CYANIDE

and

Cyanide Antidote Package

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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: Brian, 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.
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

<table>
<thead>
<tr>
<th></th>
<th>Headache</th>
<th>Nausea</th>
<th>Dypsnea</th>
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</thead>
<tbody>
<tr>
<td>Confusion</td>
<td></td>
<td>Syncope</td>
<td>Seizures</td>
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<td>Coma</td>
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<td>Agonal Respirations</td>
<td>Cardiovascular Collapse</td>
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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
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.
  \((\text{HCN} + \text{Methemoglobin} \rightarrow \text{HSCN})\)
• 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 patient's 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 lasts 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