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VOL. 47 · TOXICOLOGY & PEDIATRICS

# Poisoning & Pediatric Lead Exposure

*Emergency management · Antidotes · Chelation · Family teaching*

TOXICOLOGY | PEDIATRICS | EMERGENCY | SAFETY / RISK REDUCTION | PHARMACOLOGY

**SOURCE DISCLOSURE**

This topic was not present in your uploaded personal notes. Content compiled from: **Saunders Comprehensive Review for the NCLEX-RN**, **ATI RN Pharmacology & Pediatrics**, **Lippincott Manual of Nursing Practice**, **CDC Childhood Lead Poisoning Prevention** (BLL reference value 3.5 mcg/dL, updated 2021), and the **American Academy of Pediatrics (AAP) lead screening guidance**. Drug doses and antidote pairings verified against current institutional protocols.

## 01 DEFINITION · OVERVIEW
## What is poisoning & why lead is different

> ***Poisoning is the harmful exposure to any substance — by ingestion, inhalation, absorption, or injection — in a dose that disrupts normal physiology. In children, the home is the #1 site of exposure; in adults, suspect intentional ingestion, occupational exposure, or medication error.***

**ACUTE POISONING**

Single large exposure → rapid symptoms. Examples: acetaminophen overdose, opioid overdose, household chemical ingestion. **Treat the ABCs first, identify the agent second.**

**CHRONIC POISONING (LEAD)**

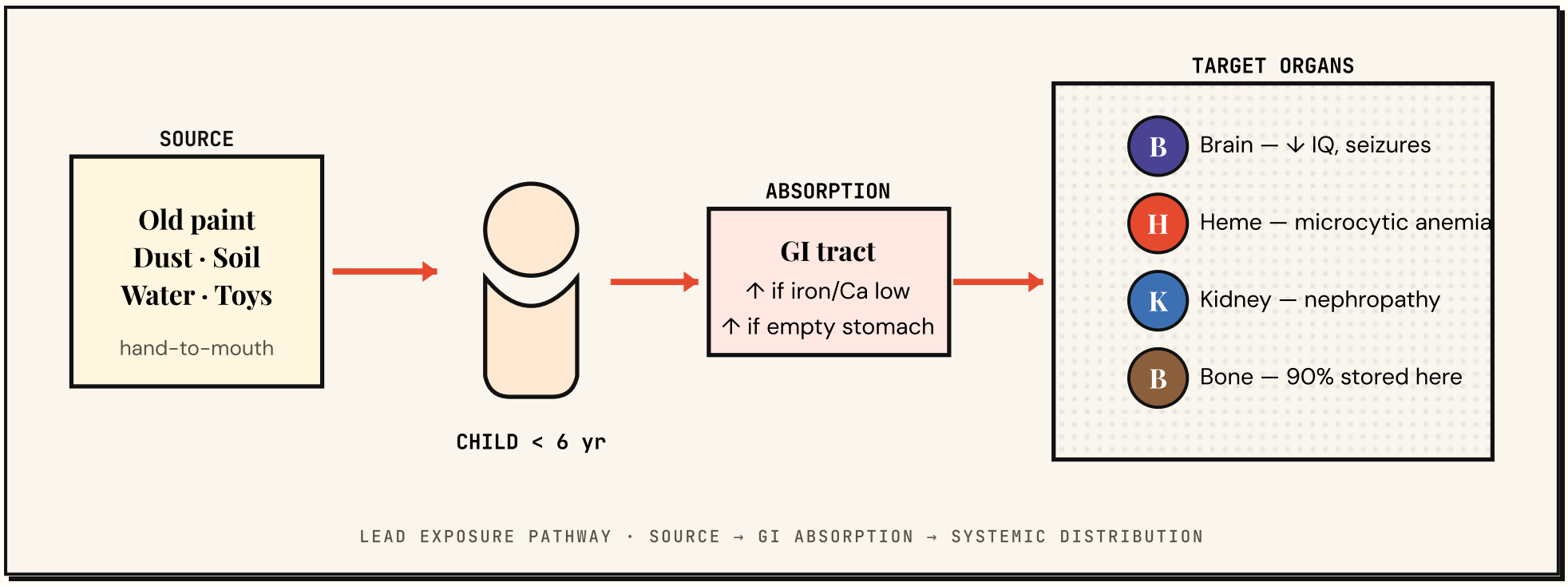
Slow, cumulative exposure → insidious neurologic and developmental damage. Children < 6 are at highest risk because their brains are still developing and they absorb 4–5× more lead per dose than adults.

- **Universal first call:** Poison Control Center **1-800-222-1222** (U.S., 24/7, free, confidential).
- **Five questions to answer immediately:** What? How much? When? By what route? Symptoms now?
- Lead has **no safe blood level** — CDC reference value was lowered from 5 → **3.5 mcg/dL** in 2021.

02

PATHOPHYSIOLOGY

# How lead damages the developing child




STEP 1

### Ingestion

Pica + hand-to-mouth in toddlers. Empty stomach & low iron/calcium **increase absorption**.

STEP 2

### Heme blockade

Lead inhibits delta-ALA dehydratase & ferrochelatase → **microcytic anemia**.

STEP 3

### Mimics calcium

Crosses blood-brain barrier; disrupts neurotransmitters & bone deposition.

STEP 4

### End-organ damage

Brain (irreversible cognitive loss), kidney (nephropathy), nerves (foot/wrist drop).

03

SIGNS & SYMPTOMS

# What you'll actually see — and what you'll miss

## GENERAL POISONING · TOXIDROMES (PATTERN RECOGNITION)

| TOXIDROME | CLASSIC FINDINGS | THINK OF |
|---|---|---|
| **Opioid** | Pinpoint pupils, ↓ RR, ↓ LOC, ↓ BP | Heroin, morphine, fentanyl, oxycodone |
| **Cholinergic (SLUDGE)** | Salivation, Lacrimation, Urination, Defecation, GI cramps, Emesis · miosis | Organophosphates, sarin, pilocarpine |
| **Anticholinergic** | "Hot, dry, red, blind, mad" — flushed skin, dilated pupils, ↑ HR, retention, delirium | Atropine, antihistamines, TCAs, jimson weed |
| **Sympathomimetic** | ↑ HR, ↑ BP, mydriasis, diaphoresis, agitation, seizures | Cocaine, methamphetamine, MDMA |
| **Sedative-hypnotic** | ↓ LOC, ↓ RR, slurred speech, ataxia (normal pupils) | Benzodiazepines, barbiturates, alcohol |
| **Salicylate** | Tinnitus, hyperventilation, mixed acid-base disorder, fever | Aspirin, oil of wintergreen, Pepto-Bismol |

## PEDIATRIC LEAD POISONING · BY SEVERITY

### EARLY / MILD

- **Often asymptomatic** — caught only by screening
- Irritability, fatigue
- Decreased appetite
- Mild abdominal pain
- Subtle developmental delay

### MODERATE

- **Microcytic anemia** (mimics iron deficiency)
- Constipation, vomiting
- Learning & attention problems
- Hearing impairment
- Poor school performance

### SEVERE 🚨

- **Lead encephalopathy**
- Seizures, altered LOC, coma
- Ataxia, peripheral neuropathy (foot drop)
- Persistent vomiting, ↑ ICP
- Burton's line (blue-black gum line — rare in kids)

❗ **RED FLAG · BLL ≥ 70 mcg/dL OR any symptomatic child:** medical emergency. Admit, start dual chelation, monitor for cerebral edema, seizure precautions, neuro checks q1h.

04

PRIORITY NURSING INTERVENTIONS · ABC FRAMEWORK

# What you do — in order

### A · AIRWAY

- Assess patency; suction if vomiting
- Position on **side** if ↓ LOC (aspiration risk)
- Prepare for intubation if RR < 10 or unresponsive
- For caustic ingestion: **do not blindly lavage** — risk of perforation

### B · BREATHING

- Pulse ox, ABG if indicated
- 100% $O_2$ for carbon monoxide; hyperbaric if available
- Watch for opioid-induced respiratory depression

### C · CIRCULATION

- Two large-bore IVs; isotonic fluids
- Continuous cardiac monitor (TCA, digoxin, cocaine all dysrhythmogenic)
- 12-lead ECG on arrival

### D · DECONTAMINATE

- **Activated charcoal** within 1 hr of ingestion (most agents)
- Skin: remove clothes, copious water flush 15+ min
- Eye: irrigate **inner → outer canthus**, 15+ min
- Whole-bowel irrigation for iron, sustained-release, lead paint chips

### E · ENHANCED ELIMINATION & ANTIDOTE

- Give specific antidote when identified (see §5)
- Hemodialysis for: lithium, salicylates, methanol, ethylene glycol
- Urine alkalinization (bicarb) for salicylates & TCAs

### F · LEAD-SPECIFIC CARE

- **Remove from source FIRST** — chelation without removal is pointless
- Ensure hydration; monitor I&O strictly during chelation
- Monitor BUN, creatinine, LFTs, CBC, BLL
- Seizure precautions if encephalopathy
- Notify public health department (mandatory reporting)

**DO NOT INDUCE VOMITING IF:** caustic agent (acid/alkali), petroleum product (gasoline, kerosene, furniture polish), sharp object, ↓ LOC, seizing, or < 6 months old. *Ipecac is no longer recommended routinely by the AAP.*

05

PHARMACOLOGY · ANTIDOTES & CHELATORS

# Pair the poison with its antidote

### QUICK-PAIR ANTIDOTE GRID

**Acetaminophen**
→ N-acetylcysteine (Mucomyst)

**Opioids**
→ Naloxone (Narcan)

**Benzodiazepines**
→ Flumazenil (Romazicon)

**Warfarin**
→ Vitamin K (phytonadione)

**Heparin**
→ Protamine sulfate

**Digoxin**
→ Digoxin immune Fab (Digibind)

**Iron**
→ Deferoxamine

**Anticholinergics**
→ Physostigmine

**Cholinergic / OP**
→ Atropine + Pralidoxime (2-PAM)

**Beta-blockers**
→ Glucagon

**Carbon monoxide**
→ 100% $O_2$ / hyperbaric

**Cyanide**
→ Hydroxocobalamin / Na thiosulfate

**Methanol / Ethylene glycol**
→ Fomepizole (or ethanol)

**Magnesium sulfate**
→ Calcium gluconate

**Tricyclic antidepressants**
→ Sodium bicarbonate

### LEAD CHELATION THERAPY

| DRUG | BLL INDICATION | ROUTE | KEY NURSING CONSIDERATIONS |
|---|---|---|---|
| **Succimer (DMSA, Chemet)** | ≥ 45 mcg/dL | PO (capsules can be opened on food) | First-line outpatient agent. Monitor LFTs & CBC. Sulfur-egg odor common. **Rebound BLL** may occur as lead leaves bone. |
| **Calcium disodium EDTA** | ≥ 45 (with BAL if ≥ 70 or symptomatic) | IV or deep IM (with procaine) | **Never confuse with edetate disodium** (causes fatal hypocalcemia). Push fluids; monitor renal function q24h; avoid in anuria. |
| **Dimercaprol (BAL in oil)** | ≥ 70 mcg/dL or encephalopathy | Deep IM only (peanut oil base) | **Contraindicated in peanut allergy & G6PD deficiency.** Painful injection. Always give **before** EDTA when used together. Monitor for HTN, fever, nausea. |
| **D-Penicillamine** | Alternative oral agent | PO | Off-label. Risk of allergic reaction; cross-sensitivity with penicillin. |

! **DURING CHELATION:** push oral and IV fluids generously, strict I&O, daily BUN/creatinine, daily CBC, BLL rechecks. *Remove the child from the lead source before — or simultaneously with — chelation, or rebound is guaranteed.*

06

BLOOD LEAD LEVEL SEVERITY SCALE

# Action thresholds (CDC 2021+)

| < 3.5 | 3.5 - 19 | 20 - 44 | 45 - 69 | ≥ 70 |
|---|---|---|---|---|
| Below reference value · routine screening | Confirm; environmental investigation; nutrition; recheck | Public health referral; medical eval; remove from source | **Chelation indicated** · Succimer (DMSA) outpatient | **EMERGENCY** · admit · BAL + EDTA · neuro precautions |

*Universal screening at 12 and 24 months is recommended for Medicaid-eligible children, immigrants/refugees, and children in pre-1978 housing or near smelters. Confirm capillary (fingerstick) elevations with venous draw before treating.*

07

NCLEX TEST TRAPS

## The wrong answer that looks right

| ✗ TRAP | ✓ CORRECT |
| --- | --- |
| "Toddler swallowed drain cleaner — give ipecac to induce vomiting." | **Do NOT induce vomiting for caustics** (acid/alkali). Re-exposing the esophagus to caustic on the way up doubles the burn. Dilute with small amounts of water/milk if instructed by Poison Control; transport. |
| "Child swallowed gasoline — induce vomiting immediately." | **No emesis for petroleum/hydrocarbons** — aspiration causes lethal chemical pneumonitis. Airway and supportive care only. |
| "BLL is 32 mcg/dL — start IV EDTA chelation now." | **Chelation is not indicated until BLL ≥ 45.** Priority for 20–44 range: **identify and remove the lead source**, nutritional support (Ca, Fe, vit C), repeat BLL. |
| "Microcytic anemia in a toddler — just start iron supplements and discharge." | **Always check BLL alongside iron studies.** Lead poisoning mimics iron deficiency anemia. Iron is essential — but missing the lead source is the error that ends careers. |
| "Activated charcoal works for everything — give it for the lithium overdose." | **Charcoal does NOT bind:** lithium, iron, lead, alcohol, caustics, hydrocarbons. ("*PHAILS*" — Pesticides, Hydrocarbons, Acids/Alkalis, Iron, Lithium, Solvents.) |
| "Mom asks if her child can return to the apartment after one chelation cycle." | **NO — never return to the source.** Chelation does not protect from re-exposure; BLL will rebound. Stay with relatives or in alternate housing until abatement is verified. |
| "BAL is fine to give — patient just has a peanut allergy, give it IV." | **BAL is contraindicated in peanut allergy** (suspended in peanut oil) and in G6PD deficiency. Also **IM only, never IV**. Use succimer or EDTA-alone instead. |

08

PATIENT & FAMILY TEACHING

# Prevention starts at home

### HOME ENVIRONMENT

- **Wet-mop & damp-dust** weekly — never dry sweep (aerosolizes dust)
- Wash child's hands & face before every meal and bedtime
- Wash toys, pacifiers, bottles often
- **Remove shoes** at the door
- Never sand, scrape, or burn old paint — call a certified abatement contractor
- Cover bare soil with grass or mulch

### WATER & FOOD SAFETY

- Use **cold tap water only** for drinking, cooking, formula (hot water leaches more lead)
- Run water 1–2 minutes before use, especially after pipes have sat unused
- Avoid imported pottery, cosmetics (kohl, kajal), folk remedies (azarcón, greta), some imported candies and toys
- Do not store food in lead-glazed ceramics

### NUTRITION

- **Iron-rich foods** (lean meats, beans, fortified cereals) — iron competes with lead for absorption
- **Calcium-rich foods** (milk, yogurt, cheese, leafy greens)
- **Vitamin C** (citrus, strawberries, peppers) — enhances iron uptake
- Regular meals — empty stomach increases lead absorption
- Limit fatty/fried foods (fat increases lead absorption)

### OCCUPATIONAL / HOBBY EXPOSURE

- Parents in construction, battery work, soldering, ceramics, firing ranges: **change clothes & shower before contact with child**
- Wash work clothes separately from family laundry
- No work boots or work clothes inside the home
- Hobbies: stained glass, fishing-weight casting, gun-cleaning — store and perform away from children

### BEHAVIORAL · PICA

- Educate about **pica** (eating non-food items) — common in toddlers and developmentally delayed children
- Redirect to safe chew items
- Iron-deficient children pica more — treat the anemia

### FOLLOW-UP & WHEN TO CALL

- Keep **all BLL recheck appointments** — every 1–3 months until trending down
- Call provider for: persistent vomiting, seizure, lethargy, behavior changes, refusing chelation doses
- Develop & lock in **Poison Control: 1-800-222-1222**
- Early Intervention / IEP referral if developmental delay is present

09

MEMORY BOOSTERS · MNEMONICS

# What to chant in the testing center

## LEAD

- **L** — **Lethargy**, learning problems, low IQ
- **E** — **Encephalopathy** & environmental source
- **A** — **Anemia** (microcytic) & abdominal pain
- **D** — **Developmental delay** & dust/paint

## PHAILS

**Activated charcoal does NOT work for:**

- **P** — Pesticides
- **H** — Hydrocarbons (gasoline, kerosene)
- **A** — Acids / Alkalis (caustics)
- **I** — Iron
- **L** — Lithium · Lead
- **S** — Solvents (alcohols)

## SLUDGE

**Cholinergic toxidrome (organophosphates):**

- **S** — Salivation
- **L** — Lacrimation
- **U** — Urination
- **D** — Defecation
- **G** — GI cramps
- **E** — Emesis

## Hot · Dry · Red · Blind · Mad

**Anticholinergic toxidrome:**

- 🔥 **Hot** as a hare — hyperthermia
- 🏜️ **Dry** as a bone — no sweat/secretions
- 🍅 **Red** as a beet — flushed skin
- 🦇 **Blind** as a bat — dilated pupils
- 🎩 **Mad** as a hatter — delirium

## Pattern recognition shortcuts

- **Pinpoint pupils + ↓ RR** = opioid → Naloxone
- **Yellow-green halos** = digoxin toxicity → Digibind
- **Tinnitus + hyperventilation** = aspirin → bicarbonate, dialysis
- **Cherry-red skin** = carbon monoxide → 100% $O_2$
- **Bitter almond breath** = cyanide → hydroxocobalamin
- **Burton's blue gum line + pica + microcytic anemia** = LEAD

10

NCJMM · 6-STEP CLINICAL JUDGMENT SCENARIO

# "My 2-year-old keeps eating paint chips"

> ***Scenario. A 2-year-old male is brought to the pediatric clinic by his mother. They live in a 1955 apartment building. He has been irritable, eating less, occasionally vomiting, and "chewing on the windowsill paint." Capillary BLL today: 52 mcg/dL. Hgb 9.2, MCV low. He is alert, fussy, no focal neuro deficits.***

**1 RECOGNIZE CUES**

WHAT DID I NOTICE?

Pre-1978 housing, pica behavior (windowsill paint), GI symptoms (anorexia, vomiting), behavioral change (irritability), microcytic anemia, and BLL 52 mcg/dL — all consistent with moderate-to-severe lead poisoning.

**2 ANALYZE CUES**

WHAT DO THEY MEAN TOGETHER?

The capillary BLL must be confirmed by venous draw, but the clinical picture already supports lead toxicity. The anemia is likely lead-induced (heme synthesis inhibition) but iron deficiency is concurrent — both must be addressed. BLL 52 falls in the chelation-indicated range (≥ 45).

**3 PRIORITIZE HYPOTHESE**

WHAT IS MOST LIKELY & MOST URGENT?

**Most likely:** moderate lead poisoning from peeling lead-based paint. **Most urgent concern:** ongoing exposure → continued absorption → potential encephalopathy. Iron deficiency and developmental risk are secondary but real.

**4 GENERATE SOLUTIONS**

WHAT ARE MY OPTIONS?

(a) Confirm with venous BLL; (b) Notify public health department for environmental investigation; (c) Remove child from apartment until abatement; (d) Start succimer (DMSA) chelation — outpatient; (e) Iron + calcium + vitamin C nutritional plan; (f) Developmental screening & Early Intervention referral; (g) Repeat BLL in 2–4 weeks.

**5 TAKE ACTION**

WHAT DO I DO, IN WHAT ORDER?

**1.** Draw confirmatory venous BLL, CBC, iron studies, BMP. **2.** Counsel mother — do NOT return to apartment; arrange alternate housing. **3.** Initiate succimer 10 mg/kg PO q8h × 5 days, then q12h × 14 days. **4.** Push fluids; teach signs to call back (vomiting, seizure, ↓ LOC). **5.** Report case to local health department. **6.** Schedule recheck in 2 weeks.

**6 EVALUATE OUTCOMES**

DID IT WORK?

At 2-week recheck: BLL trending down (e.g., 38), behavior improving, GI symptoms resolved, Hgb rising with iron supplementation, family in safe housing, abatement scheduled. If BLL has not fallen or has risen → reassess source removal & medication adherence; consider second chelation cycle (with 2-week drug-free gap to allow rebound from bone stores).