Carbon Monoxide Poisoning

Abdelkader Battah, MD, PhD

Professor of Toxicology

Faculty of Medicine

The University of Jordan

Carbon Monoxide (CO)

- An odorless, colorless, nonirritant, tasteless gas .
- Results from incomplete combustion of organic matter in the presence of insufficient oxygen supply to enable complete oxidation to carbon dioxide.
- Normal atmospheric concentration <0.001%.
- Principal source of the gas include motor vehicle exhaust fumes as well as other Gasoline, diesel and propane - powered engines.
- Smoke from charcoal fire.
- Tobacco smoke
- Methylene chloride (industrial solvent in paint and cleaning)

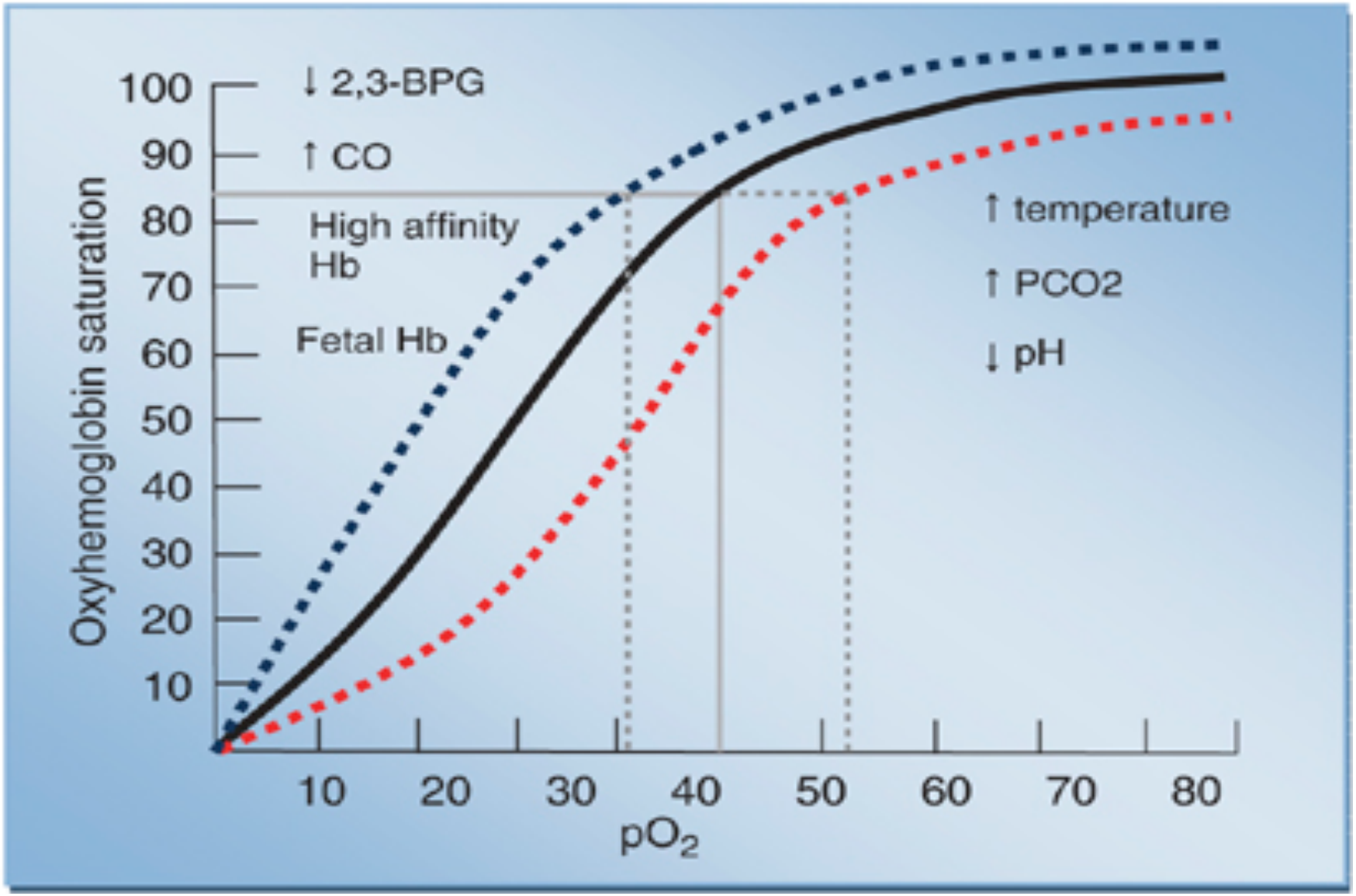
Carbon monoxide poisoning

- It occurs after exposure to CO .
- One of the most common causes of morbidity and death due to poisoning worldwide.
- Peak time of day 6:00-10:00 pm.
- Peak months are December and January for non-fire CO incidents.
- The true number of incidents of CO poisoning is unknown, since many non-lethal exposures go undetected .

- 46% suicide, 28% burns or fire, 21% unintentional .
- Almost (89%) of non-fire CO incidents took place at home.

Toxicokinetics

- CO reversibly binds hemoglobin resulting in functional anemia.
- Because it binds HB (200-300) times more avidly than Oxygen, even small concentrations can result in significant carboxyhemoglobin (HbCO).
- CO displaces the oxygen-carrying capacity of Hb, and shifts oxygen –Hb dissociation curve to the left .
- Binds to cytochrome and myoglobin


Oxyhemoglobin saturation
100
90
80
70
60
50
40
30
20
10
↓ 2,3-BPG
↑ CO
High affinity Hb
Fetal Hb
↑ temperature
↑ PCO2
↓ pH
10
20
30
40
50
60
70
80
pO2

- This binding reduces the ability of blood to carry oxygen to organs.
- CO prevents the oxygen that is present from being readily released to and used properly by tissues(bohr effect)
- Body systems most affected are the cardiovascular and central nervous systems.

Half-life of Carbon Monoxide

- Half-life: it is the time required for half the quantity of a drug or other substance to be metabolized or eliminated.

- CO half-life on 21% room air O_2: 4-6 hours.
- CO half-life on 100% O_2:80 minutes.
- CO half-life with hyperbaric O_2: 22 minutes.

{CO} Levels

Fresh air	0.06 - 0.5 ppm
Smoke filled room	2 – 16 ppm
Cooking on gas stove	100 ppm
Actively smoking cigarette	400 – 500 ppm
Automobile exhaust	100,000 ppm

Expected carboxyhemoglobin levels

- COHB % =RMV *{CO}*TIME
- Non-smokers: 5%
- Smokers: up to 10%
- 5 – 6% for a 1 pack per day smoker.
- 7 - 9% for a 2-3 pack per day smoker.
- Up to 20% reported for cigar smokers.

Signs and symptoms of CO poisoning

- Carboxyhemoglobin levels of 5–20 %

- Mild severity:
- ASYMPTOMATIC
- Headache – mild to moderate.
- Shortness of breath.
- Nausea and vomiting.
- Dizziness.
- Blurred vision.

Signs and symptoms of CO poisoning

- Carboxyhemoglobin levels of 21 – 40%

- Moderate severity:

- Worsening headache.
- Confusion.
- Syncope.
- Chest pain.
- Dyspnea.
- Tachycardia.
- Tachypnea.
- Weakness.

Signs and symptoms of CO poisoning

- Carboxyhemoglobin levels of 41 - 60%

- Severe:

- Dysrhythmias, palpitations.
- Hypotension.
- Cardiac ischemia.
- Confusion.
- Respiratory arrest.
- Pulmonary edema.
- Seizures.
- Coma.
- Cardiac arrest.

Patients with an increased risk

- Infants.
- Pregnant women
  - Fetus is at greatest risk because fetal hemoglobin has a greater affinity for oxygen and CO compared to adult hemoglobin.
- Elderly.
- Patients with physical conditions that limit the body's ability to use oxygen:
  - COPD.
  - Heart disease.
- Patients with physical conditions with decreased O_2 carrying capacity

Long term cardiovascular effects

- Myocardial injury from hypoxia and cellular damage
- Premature death especially if myocardial damage occurred at the time of initial exposure.
- Factors increasing myocardial injury risk:
- Male gender.
- History of hypertension.
- GCS <14 when the patient was first found.

Long term neurological effects

- Approximately 10-30 % of victims with severe acute poisoning will display delayed-onset neurobehavioral dysfunction also known as (CO-induced delayed neuropsychiatric syndrome)
- characterized by impaired cognitive function, dementia.
- Factors increase the risk :

  Heart disease, COPD, anemia, infant

Treatment of CO poisoning

- Remove from contaminated area into fresh air.
- Give artificial respiration or CPR, as appropriate.
- Oxygen 100%
- Keep resting.

To avoid of CO poisoning

- Never stay with an open flame without proper ventilation
- Never sleep in or near vehicles with the engine running.
- Never operate engines in a closed garage without exhaust ventilation.

- Avoid the use of unvented heaters and charcoal grills or any open flame in closed areas.
- Make sure heaters are set at the proper combustion ratio and heating system is leak free.
- Install a carbon monoxide detector.