPPP: https://www.mass.gov/orgs/childhood-lead-poisoning-prevention-program
• Healthy Homes: 1-800-897-LEAD
• PEHSUs: www.pehsu.net
• EPA: https://www.epa.gov/lead
Thank You