Toxicity of CO,H2S,Cyanide
Dr.Manal

Carbon Monoxide

- The most common form of poisoning
- From 1979 to 1988, 56,000 people died from CO
- Colorless, odorless, nonirritating gas
- Produced by incomplete combustion of carbon containing compounds
- Combines with Hb to form carboxyhemoglobin
- CO-Hb will not transport O2
- T 1/2 of CO-Hb is 5-6 hours in room air,

Carbon monoxide, cont.

- Sources:
  - propane powered engines
  - natural gas appliances - space heaters
  - automobile exhaust
  - gas log fireplaces
  - kerosene heaters
  - portable generators

Carbon monoxide, cont.

Mechanism of toxicity:

- Competes with O2 for active sites on Hb (220x the affinity for Hb as O2)
- Interference with cellular respiration at the mitochondria level, binds to cytochrome oxidase
- Induces smooth muscle relaxation
- Hypoxemia, tissue hypoxia, **no** cyanosis, CO-Hb is cherry red in color

Carbon monoxide, cont.

- Diagnosis based on patient presentation and a good history
- Signs and symptoms vary widely
- Signs depend on % CO-Hb levels in the blood
- Presence of cherry red blood is pathognomonic

Carbon monoxide, cont.

Clinical grading of CO poisoning

- **Mild** headache, nausea, dizziness, vomiting, flu like symptoms
- **Moderate** confusion, slow thinking, shortness of breath, blurred vision, tachycardia, tachypnea, ataxia, weakness
- **Severe** chest pain, palpitations, severe drowsiness, disorientation, hypotension, syncope, myocardial ischemia, pulmonary edema

Carbon monoxide, cont.

- Exposure during pregnancy can be teratogenic
- Chronic low level exposure can cause:
  - tiredness and lethargy
  - memory disturbances (most common)
  - irritability
  - visual impairment
  - increased incidence of heart disease on atherosclerosis

Carbon monoxide, cont.

Management of Toxicity:

- The antidote for CO poisoning is 100% oxygen
- hyperbaric chambers should be used more frequently than they currently are in the treatment of CO poisoning

Hydrogen sulfide poisoning

- Highly toxic, Rotten eggs odor, intensely irritating gas
- Sources:
  - decaying organic materials
  - natural gas
  - volcanic gas
  - petroleum
  - sulfur deposits
  - sulfur springs
- Most exposures are occupational

Hydrogen sulfide, cont.

Mechanism of toxicity:

- inhibits mitochondrial cytochrome oxidase
- paralyzes the electron transport system
- inhibits cellular utilization of O2
- metabolic acidosis secondary to anaerobic metabolism

Hydrogen sulfide, cont.

Mechanism of toxicity, cont.:

- more potent cytochrome oxidase inhibitor than cyanide
- rapidly absorbed through the inhalation route
- metabolized by the liver and excreted through the kidneys
- cause of death is respiratory paralysis due to toxic effects of H2S on respiratory centers in the brain

Hydrogen sulfide, cont.

Concentration (ppm)	Clinical effect
0.02	odor threshold
100-150	nose/eye irritation, olfactory nerve paralysis
250-500	sore throat, cough, keratoconjunctivits, chest tightness, pulmonary edema
500-1000	headache, disorientation, loss of reasoning, coma, convulsions
>1000	death

Hydrogen sulfide, cont.

Treatment:

- rescuer protection
- basic life support
- give O2, hyperbaric oxygenation is beneficial
- nitrates are antidotal by inducing Meth-Hb - providing a large available source of ferric-heme which has a greater affinity for H2S than does cytochrome oxidase, sequestering sulfide ions freeing cytochrome oxidase

CYANIDE TOXICITY

INGESTION

LETHAL DOSES

60- 90 mg	Hydrogen Cyanide (HCN)
200 mg	Potassium Cyanide (KCN)

CYANIDE TOXICITY

INHALATION

Concentration ($mg.m^{-3}$)	Effect
300	immediately lethal
200	lethal after 10 minutes
150	lethal after 30 minutes
120-150	lethal after 30-60 minutes
50-60	20 minutes to 1 hour without effect
20-40	light symptoms after several hours

Cyanide

- Hydrocyanic acid, Prussic acid, HCN
- In 1998 only 8 fatal exposures reported

- Cyanide may be a major contributor to **morbidity and mortality** observed in approx. 5,000-10,000 deaths occurring each year from smoke inhalation. Many compounds contains nitrogen and carbon produce cyanide when burned (so do household plastics, polyurethane foam in furniture, etc).

CYANIDE
SIGNS AND SYMPTOMS

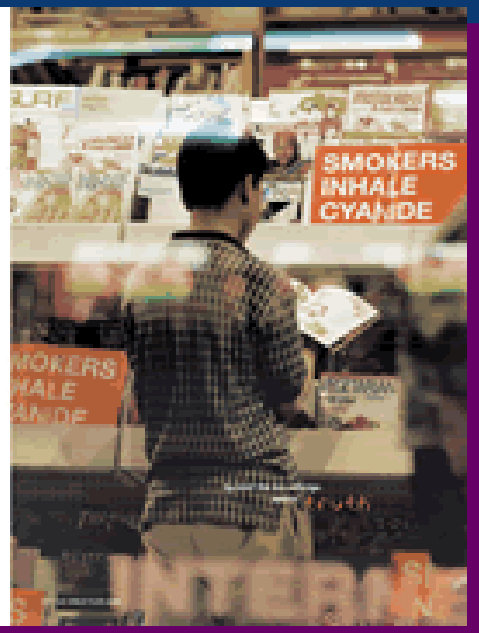
Mild Toxicity
- Nausea
- Dizziness
- Drowsiness

Moderate Toxicity
- Loss of consciousness for a short period
- Convulsion
- Vomiting
- Cyanosis

Severe Toxicity
- Deep coma
- Dilated non-reactive pupils
- Deteriorating cardio-respiratory function

CYANIDE

SMOKERS
INHALE
CYANIDE



CYANIDE PLANTS

Almonds

250 mg CN/100g plant tissue

Cassava

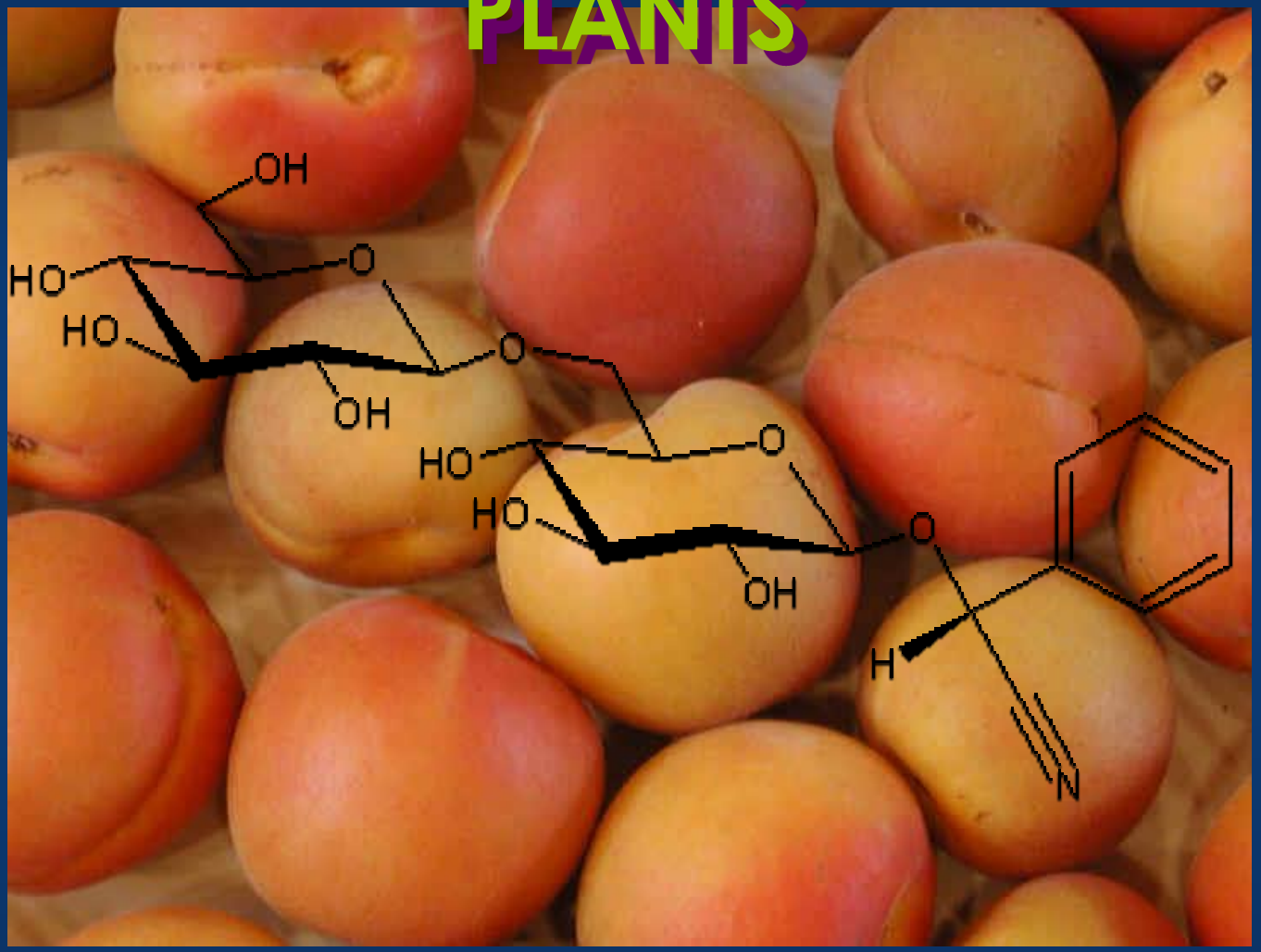
104 mg CN/ 100 g plant tissue

Wild Cherries

140-370 mg CN/ 100 g plant material

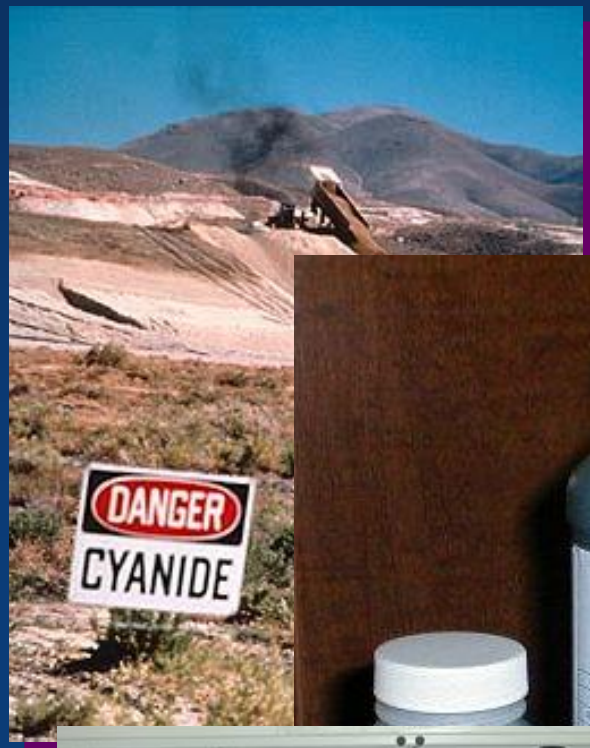
CYANIDE

PLANTS



AMYGDALIN

CYANIDE
INDUSTRY



ELECTROPLATING

HARDENING METALS

GOLD EXTRACTION

LABORATORIES

CYANIDE

FIRE

CYANIDE/CARBON MONOXIDE

CYANIDE

RODENTICIDE/FUMIGANT

ZYCLON B

Cyanide, cont.

Mechanism of action:

- causes tissue hypoxia by binding with ferric iron of mitochondrial cytochrome oxidase, thus inhibiting the functioning of the electron transport chain and the cells ability to utilize O2 in oxidative phosphorylation
- substantial decrease in ATP production
- see a shift to anaerobic metabolism
- increased lactic acid production - metabolic acidosis

CYANIDE
INVESTIGATIONS

History

Occupation, access to cyanide

Smell

Bitter almonds

ECG

Sinus tachycardia/bradycardia
Ischaemic changes

Pulse oximetry

Normal

CYANIDE
INVESTIGATIONS

ABG(arterial blood gas)

Metabolic acidosis, normal oxygen

Anion gap (Na^+ – [Cl^- + HCO_3^-])

Elevated

Serum lactate

Elevated

Blood cyanide level

Elevated – difficult to rapidly determine

CYANIDE MANAGEMENT

HAZARD ASSESSMENT

ABC's

TOXICOKINETICS

- ABSORPTION
- DISTRIBUTION
- METABOLISM
- ELIMINATION

TOXICODYNAMICS

- SUPPORTIVE CARE

CYANIDE MANAGEMENT

HAZARD ASSESSMENT

Cyanide is hazardous by:

- Ingestion
- Respiratory exposure
- Dermal exposure

CYANIDE MANAGEMENT

ABC's(airway,breathing ,circulation)

Avoid:

mouth to mouth, or
mouth to nose artificial ventilation

CYANIDE MANAGEMENT

DECONTAMINATION (absorption)

- Nasogastric aspiration
- Activated charcoal
- Gastric lavage
- Emesis

CYANIDE MANAGEMENT

ANTIDOTES (distribution/metabolism)

Enhanced cyanide metabolism

Cyanide ion binding

CYANIDE
ANTIDOTES

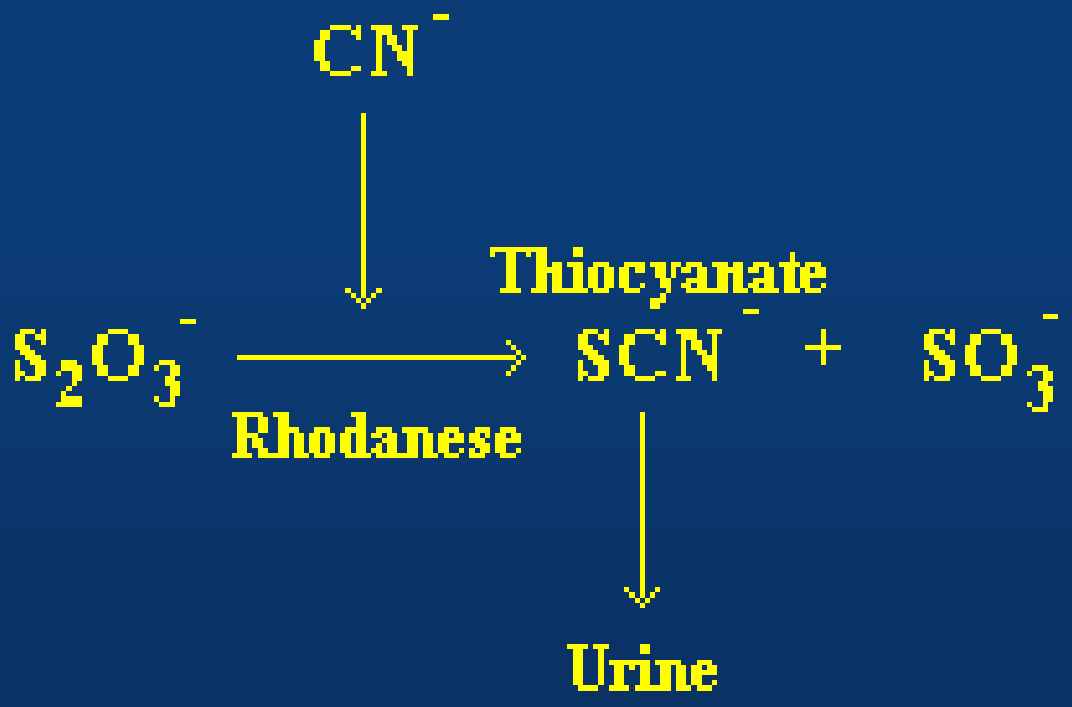
Enhanced cyanide metabolism

Enhancement of body's natural mechanisms for dealing with cyanide:

i. oxygen
ii. Sodium thiosulphate

CYANIDE
ANTIDOTES

Enhanced cyanide metabolism



CYANIDE
ANTIDOTES

Cyanide ion binding

Cobalt containing drugs

Methaemoglobin forming drugs

CYANIDE
ANTIDOTES

Cyanide ion binding

<u>Cobalt containing drugs</u>:

Cyanide ions will bind to cobalt which can be supplied in the form of either;

i. Hydroxocobalamin, or
ii. Dicobalt edetate.

CYANIDE
ANTIDOTES

Cyanide ion binding

Methaemoglobin forming drugs:

Cyanide will also bind to methaemoglobin formed after administration of:

i. Amyl nitrite;
ii. Sodium nitrite, or;
iii. 4-dimethylaminophenol (4-DMAP)

CYANIDE
ANTIDOTES

Cyanide ion binding