

Iron Overdose

James Roy Waymack, MD*, Marit Tweet, MD* and Richard Austin, MD*

*Southern Illinois University, Division of Emergency Medicine, Department of Surgery, Springfield, IL

Correspondence should be addressed to James Roy Waymack, MD at jwaymack@siumed.edu

Submitted: April 12, 2018; Accepted: July 25, 2018; Electronically Published: January 15, 2019; <https://doi.org/10.21980/J8MD1P>

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ABSTRACT:

Audience: Emergency medicine residents and medical students on emergency medicine rotations.

Introduction: Iron overdose is an uncommon but potentially fatal ingestion that requires unique evaluation and management skills. Most commonly, iron overdose occurs as a result of unintentional ingestion in pediatric patients through iron-containing vitamins or other iron supplements. There are around 11,000 annual ingestions reported in the United States in children less than six years of age which comprise around 75% of all ingestions.^{1,2} It is still important for providers to be aware of intentional ingestions, which occur less commonly but carry a greater mortality rate, 10% compared to the 1% of unintentional ingestions. Intentional ingestions occur more frequently in female patients with a mean age of 19.8 years.³ Patients commonly present with gastrointestinal disturbances in the first few hours after an ingestion. There is a latent phase during which the patient may become asymptomatic prior to entering a phase of shock and organ failure. It is important for providers to recognize this latent phase because patients with a history of ingestion will still require a thorough work up for iron toxicity. Depending on amount of ingestion and iron levels, patients may require chelation therapy and other supportive measures.

Objectives: By the end of this oral boards case, learners will: 1) demonstrate evaluation of a patient presenting with toxic ingestion, including obtaining pertinent history, 2) review the signs and symptoms of the different presenting phases of acute iron ingestion, and 3) demonstrate appropriate treatment of iron overdose, namely, iron chelation therapy with deferoxamine.

Method: Oral boards case.

Topics: Overdose, iron toxicity, toxicology, deferoxamine.



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Learner Audience:

Medical Students, Interns, Junior Residents, Senior Residents

Time Required for Implementation:

Case: 15 minutes

Debriefing: 10 minutes

Learners per instructor:

Recommend 1-2 learners per instructor

Topics:

Overdose, iron toxicity, toxicology, deferoxamine.

Objectives:

By the end of this oral boards case, learners will:

1. Demonstrate evaluation of a patient presenting with toxic ingestion, including obtaining pertinent history to be able to develop a diagnostic and management plan.
2. Review the signs and symptoms of the different presenting phases of acute iron ingestion.
3. Demonstrate appropriate treatment of iron overdose, namely, iron chelation therapy with deferoxamine.

Linked objectives, methods and results:

This oral boards case allows learners to have exposure to an uncommon, but life-threatening ingestion. Completion of the case affords learners the opportunity to obtain a history and evaluation focused towards managing an ingestion patient (objective 1). They should demonstrate appropriate treatment of acute iron toxicity (objective 3). Learners will be able to better understand the presenting phases of iron ingestion after the debriefing with the instructor (objective 2). During the case, learners may consult with medical toxicology to assist them in navigating the management of iron ingestion.

During the debriefing session, the instructor will be able to further probe the learners' understanding of iron ingestion. They can fill in any gaps in knowledge regarding the presentation or management of iron ingestion and discuss the signs and

symptoms of various phases of acute iron toxicity in more detail (objective 2).

Recommended pre-reading for instructor:

- Eggerman D, Huang A, Swartz J, et al. Whole bowel irrigation. WikiEM. https://www.wikem.org/wiki/Whole_bowel_irrigation. Published May 16, 2017. Accessed December 13, 2018.
- Huang A, Snyder A, Swartz J, et al. Iron toxicity. WikiEM. https://www.wikem.org/wiki/Iron_toxicity. Published November 10, 2018. Accessed December 21, 2018.
- Liebelt EL. Acute iron poisoning. In: Burns MM, Traub SJ, Wiley JF, eds. *UpToDate*. Waltham, MA: UpToDate Inc. www.uptodate.com. Updated May 30, 2017. Accessed December 13, 2018.
- Nickson, C. Iron overdose. *Life in the Fastlane*. <https://lifeinthefastlane.com/cc/iron-overdose/>. Published May 23, 2014. Accessed December 13, 2018.
- Velez LL, Delaney KA. Heavy metals. In: Marx JA, Hockberger RS, Walls RM, Adams J, eds. *Rosen's Emergency Medicine: Concepts and Clinical Practice*. 7th ed. Philadelphia, PA: Mosby; 2010:2019-2026.

Results and tips for successful implementation:

This case was piloted with 18 emergency medicine residents in all stages of training (PGY 1-3). Learners of all levels found the case to be beneficial for reviewing iron toxicity as well as other toxic ingestions. Specific learning points that were found to be most helpful included the stages of iron toxicity and treatments. No formal assessments were done of the participants.

- Novice learners may need some prompting to get to the presenting problem of a toxic ingestion. Prompting from the parents in the case may be helpful.
- Novice learners may require more prompting to discover key pieces in the history (amount and dosage of iron tablets), recognize different phases of iron ingestion and order appropriate diagnostic testing (iron level, common co-ingestants).
- This case could be easily translated to the simulation environment.
- It is important to debrief the case with the learner after the completion of the case or to provide post-case reading material.

References/suggestions for further reading:

1. Bateman N, Eagling V, Sandilands E, et al. Iron overdose epidemiology, clinical features and iron concentration-effect relationships: the UK experience 2008–2017. *Clin Toxicol (Phila)*. 1028;56(11):1098-1106. doi: 10.1080/15563650.2018.1455978



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3. McGuigan MA. Acute iron poisoning. *Pediatr Ann*. 1996;25(1):33-8.
4. Valentine K, Mastropietro C, Sarnaik AP. Infantile iron poisonings: challenges in diagnosis and management. *Pediatr Crit Care Med*. May 2009. 10 (3): e31-33.
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6. Howland MA. Deferoxamine. In: Nelson LS, Lewin NA, Howland MA, Hoffman RS, Goldfrank LR, Flomenbaum NE, eds. *Goldfrank's Toxicologic Emergencies*. 9th ed. New York, NY: McGraw-Hill; 2011:604-608.
7. Huang A, Snyder A, Swartz J, et al. Iron toxicity. WikiEM. https://www.wikem.org/wiki/Iron_toxicity. Published November 10, 2018. Accessed December 21, 2018.
8. Liebelt EL. Acute iron poisoning. In: Burns MM, Traub SJ, Wiley JF, eds. *UpToDate*. Waltham, MA: UpToDate Inc. www.uptodate.com. Updated May 30, 2017. Accessed December 13, 2018.
9. Nickson, C. Iron overdose. Life in the Fastlane. <https://lifeinthefastlane.com/cc/iron-overdose/>. Published May 23, 2014.
10. Perrone J. Iron. In: Nelson LS, Lewin NA, Howland MA, Hoffman RS, Goldfrank LR, Flomenbaum NE, eds. *Goldfrank's Toxicologic Emergencies*. 9th ed. New York: McGraw-Hill; 2011:596-603.
11. Velez LL, Delaney KA. Heavy Metals. In: Marx JA, Hockberger RS, Walls RM, Adams J, eds. *Rosen's Emergency Medicine: Concepts and Clinical Practice*. 7th ed. Philadelphia, PA: Mosby; 2010:2019-2026.
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FOR EXAMINER ONLY

Oral Case Summary

Diagnosis: Iron Toxicity

Case Summary: A 17-year-old female presents to the emergency department (ED) in the company of her parents with report of abdominal pain, vomiting, and hematemesis that appear to be improving. Her parents noticed the symptoms this morning and brought the patient in for evaluation. She admits to ingesting several iron supplements approximately eight hours prior to arrival, and she had a 3-month supply filled last week. She denies taking any other medications. She states she has recently broken up with her boyfriend and was feeling depressed. Patient has no previous ingestions or suicide attempts. If asked, parents have the empty pill bottle labeled ferrous sulfate 325 mg tablets with a fill date one week ago for 90 tablets.

On physical examination, the patient is in mild distress. She is tachycardic with a decreased blood pressure. There is dark vomit around her lips. Her abdomen is soft with mild diffuse tenderness. Her mood appears depressed and she is tearful at times.

Order of Case: The learner should obtain the history from the patient, supported by details from the parents as needed. A full physical examination should be performed. The patient should be stabilized and have a full toxicological evaluation performed, including acetaminophen and salicylate levels. Medical toxicology services may be consulted. An abdominal radiograph and serum iron level must be obtained. Once the elevated iron level returns and pill fragments are seen on the radiograph, iron chelation therapy with deferoxamine should be initiated. The patient should be admitted for further treatment and observation. While the patient is being medically stabilized, staff should be instructed to maintain suicidal precautions for the patient's safety, and psychiatry should be consulted. The patient's parents should be updated regarding the plan, and the learner should be prompted to discuss the later stages of iron toxicity.

Disposition: Telemetry with suicidal precautions.

Asymptomatic patients observed for six hours with iron levels less than 300 mcg/dL may be discharged. Those with a significant iron ingestion will require admission for further treatment and evaluation. Cardiac telemetry monitoring would be advised for patients with tachycardia or electrolyte abnormalities. Unstable patients may require higher levels of care in the ICU. Patients with suicidal ideation will also require one-on-one observation.



FOR EXAMINER ONLY

Critical Actions:

1. Obtain an appropriate history and identify likely iron ingestion.
2. Initiate the primary interventions for monitoring and treating the patient including intravenous access with fluid resuscitation, cardiac monitoring, pulse oximetry, and a blood glucose.
3. Obtain a serum iron level, complete blood count (CBC), basic metabolic panel (BMP), pregnancy test, acetaminophen level, salicylate level, and type and crossmatch.
4. Obtain an abdominal radiograph.
5. Initiate treatment for significant iron ingestion to include whole bowel irrigation and iron chelation therapy.
6. Admit the patient to telemetry for continued therapy.
7. Maintain suicidal precautions for the patient and consult psychiatry for mental health evaluation.



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Historical Information

Chief Complaint: Abdominal pain and vomiting

History of present illness: A 17-year-old female presents to the emergency department with report of diffuse abdominal pain with cramping and vomiting. Her symptoms started last night. This occurred approximately six hours ago. The patient states that she is beginning to feel better now and is wondering why she had to come in. She states that she has been up all night and is tired and would just like to go home to rest. Her parents are worried because they saw very dark vomit around her lips and thought she may have been vomiting blood. The patient also reports some dark diarrhea.

She had an argument with her boyfriend of six months, felt very depressed and decided she was going to overdose on the iron pills she takes for chronic anemia. She takes 325mg of ferrous sulfate daily to help with anemia she developed due to heavy menstrual periods. One week ago, she filled a 90-day supply of the tablets. She denies taking any other medications, alcohol or drugs. She has not been diagnosed with depression or been hospitalized for psychiatric reasons in the past. She states she was foolish for taking the pills and no longer feels like she wants to do herself harm.

Past medical history: Heavy menstrual periods causing anemia necessitating iron supplementation.

Past surgical history: Bilateral tympanostomy tubes.

Patients medications: Ferrous sulfate 325 mg daily, oral contraceptive pill.

Allergies: none

Social history:

- Smoking: Denies
- Tobacco: Denies
- Drug use: Denies

Family history: No familial disease or psychiatric history in the family.



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Physical Exam Information

Vitals: HR 120 BP 90/50 RR 22 Temp 98.6°F O₂Sat 98% on room air

Weight: 50kg

General appearance: Sad, remorseful. When asked probing questions she becomes tearful. Dried dark vomit is on her lips and chin.

Primary survey:

- **Airway:** Intact, speaking in full sentences
- **Breathing:** No respiratory difficulty
- **Circulation:** Warm skin, normal capillary refill

Physical examination:

- **General appearance:** Sad, remorseful. When asked probing questions she becomes tearful
- **Head, eyes, ears, nose and throat (HEENT):**
 - **Head:** Within normal limits
 - **Eyes:** Within normal limits
 - **Ears:** Within normal limits
 - **Nose:** Within normal limits
 - **Throat:** Mild erythema, dark appearing vomit around lips
- **Neck:** Within normal limits
- **Chest:** Equal expansion, lungs are clear to auscultation
- **Cardiovascular:** Tachycardia, no murmurs
- **Abdominal/GI:** Normal bowel sounds. Soft. Diffuse mild tenderness
- **Genitourinary:** Within normal limits
- **Rectal:** Deferred
- **Extremities:** Within normal limits
- **Back:** Within normal limits
- **Neuro:** Within normal limits
- **Skin:** Within normal limits
- **Lymph:** Within normal limits
- **Psych:** Sad, she appears sorry and remorseful for what she has done, she felt like ending her life earlier but now does not feel suicidal



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Critical Actions and Cueing Guidelines

1. Obtain an appropriate history to evaluate iron ingestion.

The learner should ask pertinent questions to discover what was ingested, when, and how much. Specific doses or concentration are important to quantify possible toxic concentrations ingested. Other medications, alcohol, or recreational drugs should be asked about as well because their co-ingestion may complicate the management of the case. It will also be important for the learner to demonstrate that there are progressive phases of iron ingestion and the patient may be entering the latent phase.

a. Cueing Guideline:

If the learner has not obtained the historical information, the parents may ask questions that could lead the learner to these points, “Doctor we just filled the prescription last week; could that be too many pills to take at once?” Also, the parents may offer to provide the pill bottle to the learner if not requested. The patient can help probe the learner’s understanding of iron ingestion phases by asking, “I don’t feel like vomiting anymore; aren’t I getting better?” The on-call medical toxicologist can direct the learner to revisit important historical pieces if they are missed also.

2. Initiate early patient monitoring and treatment routes to include intravenous (IV) access with fluid resuscitation, cardiac monitoring, pulse oximetry, and a blood glucose.

It is important that all patients have the monitoring initiated as well as IV access placed early during their ED visit so they are adequately monitored and staff are prepared if decompensation occurs. This patient requires IV fluid resuscitation because of hypotension and tachycardia.

a. Cueing Guideline:

If learners have not yet established the monitoring routes and IV access, the nurse can ask them if they would like the patient placed on the monitor or to have an IV established.

3. Obtain a serum iron level, CBC, BMP, pregnancy test, acetaminophen level, salicylate level, and type and crossmatch.

Obtaining a serum iron concentration and other essential labs for co-ingestants in the setting of a gastrointestinal bleed will assist the learner in determining the significance of the ingestion and guide management.

a. Cueing Guideline:





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If the learner does not order a serum iron concentration, the nurse could ask the learner if iron levels can be measured with a blood test. The on-call medical toxicologist can also guide the learner towards obtaining a serum iron level and common co-ingestants. If the learner is not ordering labs relevant to a probable gastrointestinal bleed, the nurse may also prompt with suggestions for CBC and type and crossmatch.

4. Obtain an abdominal radiograph.

Obtaining an abdominal radiograph may help the learner determine how significant the ingestion is, if there are possibly pill fragments still in the GI tract, and help the learner determine if whole bowel irrigation may be necessary.

a. Cueing Guideline:

If learners do not order an abdominal radiograph to look for pill fragments, the nurse could ask if they would like any other tests or x-rays. A radiology tech passing by in the hallway may also ask learners if they need an x-ray in the patient's room.

5. Initiate treatment for significant iron ingestion with iron chelation therapy.

In this case the patient ingested a clinically significant amount of iron; it appears she is entering the latent phase and serum levels are elevated. Iron chelation therapy should be considered with the assistance of medical toxicology if desired.

a. Cueing Guideline (if applicable):

If the learner does not consider chelation therapy, the parents or staff may ask the learner if there are any therapies or antidotes that may help with the iron ingestion. If medical toxicology is consulted, they can ask the learner what if any treatments have been initiated and suggest for diagnostics or chelation therapy.

6. Admit the patient to telemetry for continued therapy.

Learners should demonstrate understanding that this patient has a significant iron ingestion and should be admitted to the hospital for further treatment and observation because it appears she is entering the latent phase. They should also demonstrate some understanding of the later phases of significant iron ingestion by discussing with the patient's parents possible progression of the overdose.

a. Cueing Guideline (if applicable):

If the learner is not considering admission for this patient, the parents may ask if it is safe for their daughter to be discharged home. The nursing staff can express



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concern for the ingestion and need for observation, "Doctor, don't most overdoses require observation?" Also, if medical toxicology is consulted, they may help the learner determine an appropriate disposition. If the learner has not discussed the later phases of iron toxicity, then the parents may ask explanation for what could happen as a result of the ingestion if not treated, or if there are any long term complications from the ingestion.

7. Maintain suicidal precautions for the patient and consult psychiatry for a mental health evaluation.

The patient in this case requires medical stabilization during the initial ED evaluation. However, it is important to remember to follow suicidal precaution guidelines to prevent further harm until psychiatry has performed a mental health screening.

a. Cueing Guideline:

The nurse may ask the learner if the patient still needs to be under suicidal precautions or if psychiatry will be consulted.



ORAL BOARDS ASSESSMENT

Iron Overdose

Learner: _____

Critical Actions:

- Obtain an appropriate history to evaluate iron ingestion
- Initiate early patient monitoring (cardiac monitoring, pulse oximetry, and a blood glucose) and IV access with fluid resuscitation
- Obtain a serum iron level, CBC, BMP, pregnancy test, acetaminophen level, salicylate level, and type and crossmatch
- Obtain an abdominal radiograph
- Initiate treatment for significant iron ingestion with iron chelation therapy
- Admit the patient to telemetry for continued therapy
- Maintain suicidal precautions for the patient and consult psychiatry for a mental health evaluation

Summative and formative comments:

Milestone assessment:

	Milestone	Did not achieve level 1	Level 1	Level 2	Level 3
1	Emergency Stabilization (PC1)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Recognizes abnormal vital signs	<input type="checkbox"/> Recognizes an unstable patient, requiring intervention Performs primary assessment Discerns data to formulate a diagnostic impression/plan	<input type="checkbox"/> Manages and prioritizes critical actions in a critically ill patient Reassesses after implementing a stabilizing intervention



ORAL BOARDS ASSESSMENT

Iron Overdose

Learner: _____

	Milestone	Did not achieve level 1	Level 1	Level 2	Level 3
2	Performance of focused history and physical (PC2)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Performs a reliable, comprehensive history and physical exam	<input type="checkbox"/> Performs and communicates a focused history and physical exam based on chief complaint and urgent issues	<input type="checkbox"/> Prioritizes essential components of history and physical exam given dynamic circumstances
3	Diagnostic studies (PC3)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Determines the necessity of diagnostic studies	<input type="checkbox"/> Orders appropriate diagnostic studies <input type="checkbox"/> Performs appropriate bedside diagnostic studies/procedures	<input type="checkbox"/> Prioritizes essential testing <input type="checkbox"/> Interprets results of diagnostic studies <input type="checkbox"/> Considers risks, benefits, contraindications, and alternatives to a diagnostic study or procedure
4	Diagnosis (PC4)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Considers a list of potential diagnoses	<input type="checkbox"/> Considers an appropriate list of potential diagnosis <input type="checkbox"/> May or may not make correct diagnosis	<input type="checkbox"/> Makes the appropriate diagnosis <input type="checkbox"/> Considers other potential diagnoses, avoiding premature closure
5	Pharmacotherapy (PC5)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Asks patient for drug allergies	<input type="checkbox"/> Selects an appropriate medication for therapeutic intervention, considering potential adverse effects	<input type="checkbox"/> Selects the most appropriate medication(s) and understands mechanism of action, effect, and potential side effects <input type="checkbox"/> Considers and recognizes drug-drug interactions
6	Observation and reassessment (PC6)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Reevaluates patient at least one time during the case	<input type="checkbox"/> Reevaluates patient after most therapeutic interventions	<input type="checkbox"/> Consistently evaluates the effectiveness of therapies at appropriate intervals



ORAL BOARDS ASSESSMENT

Iron Overdose

Learner: _____

	Milestone	Did not achieve level 1	Level 1	Level 2	Level 3
7	Disposition (PC7)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Appropriately selects whether to admit or discharge the patient	<input type="checkbox"/> Appropriately selects whether to admit or discharge Involves the expertise of some of the appropriate specialists	<input type="checkbox"/> Educates the patient appropriately about their disposition Assigns patient to an appropriate level of care (ICU/Tele/Floor) Involves expertise of all appropriate specialists
22	Patient centered communication (ICS1)	<input type="checkbox"/> Did not achieve level 1	<input type="checkbox"/> Establishes rapport and demonstrates empathy to patient (and family) Listens effectively	<input type="checkbox"/> Elicits patient's reason for seeking health care	<input type="checkbox"/> Manages patient expectations in a manner that minimizes potential for stress, conflict, and misunderstanding.
23	Team management (ICS2)	<input type="checkbox"/> Did not achieve level 1	<input type="checkbox"/> Recognizes other members of the patient care team during case (nurse, techs)	<input type="checkbox"/> Communicates pertinent information to other healthcare colleagues	<input type="checkbox"/> Communicates a clear, succinct, and appropriate handoff with specialists and other colleagues Communicates effectively with ancillary staff



Stimulus Inventory

- #1 Patient Information Form
- #2 Electrocardiogram (ECG)
- #3 Basic metabolic panel (BMP)
- #4 Liver function tests (LFTs)
- #5 Complete blood count (CBC)
- #6 Lactate
- #7 Urinalysis, urine toxicology, urine pregnancy test
- #8 Iron level
- #9 Acetaminophen level
- #10 Salicylate level
- #11 Coagulation studies
- #12 Venous blood gas
- #13 Type and Crossmatch
- #14 Abdominal radiograph



Stimulus #1

Patient Information

Patient's Name: Jenny Johnson
Age: 17
Gender: Female
Chief Complaint: Abdominal pain and vomiting

Person Providing History: Patient and family

Vital Signs:

Temp: 98.6°F
BP: 90/50 mm Hg
P: 120
RR: 14
Pulse Ox: 99% (room-air)
Weight: 50 kg



Stimulus #2

Electrocardiogram (ECG)

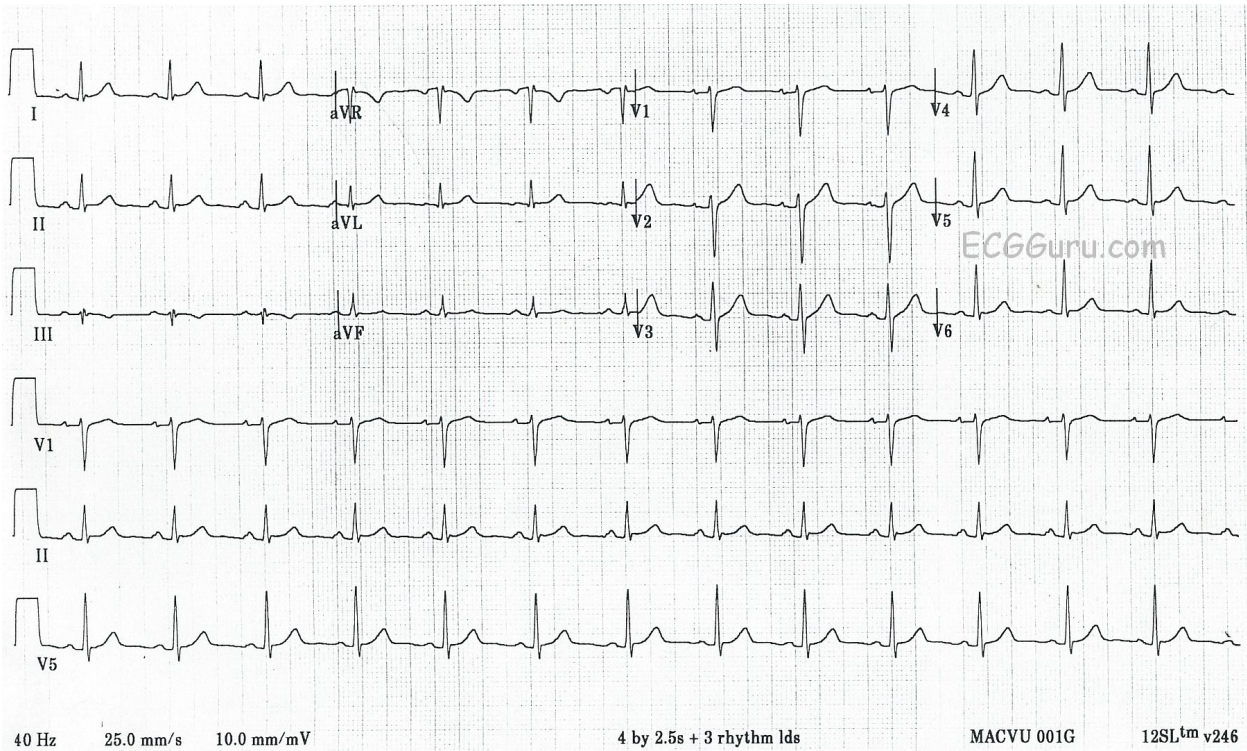


Image courtesy of: Normal 12 lead ECG with rhythm strips. Dawn Bean Altman.

<https://www.ecgguru.com/sites/default/files/N107.jpg>. Published May 12, 2016. CC BY-ND-NC 1.0



Stimulus #3

Basic Metabolic Panel (BMP)

Sodium	140 mEq/L
Potassium	4.2 mEq/L
Chloride	115 mEq/L
Carbon Dioxide (CO₂)	14 mEq/L
Blood Urea Nitrogen (BUN)	14 mg/dL
Creatinine (Cr)	0.7 mg/dL
Glucose	130 mg/dL



Stimulus #4

Liver Function Tests

Aspartate Aminotransferase (AST)	250 u/L
Alanine Aminotransferase (ALT)	240 u/L
Total Bilirubin	1.4 mg/dL
Alkaline Phosphatase	70 u/L
Albumin	4.0 g/dL



Stimulus #5

Complete Blood Count (CBC)

White blood cell count (WBC) 14 x1000/mm³

Hemoglobin (Hgb) 10 g/dL

Hematocrit (Hct) 32.2%

Platelets 198 x1000/mm³



Stimulus #6

Lactic Acid

3.2 mmol/L



Stimulus #7

Urinalysis

Appearance	Clear
Color	Straw
Glucose	Negative
Ketones	10
Sp Gravity	1.030
Blood	Negative
pH	6.1
Protein	Negative
Nitrite	Negative
Leukocyte	Negative
WBC	0/hpf
Red blood cells (RBC)	0/hpf
Squamous Cells	0/hpf
Bacteria	0/hpf
Urine Toxicology	Negative
Urine Pregnancy Test	Negative



Stimulus #8

Iron Level

Serum Iron **750 mcg/dL (Reference: 80-180mcg/dL)**



Stimulus #9

Acetaminophen

Serum Acetaminophen

Undetectable



Stimulus #10

Salicylate Level

Serum Salicylate

Undetectable



Stimulus #11

Coagulation Studies

Prothrombin Time (PT)	12.7 seconds
Partial Thromboplastic Time (PTT)	26.2 seconds
International Normalized Time (INR)	0.9



Stimulus #12

Venous Blood Gas

pH	7.3
pCO₂	30 mmHg
pO₂	35 mmHg
HCO₃	14 mEq/L
O₂ sat	45%



Stimulus #13

Type and Crossmatch

Blood Type **A**

Rh **Negative**



Stimulus #14

Abdominal Radiograph



Image courtesy of: Mike Cadogan. Life in the Fast Lane: AXR Interpretation <https://lifeinthefastlane.com/investigations/axr-interpretation/>. Permission obtained from author for use on December 12th, 2018.



DEBRIEFING AND EVALUATION PEARLS

Iron Overdose

- When investigating an ingestion, it is important to obtain the time of the ingestion, what medication/formulation was taken, the dosage, and quantity. Physicians should also inquire about co-ingestants such as alcohol, over the counter medications, or recreational drugs.
- It is important to determine the amount of elemental iron ingested.
 - Nontoxic < 20 mg/kg
 - Moderate to severe > 40 mg/kg
 - Lethality possible > 60 mg/kg
 - Elemental iron equivalents:
 - Ferrous sulfate, 20% (325 mg = 65 mg Fe)
 - Ferrous gluconate, 12%
 - Ferrous fumarate, 33%
 - Prenatal vitamins vary from 60-90 mg elemental iron per tablet.
 - Children's vitamins may contain 5-18 mg elemental iron per tablet.
- Iron toxicity presents in five phases: gastrointestinal, latent, shock and organ failure, hepatic failure and obstruction.
 - Stage I (0.5-6hr): Gastrointestinal (GI) – abdominal pain, vomiting, diarrhea, hematemesis and hematochezia.
 - Stage II (6-24hr): Latent – resolution of GI symptoms, possible development of hypotension and anion gap metabolic acidosis.
 - Stage III (6-72hr): Shock and organ failure – hypoperfusion, metabolic acidosis, coma and coagulopathy.
 - Stage IV (2-3 days): Hepatic failure – coagulopathy, hypoglycemia, jaundice, elevated liver function tests (LFTs) and bilirubin.
 - Stage V (2-4 weeks): Obstruction – gastric outlet and small bowel obstruction, abdominal pain and vomiting.
- Charcoal decontamination and gastric lavage are ineffective for iron ingestion; if iron tablets are seen on radiography then whole bowel irrigation may be considered.
 - Attempt whole bowel irrigation with polyethylene glycol
 - Peds: 10-15 mL/kg/hr
 - Adult: 1-2 L/hr
 - Monitor progression with serial radiographs.



DEBRIEFING AND EVALUATION PEARLS

- Abdominal radiograph may not show pills if in solution, already dissolved, or pediatric multivitamin: therefore, negative radiograph does not rule out lethal ingestion.
- Serum iron levels peak between 2- and 6-hours following ingestion. The peak may be delayed if the tablets are enteric coated or sustained release.
- Patients with severe ingestions (sustained GI symptoms, toxicity, serum iron level greater than 500 mg/dL or iron pills seen on radiograph and serum iron level greater than 350 mg/dL) should be considered for iron chelation therapy with deferoxamine, which is a strong binder of parenteral iron.
- Deferoxamine (DFO) is best administered as a continuous intravenous infusion slowly increasing to a rate of 15 mg/kg/hr while monitoring for hypotension.
- DFO-Iron complex causes the urine to turn a *vin rose* color; it is recommended the infusion continue until the urine clears or until the serum iron level drops below 500mcg/dL.
 - Prolonged therapy more than 24 hours may cause adult respiratory distress syndrome and increases risk of *Yersinia* infection.
- Significant iron ingestions require admission for observation, rehydration, and possible chelation therapy. Discharge criteria following iron ingestion include: asymptomatic with negative radiograph, minimal to no symptoms at six hours, and mild symptoms that have resolved without evidence of metabolic acidosis, and serum iron level less than 350 mg/dL.