

**Iron Ingestion**  
**California Poison Control 1-800-876-4766**

**Background**

1. One of the most common toxicologic emergencies in young children
2. Contributing factors include the availability of iron tablets and their candy like appearance
  - a. Ferrous sulfate tablets (20% elemental iron) are routinely administered to postpartum women, many of who have toddlers in the family
3. Toxic doses of elemental iron range from 20 mg/kg to more than 60 mg/kg
4. Iron exerts both local and systemic effects
  - a. Corrosive to GI mucosa
  - b. Affects the lungs and liver
  - c. Excess free iron is a mitochondrial toxin, leading to derangements in energy metabolism

**Pathophysiology**

1. Phase 1, during first 6 hours post ingestion
  - a. Predominantly gastrointestinal: hemorrhagic vomiting, diarrhea, and abdominal pain (direct local corrosive effects on the gastric and intestinal mucosa)
  - b. Early hypovolemia may result from GI losses and contribute to tissue hypoperfusion and metabolic acidosis
  - c. Convulsions, shock, and coma may complicate this phase if the circulatory blood volume is sufficiently compromised
2. Phase 2, 6 – 12 hours post ingestion
  - a. Usually associated with an improvement in symptoms, especially when supportive care is provided during phase 1
  - b. In serious ingestions, this improvement may only be temporary or not occur at all
3. Phase 3, 12 – 24 hours post ingestion
  - a. Multisystem damage: marked metabolic acidosis, coagulopathy, shock, seizures, and altered mental status caused by mitochondrial damage and hepatocellular injury
  - b. Ferrous iron is converted to ferric iron and an unbuffered hydrogen ion is liberated
  - c. Iron is concentrated intracellularly in mitochondria and disrupts oxidative phosphorylation, resulting in free radical formation and lipid peroxidation
  - d. This exacerbates metabolic acidosis and contributes to cell death and tissue injury at the organ level
  - e. Marked systemic toxicity caused by this mitochondrial damage and hepatocellular injury
  - f. Gastrointestinal fluid losses lead to hypovolemic shock and acidosis

- g. Cardiovascular symptoms include decreased heart rate, decreased myocardial activity, decreased cardiac output, and increased pulmonary vascular resistance
4. Phase 4, 2 – 6 weeks post ingestion
  - a. Late scarring of the GI tract causing pyloric obstruction or hepatic cirrhosis
  - b. These complications rarely occur, even in severe cases

#### Lab Studies

1. Remember that iron toxicity is a clinical diagnosis and the studies below are simply adjuncts
2. Toxic effects of iron may occur at doses of 10 – 20 mg/kg elemental iron
3. Different formulations of iron contain varying amounts of elemental iron:
  - a. Ferrous sulfate – 20%
  - b. Ferrous gluconate – 12%
  - c. Ferrous fumarate – 33%
  - d. Ferrous lactate – 19%
  - e. Ferrous chloride – 28%
4. To calculate the amount of ingested iron for a 10 kg child who took ten 320 mg tablets of ferrous gluconate:
  - a.  $10 \text{ tablets} \times 320 \text{ mg} (12\% \text{ elemental iron per tablet}) =$
  - b.  $10 \times 38.4 \text{ mg elemental iron per tablet} = 384 \text{ mg}/10 \text{ kg} = 38.4 \text{ mg/kg}$
5. Little is known about the absorption rate of iron in an overdose, the timing of peak serum iron levels, or the rate at which serum levels fall from their peak levels.
6. Serum iron levels generally correlate with clinical severity and are as follows:
  - a. Mild: Less than 300 mcg/dL
  - b. Moderate: 300 – 500 mcg/dL
  - c. Severe: More than 500 mcg/dL
7. Difficulties involved with interpretation of serum iron levels include the following:
  - a. The ideal serum iron level is a peak level at 2 – 6 hours post ingestion, and the time from ingestion is often not known
  - b. Deferoxamine (if used) interferes with standard analysis and leads to falsely decreased iron levels
  - c. Serum iron levels may not be available in a timely fashion

#### Imaging Studies

1. A positive radiographic finding is one that shows radiopaque tablets or particles and indicates: not all ingested iron has been absorbed
2. A negative radiographic finding initially may mean that no iron was ingested or that the ingested iron tablets or solution have dissolved
3. Obtaining a radiograph pre – and post – GI decontamination may yield information as to the success of therapy

- a. If the radiographic findings remain positive after decontamination, additional decontamination is required
- b. If the radiographic findings were initially positive and are negative after GI decontamination, this indicates that GI decontamination was successful
- c. Iron levels should still be monitored because of iron absorption prior to initiation of therapy

#### **Medical Care**

1. California Poison Control 1-800-876-4766
2. Provide appropriate supportive care with particular attention paid to fluid balance and cardiovascular stabilization
3. Also address the issue of preventing further absorption of iron from the GI tract
4. Gastric lavage is not recommended because iron tablets are relatively large and become sticky in gastric fluid, making lavage unlikely to be of benefit
5. Whole bowel irrigation has been used to speed the passage of undissolved iron tablets through the GI tract
  - a. A polyethylene glycol electrolyte solution (e.g., GoLYTELY) may be administered orally or nasogastrically
  - b. 250 – 500 ml/h for toddlers and preschoolers
  - c. 2 L/h for adolescents
  - d. Continue irrigation until the repeat radiographic findings are negative or rectal effluent is clear
6. Deferoxamine is the iron-chelating agent of choice
  - a. Deferoxamine binds absorbed iron (approximately 8 mg of iron is bound by 100 mg of deferoxamine) and the iron-deferoxamine complex is excreted in the urine
  - b. Deferoxamine does not bind iron in hemoglobin, myoglobin, or other iron-carrying proteins
  - c. Indications for treatment include shock, altered mental status, persistent GI symptoms, metabolic acidosis, pills visible on radiographs, serum iron greater than 500 mcg/dL, or estimated dose greater than 60 mg elemental iron per kilogram
  - d. Initiate chelation when a serum iron level is not available and symptoms are present
  - e. Deferoxamine may be administered either IM or IV. The IM route is not recommended because it is painful and less iron is excreted compared to the IV route. The IV route is administered as a continuous infusion. The standard dose is 15 mg/kg/h IV, not to exceed 6 g/24h. Most effective when provided to the circulation continuously by infusion
  - f. No clear end-point of therapy exists; however, indications for cessation include significant resolution of shock and acidosis
    - i. For moderate toxicity: 8-12 hours of deferoxamine
    - ii. For severe toxicity: 24 hours of deferoxamine

- g. Adverse effects from deferoxamine are unusual. Pulmonary toxicity (ie, acute respiratory distress syndrome [ARDS], tachypnea) and hypotension have been described, especially if patients are treated with deferoxamine for more than 24 hours**
- h. Does not effectively chelate other trace metals of nutritional importance**

#### **Surgical Care**

- 1. If clumps of iron tablets remain after GI decontamination, consider surgery for their removal**
- 2. Failure to remove the iron can result not only in continued iron absorption and exacerbation of systemic symptoms but also in gastric perforation and severe hemorrhage**

#### **Complications**

- 1. Infectious – Yersinia Enterocolitica Septicemia**
  - a. Requires iron as a growth factor**
  - b. Deferoxamine acts to solubilize iron and aid in intracellular entry for Yersinia**
  - c. Suspect Yersinia infection in patients who develop abdominal pain, fever, and diarrhea following resolution of iron toxicity**
- 2. Pulmonary – ARDS**
- 3. Gastrointestinal – Fulminant hepatic failure, hepatic cirrhosis, pyloric or duodenal stenosis**

#### **Prognosis**

- 1. If a patient does not develop symptoms of iron toxicity within 6 hours of ingestion, iron toxicity is unlikely to develop**
- 2. Expect clinical toxicity following an ingestion of 20 mg/kg of elemental iron**
- 3. Expect systemic toxicity with an ingestion of 60 mg/kg**
- 4. Ingestion of more than 250 mg/kg of elemental iron is potentially lethal**