

CYANIDE

and

Cyanide Antidote Package

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Cheryl Barbanel, MD, MBA, MPH, FACOEM
Chief, Occupational & Environmental Medicine
Boston Medical Center, Boston University
Medical Director, BU Occupational Health Center

Cyanide is a highly reactive Chemical

Uses:

- Chemical synthesis, laboratory analysis
- Plastic industry
- Metal plating, mining, electroplating
- Apricot pits, Cassava, and other seeds
- Acetonitrile, artificial nail remover

Cyanide is a highly reactive Chemical

- Cyanide Is the Most Rapidly Lethal Poison Known to Man
- Primary Mechanism of Action Is Blocking the Ability of Cells to Use Oxygen by Inactivating Cytochrome Oxidase (Aa_3) and Cellular Respiration
- Tissues With the Highest Oxygen Affinity Are Most Affected: Brain, Heart, Liver

Hydrogen Cyanide Gas

- Generated by mixing acid with cyanide salts
- Common by product of burning plastics, wool or synthetic products
- Hydrogen cyanide is used in deliberate suicide and homicide
- Cause of death from structural fires

Cyanide

- State executions by the ancient Greeks, Romans, Californians.
- The 1st chemist to synthesized HCN gas died in 1786 when a vial of the gas broke.
- Mass suicide:
in 1978 hundreds died in Jonestown,
British Guiana.

Mechanism of Toxicity

- Chemical Asphyxiant
- Blocks Cytochrome Oxidase
- Blocks the Aerobic Use of Oxygen
- Unbound Cyanide is Detoxified by Metabolism to Thiocyanate
- Excreted in the Urine

Examples of Cyanides

- Potassium Cyanide
- Sodium Cyanide
- Sodium Cyanoborohydride
- TMS Cyanide

Toxic Dose of HCN

- Even at low levels (150–200 ppm) can be fatal
- Air level considered immediately dangerous to life and health is 50 ppm
- The recommended workplace ceiling limit
- ACGIH TLV–C is 4.7 ppm
- Easily absorbed through intact skin

Prevent Exposure

- Prevent Dispersion of DUST!
- STRICT HYGIENE
- Avoid any skin or eye contact
- Seek immediate medical attention if exposed

Toxic Doses of Cyanide Salts

NaCN/KCN

- Ingestion of Cyanide salts may be fatal with as little as 200 mg
- Solutions of Cyanide Salts can be absorbed through intact skin or through the conjunctiva of the eye

Storage and Handling

- Work in a fume hood
- Wear Splash goggles
- Wear impermeable gloves
- Store Cyanide salts in a cool, dry place, away from acids
- Reacts with acids to release cyanide gas

Routes of Exposure

- Inhalation
- Skin
- Eye
- Ingestion

Routes of Exposure

Inhalation

- Prevention
- Work in chemical fume hood that has been tested
- Air purifying or supplied air respirators available for emergencies when working with large quantities (several grams of cyanide compounds)
- Any release outside the hood requires evacuation of the lab

Routes of Exposure

Skin

- Immediately wash with soap and water
- remove and isolate contaminated clothing

Routes of Exposure

Eye

- Can absorb cyanide gas
- Causes redness, pain, severe deep burns
- In case of eye contact, wash promptly with water for 15 minutes lifting upper and lower lid occasionally

Routes of Exposure

Ingestion

- Do not smoke, drink, eat or apply cosmetics during work
- Wash hands before eating
- Ingestion causes burning sensation, nausea, vomiting and diarrhea
- Obtain medical attention immediately!
- Medical treatment: activated charcoal, gastric lavage

Clinical Presentation of Cyanide Poisoning

Abrupt Onset of Profound
Toxic Effects Is the
Hallmark of Cyanide
Poisoning

Symptoms of Cyanide Poisoning

Headache	Nausea	Dypsnea
Confusion	Syncope	Seizures
Coma	Agonal Respirations	Cardiovascular Collapse

Physical Findings in Cyanide Poisoning

- Generally non-specific
- Despite poor perfusion , skin color may remain pink from high arterial and venous oxygen saturation and the reddish pigment of cyanhemoglobin
- Cyanide has poor warning properties
- Cherry red skin and smell of burnt almonds is inconsistent

Contents

Cyanide Antidote Package

- 2 ampoules Sodium Nitrite Injection
(300 mg in 10 ml of water/ a 3% solution)
- 2 vials Sodium Thiosulfate Injection
(12.5 g in 50 ml of water/ a 25% solution)
- 12 ampoules Amyl Nitrite Inhalants

Contents Continued

Cyanide Antidote Package

- Also: 10 mL plastic disposable syringe with a 22 gauge needle
- 1 sterile 60 ml plastic disposable syringe
- 1 sterile 20 gauge needle
- 1 stomach tube
- 1 non-sterile 60 ml syringe
- 1 tourniquet
- 1 set of instructions

Actions 1

- Sodium Nitrite + Hemoglobin forms Methemoglobin
($\text{NaNO}_2 + \text{Hemoglobin} \rightarrow \text{Methemoglobin}$)
- Methemoglobin has a greater affinity for CN than Oxyhemoglobin
- Methemoglobin removes Cyanide ions from tissues and forms Cyanomethemoglobin, which has a relatively low toxicity.
($\text{HCN} + \text{Methemoglobin} \rightarrow \text{HSCN}$)

Actions 2

- Sodium Thiocyanate converts Cyanide to Thiocyanate by an enzyme, rhodanese
- $\text{Na}_2\text{S}_2\text{O}_3 + \text{HCN} + \text{O} \rightarrow \text{HSCN}$
- The combination of Sodium Nitrite and Sodium Thiosulfate are the best available treatment against cyanide and hydrocyanic acid poisoning

When to Use a Cyanide Antidote Package

- Without proper treatment cyanide poisoning may be rapidly fatal
- Exposure followed by collapse, difficulty breathing, or bluish discoloration of the skin, indicates immediate need for treatment

When to Use the Antidote Package

Otherwise wait for Emergency Medical Services to arrive

- Reason: Inability to treat low blood pressure that may result from the use of the Amyl Nitrite and the development of excessive methemoglobinemia
- Nitrites might work through vasodilatation rather than formation of methemoglobin

What to do when you suspect Cyanide Poisoning

1. Remove patient to non-contaminated area

- All occupants should leave the area to non-contaminated areas, in order to protect those that are not yet affected
- Take cyanide antidote package

2. Call 911

In case of emergency, call 911

Report an emergency involving the use of cyanide

Identify yourself

Identify the type of emergency

(spill/exposure/name of chemicals involved)

Specify the location (address, room, building)

Provide details on exposure victims

(#, route of exposure, conscious, breathing)

Other information (when it occurred, how long the victims have been unconscious)

Provide your phone number

3. Maintaining an adequate airway is mandatory

- Establish an airway
- If the patient has stopped breathing administer artificial respiration with non–rebreather respirator or a manual bag with pure O₂
- No mouth to mouth resuscitation unless no other choice, especially if ingestion is route of exposure
- Ventilate with 100% Oxygen if available

4. Amyl Nitrite (in package)

- While administering artificial respiration, have an assistant break the ampoule of **amyl nitrite**, one at a time, in a handkerchief or gauze sponge and holds it in front of the the patients mouth for 15 seconds, followed by a rest for 15 seconds. Repeat
 - Persistent use without a 15 second rest may prevent adequate oxygenation
 - Each ampoule last 2–3 minutes

Amyl Nitrite – Step 4 continued

- If the victim is receiving respiratory support, place the ampoules in the face mask or port access to the endotracheal tube
- Amyl Nitrite Produces cyanide scavenging methemoglobin similar to sodium nitrite

5. Decontamination

Remove clothes that are contaminated by cyanide (skin absorption) including socks and shoes

- Wash contaminated areas with water
- Victim's vomits may contain cyanide
- Wash immediately if vomit gets on skin

6. Keep Patient Warm

Cyanide Antidote Package

(presumes medical personnel have arrived)

Step 1: Initiate 100% Oxygen while preparing for intravenous administration

Step 2: Simultaneously with oxygen, administer Amyl Nitrite Inhalant for 15 to 30 seconds every 2 or 3 minutes

Step 3: Discontinue administration of Amyl Nitrite and inject Sodium Nitrite intravenously 300 mg at the rate of 2.5 to 5 mL/minute

Cyanide Antidote Package

(presumes medical personnel has arrived)

Step 4: Immediately thereafter inject 12.5 g of Sodium Thiosulfate

The same needle and vein may be used for step 3 and step 4

Step 5: If the poison was taken by mouth, gastric lavage should be performed as soon as possible, but this should not delay the treatments outlined above. Lavage may be done concurrently by a third person (physician/nurse)

Monitoring Patient

- Patient should be watched closely for 24–48 hours. If signs of poisoning reappear, injection of both sodium nitrate and sodium thiosulfate should be repeated, but each at half the original dose
- Even if the patient appears perfectly well the medication may be given for prophylactic purposes 2 hours after the initial dose

Warning

- Sodium Nitrite and Amyl Nitrite in excessive doses induce dangerous methemoglobinemia and can cause death
- The amounts in a single Cyanide Antidote Package are not excessive for an adult according to the manufacturer
- Signs of methemoglobin are blue skin and mucous membranes, vomiting, shock, coma. 1% methylene blue solution should be given IV (1-2 mg/kg of body weight over 5-10 minutes, repeated in 1 hour if necessary)

Laboratory Tests

- Arterial and venous blood gases
- Pulse Oximetry
- Red blood cell and plasma cyanide concentrations
- Methemoglobin concentration
 - Greater than 10% indicates that further nitrite therapy is not indicated

Diagnosis

- Based on History of Exposure
- Rapidly progressive symptoms and signs
- Elevated venous oxygen saturation
- Bitter almond odor of hydrogen cyanide
- Whole blood levels $> .5 - 1$ mg/L are toxic