

TOXICOLOGY

GAS EXPOSURE FROM HOUSEHOLD FIRES

Smoke produced by fire only represents the visible proportion of airborne matter. Burning household materials also release an array of toxic gases, exposure to which results in more fire related deaths than burns
Released gases can be broadly divided into two categories:

- **Asphyxiants** (e.g. CO, CO₂ & HCN) impede cellular respiration by direct cellular effect or inhibition of O₂ delivery
- **Irritants** (e.g. Chlorine or Sulphur dioxide) react with pulmonary mucosal fluid to form acids which cause tissue inflammation and destruction

Carbon Monoxide Poisoning

CO affects both the binding and release of O₂ from haemoglobin (Hb)

- CO binds to Hb with >200 times the affinity of O₂
- When CO binds to Hb it increases Hb's affinity for O₂, shifting the dissociation curve to the left

Symptoms are non-specific including headache, nausea & tiredness

They can progress to cardiac arrhythmia, ataxia, delirium, hallucinations and coma

Be suspicious of CO poisoning if soot in nose or mouth as it indicates significant exposure to fire products

Non-invasive oxygen saturation readings are unreliable

Diagnosis is made based on carboxyhaemoglobin (COHb) levels on an ABG

- Normal level for a non-smoker is <3%, for a smoker this may be ≤10%

The main **curative treatment is high flow oxygen therapy** as this speeds dissociation of CO from Hb
The half-life is approximately 80 minutes with O₂

Cyanide poisoning

HCN inhibits respiration by mitochondria blocking

ATP production, by inhibition of cytochrome c oxidase
Produced by burning of substances containing nitrogen in their structures e.g. wool, nylon, vinyl and polyurethane (used for insulation and upholstery)

At sufficiently high levels death may occur within seconds

Symptoms at lower exposures include weakness, vertigo, giddiness & confusion

Signs include a cherry red complexion

There are a variety of treatment options all of which rely on producing a substance with higher affinity for cyanide than cytochrome c oxidase:

Hydroxocobalamin binds CN to become harmless cyanocobalamin but massive doses are required

Nitrites convert Hb to methmoglobin

Methmoglobin cannot carry O₂ & may itself require treatment with methylene blue

Cobalt (e.g. dicobalt edetate) is chemically similar to iron and chelates CN, but it itself toxic

Chlorine gas poisoning

Following inhalation Chlorine diffuses into mucosal fluid in the respiratory tract

Here it can react directly or **hydrolyzes to hydrochloric or hypochlorous acid damaging surrounding tissues**

Produced by burning PVC (e.g. window frames & doors) or household cleaning products

Symptoms will mainly be respiratory related such as upper airway irritation, dyspnoea, cough and chest pain

There will likely be other symptoms related to irritation of other mucosa e.g.

- Painful watery eyes
- Chemical skin burns

Management is mainly about **decontamination and supportive therapies** e.g. high flow O₂ & bronchodilators

Other acidic substances e.g. sulphur dioxide, nitrogen dioxide and bromine produce similar effects