Ethanol Ingestion

What would you do next?

Work it up!

- Obtain IV access!
- Serum Ethanol Level
- POC Blood Glucose
- BMP
  - Calculate anion gap
  - Calculate osmolal gap
- Blood gas with pulse oximetry
- Serum acetaminophen and salicylate levels
- EKG
- Urine toxicology
- Chest x-ray
- Urine pregnancy test

Toxic Effects of Ethanol

- CNS Depression
- Hypoglycemia
- Hypothermia
- Metabolic acidosis
- Inhibition of anti-diuretic hormone in the kidneys
  - Polyuria with mild to moderate dehydration
- Direct irritation of gastric mucosa
  - Vomiting, abdominal pain, hematemesis

Toxic Dose in Adolescents

- Most show signs of inebriation at serum ethanol levels of 50 to 100 mg/dL
- This peak blood level is typically achieved in a 50kg child after
  - 1-2 12-ounce (360 mL) beers (5% ethanol content)
  - 1 glass of wine
  - 1 shot of liquor
- Severe toxicity is expected with an ingestion equivalent to 6 mL/kg of 100% ethanol.

Toxic Dose in Infants/Children

- Toxic dose is 0.4 mL/kg of 100% ethanol and would be expected to result in a peak serum ethanol level of 50 mg/dL
- Deep coma with respiratory depression is estimated at 4 mL/kg of 100% ethanol, resulting in a peak ethanol level of >500mg/dL

Hypoglycemia in Infants/Children

- Fatal hypoglycemia (seizure) has occurred in young children with blood ethanol concentrations below 100 mg/dL
  - Gluconeogenesis is inhibited and glycogen reserves are eventually exhausted in maintaining blood glucose
  - Not responsive to glucagon administration
- Thus, any symptoms after exposure to ethanol in the young child warrant emergent medical evaluation regardless of estimated amount ingested.

Ethanol Toxicity Management

- Supportive care is the mainstay
- Supplemental oxygen and nasopharyngeal airway usually sufficient to maintain normal O2 sats
  - Coma with absent gag reflex requires intubation with mechanical ventilation

Ethanol Toxicity Management

- Isotonic IV fluids (normal saline or LR) should be administered to correct hypovolemia
  - Potassium-containing solutions may be needed to treat hypokalemia if patient has frequent vomiting
- Watch temperatures in younger patients and those exposed to cool environments prior to arrival
  - Hypothermic patients need active external warming with radiant heat, heat lamps, or warm blankets

Ethanol Toxicity Management

- IV lorazepam should be initially administered to patients whose seizures do not abate with correction of hypoglycemia
- Hypoglycemic patients should receive a rapid 0.25g/kg IV bolus of dextrose followed by a continuous infusion of D5 or D10 with 1/4 to 1/2 NS to maintain dex > 60 mg/dL

Ethanol Elimination

- The elimination of ethanol in acute overdose is typically constant over time, regardless of peak levels.
- In nontolerant individuals, the decline in ethanol ranges from 10 to 25 mg/dL per hour
- The estimated time to no ethanol in the blood stream in hours is calculated by dividing the peak serum ethanol concentration (mg/dL) by 10 (longest likely duration) or 25 (shortest likely duration).

Ethanol Elimination

- The major metabolic pathway utilizes the enzyme alcohol dehydrogenase to convert ethanol to acetaldehyde and the reduction of NAD+ to NADH.
- In children under 5 years of age, immaturity of hepatic dehydrogenase activity diminishes their ability to metabolize ethanol.
  - This leads to rapid increases in blood levels and intoxication.

Stay or Go?

- Asymptomatic children with ethanol ingestion expected to produce a peak serum level >50 mg/dL should undergo rapid blood glucose testing and be observed until six hours after ingestion.
  - Estimation of ingested volume can be difficult. Consider evaluating all asymptomatic children with ethanol exposure regardless of the reported amount.
- Children who are asymptomatic for six hours after a limited exposure to ethanol may be discharged home as long as close observation and ability to rapidly return for medical care if needed is assured.
- Patients who ingest ethanol with intent of self-harm should undergo mental health consultation, measurement of serum acetaminophen levels, and careful evaluation for other coingestants.

Presentation

- A 2 year old girl is brought in by EMS after her parents found her in their bathroom with a bottle of rubbing alcohol. The bottle was new but now noted to be half-empty and the girl was not acting like herself.
- Diagnosis?

Isopropyl Alcohol Ingestion

- Found in disinfectant, antifreeze, solvent, and comprises 70% of “rubbing alcohol”
  - Harsh taste often deters children from imbibing large amounts
- Hallmark of metabolism is marked ketonemia and ketonuria in the ABSENCE of metabolic acidosis and high anion gap
- In addition to the basic studies, obtain
  - Serum isopropyl alcohol and acetone levels
  - OR serum osmolality with calculation of osmolal gap if serum level not available

Isopropyl Alcohol Ingestion

- Managed similarly to ethanol ingestion. No role for antidotal therapy.
- Rarely, massive ingestions result in serum isopropyl alcohol concentrations >500mg/dL and osmolal gap >100.
  - Obtain Nephrology consultation for hemodialysis
- Asymptomatic children with accidental ingestions can be managed with home observation (mouthful or less).

Presentation

- A babysitter comes to the ER carrying a drowsy 4 year old boy. She explains that she found him in the garage drinking from a Gatorade bottle that had green fluid in it, but it did not smell like Gatorade.
- Diagnosis?

Methanol/Ethylene Glycol Intoxication

- Frequently found in high concentrations in automotive antifreeze, de-icing solutions, windshield wiper fluid, solvents, cleaners, fluids and other industrial products
- Illicit distillation – “moonshine”

Methanol/Ethylene Glycol Toxicity

- “Parent alcohols” are relatively nontoxic but are profoundly toxic when oxidized by alcohol dehydrogenase and adlehyde dehydrogenase
- Methanol → formate
  - Retinal injury with optic disc edema and eventual permanent blindness
  - Ischemic/hemorrhagic injury to basal ganglia (disruption of mitochondrial function)
- Ethylene glycol → glycolate, glyoxylate and oxalate
  - Reversible oliguric or anuric ARF primarily due glycolate-induced tubule damage
  - Hypocalcemia results from calcium oxalate formation

Methanol/Ethylene Glycol Intoxication

- Early toxicity: CNS sedation and inebriation similar to ethanol intoxication
- Late toxicity: Further decrease in mental status with tachypnea (to compensate for systemic acidosis)
  - Methanol causes ocular toxicity
  - Ethylene glycol causes renal failure

Methanol/Ethylene Glycol Work-up

- Blood gas, BMP, serum osmolality, serum ethanol level
- Urinalysis for oxalate crystals
- Serum calcium level to r/o ethylene glycol associated hypocalcemia
- Serum methanol, ethylene glycol, and isopropanol levels to help determine diagnosis
  - Almost always a send-out lab; rarely helpful in time

Indications for Antidotal Therapy

- Serum methanol or ethylene glycol concentration >20 mg/dL

  OR
- Documented recent history of ingesting toxic amounts of either and serum osmol gap >10

  OR
- Strong clinical suspicion of poisoning and at least 2:
  - Arterial pH < 7.3
  - Serum bicarb < 20
  - Osmol gap > 10
  - Urinary oxalate crystals present

- Block alcohol dehydrogenase with **fomepizole (**15mg/kg IV loading dose followed by 10mg/kg Q12H x 4 doses)

- If fomepizole unavailable, use ethanol (8mL/kg of 10% ethanol solution followed by infusion of 1mL/kg per hour)
  - Titrate to serum ethanol concentration of 100 mg/dL

Methanol/Ethylene Glycol Treatment

- If pH < 7.3, administer sodium bicarbonate bolus followed by infusion
  - Administer folic acid 50mg IV Q6H, thiamine 100mg IV, and pyridoxine 50mg IV
- Hemodialysis is indicated in severe toxicity:
  - Metabolic acidosis, regardless of drug level
  - Serum toxic alcohol levels > 50mg/dL, unless pH is > 7.3
  - Evidence of end-organ damage (visual changes, renal failure)

Take Home Point: Osmolal Gap

- An unexplained, large osmolal gap is presumptive evidence of a recent methanol, ethylene glycol, or isopropyl alcohol exposure as long as significant ethanol ingestion has been excluded.
- Osmolal gap is the the difference between the measured osmolality and the calculated plasma osmolality:
  - Calculated Posm: (2xNa) + (Glu/18) + (BUN/2.8)

Take Home Point: Osmolal Gap

- Normal values is considered < 10 units.
  - Few substances cause levels >25, and most severely poisoned methanol/ethylene glycol patients manifest these levels shortly after ingestion
- Cannot distinguish among ethanol, isopropyl, methanol or ethylene glycol.
- Increases only in the presence of parent alcohols
  - Therefore insensitive in late presentations
- Not sufficiently sensitive to exclude a small ingestions

Board Prep

- A grandmother discovers her 18-month-old grandson in the garage near an opened container of greenish fluid that she suspects to be antifreeze. She brings the child to the urgent care center for evaluation. On physical examination, the boy appears sleepy and somewhat ataxic. Initial laboratory evaluation reveals:

* Sodium, 140 mEq/L
* Potassium, 4.1 mEq/L
* Chloride, 105 mEq/L
* Bicarbonate, 16 mEq/L
* Calcium, 9.0 mg/dL
* Magnesium, 2.0 mEq/L
* Phosphorus, 5.5 mg/dL
* Glucose, 90 mg/dL
* Blood urea nitrogen, 14 mg/dL
* Creatinine, 0.4 mg/dL
* Albumin, 4.0 g/dL
* Serum osmolality, 310 mOsm/kg

Of the following, the osmolar gap in this child, who has a possible ingestion, is CLOSEST to

A. 8
B. 12
C. 16
D. 20
E. 24

Take Home Points

- Visual blurring and blindness suggest methanol poisoning
- Flank pain, hematuria, and oliguria suggest ethylene glycol poisoning
- Few conditions other than methanol and ethylene glycol cause a profoundly high AG metabolic acidosis (bicarb < 8) and most of those conditions present with high serum lactate
  - Status epilepticus, profound shock, ischemic bowel, DKA
- Isopropyl alcohol DOES NOT present with a high AG metabolic acidosis