BASF Chemical Emergency Medical Guidelines

Cyanides (CN); Hydrocyanic acid C 1

Information and recommendations for doctors at hospitals/emergency departments

- **Patients exposed only to cyanide vapor do not pose a significant risk of secondary contamination. Patients whose clothing is contaminated with cyanide-containing liquids may secondarily contaminate rescue and medical personnel by direct contact or through evaporation of cyanides.**
- **Cyanide poisoning may lead to death within minutes. Given reason to believe that cyanide-containing material is present, severe hypoxic signs in the absence of cyanosis suggest the diagnosis.**
- **In case of suspected cyanide poisoning immediate administration of 100% oxygen is crucial. If the patient is symptomatic use the recommended cyanide antidotes.**

1. Substance information

Cyanide (CN)
Cyanides are the salts of hydrocyanic acid (e.g. Cyanogen potassium and similar). Their physical and chemical properties are dependent on the nature of the chemical in question. The odor of cyanide compounds does not provide adequate warning of hazardous concentrations.
Alkaline cyanide salts are used for gold and silver ore extraction, metal heat treating, electroplating as well as for the production of dyes, pigments, and as fumigants and insecticides.
Cyanide can also be released by hepatic metabolism from various nitrile compounds that are used in the production of plastics or occur naturally in plants.

2. Routes of exposure

Inhalation

All respirable forms of cyanide are readily absorbed via the lung.

Skin/eye contact

Cyanide is absorbed through skin or mucous membranes, although the onset of toxic symptoms may be delayed. Exposure to cyanides may result in skin and eye irritation.

Ingestion

Most cyanides are immediately absorbed from the gastrointestinal tract. Alkali salts of cyanide are toxic only when ingested.

3. Acute health effects

Cyanide combines with the ferric ion in mitochondrial cytochrome oxidase, thus inhibiting oxidative phosphorylation and ATP production. The inhibition of oxidative metabolism places increased demands on anaerobic glycolysis, which results in lactic acidosis.

CNS

CNS signs and symptoms usually develop rapidly. Initial symptoms are nonspecific and include excitement, dizziness, nausea, vomiting, and headache. This then may progress to stupor, apnea, generalized seizures, and coma.

Cardiovascular

Abnormal heartbeat can occur in cases of severe poisoning. Bradycardia, intractable low blood pressure, and death may result. High blood pressure and a rapid heartbeat may be early, transient findings.

Respiratory

After systemic poisoning begins, victims may complain of shortness of breath and chest tightness. Pulmonary findings may include rapid breathing and increased depth of respirations. As poisoning progresses, respirations become slow and gasping; cyanosis may or may not be present. Pulmonary edema may develop.

Metabolic	An anion gap, metabolic acidosis occurs in severe poisoning from increased blood levels of lactic acid.
Dermal	Contact with liquid cyanides causes skin irritation. Dermal absorption can occur, leading to systemic toxicity.
Ocular	When splashed in the eye, liquid cyanides can cause eye irritation and swelling. Eye contact with cyanide salts has produced systemic symptoms in experimental animals.
Potential sequelae	Survivors of serious exposure should be evaluated for damage to the brain and heart. Patients who have serious cyanide poisoning may be at risk for CNS sequelae including memory deficits and Parkinson-like syndromes; they should be clinically evaluated for several weeks to months afterwards.

4. Actions

Self-protection	Patients whose clothing is contaminated with cyanide-containing liquids may secondarily contaminate rescue and medical personnel by direct contact or through evaporation of cyanides.
Initial treatment	**Speed is critical. For symptomatic patients, provide treatment - 100% oxygen and specific antidotes as needed. Treatment should be given simultaneously with decontamination procedures.** Treatment with antidotes should be given under medical supervision to unconscious patients who have known or strongly suspected cyanide poisoning (see *Antidotes* below).
Decontamination	All patients with suspected exposure to cyanide-containing solutions require decontamination. Patients who are able and cooperative may assist with their own decontamination. If not already done, rapidly remove and double-bag contaminated clothing while flushing exposed skin and hair with plain water for 5 minutes. Protect eyes during flushing of skin and hair. Assure that exposed skin and hair have been flushed with plain water for at least 5 minutes. Assure that exposed or irritated eyes have been irrigated with plain water or saline for 5 minutes. If not, continue eye irrigation during other basic care or transport. Remove contact lenses if present and easily removable without additional trauma to the eye. In case of ingestion do not induce emesis. If it has not been done previously, perform gastric lavage and give activated charcoal as soon as possible. Isolate gastric washings and vomitus; they may evaporate hydrogen cyanide. Intubation of the trachea or an alternative airway management should be considered in cases of respiratory compromise. When the patient's condition precludes this, consider cricothyrotomy if equipped and trained to do so.
Antidotal treatment	**The following treatment with antidotes should be given under medical supervision to unconscious patients who have known or suspected cyanide poisoning.** The availability of antidotes may vary due to statutory and regulatory differences among different countries. Note: In some countries administration of 0.2-0.4 ml amyl nitrite via anesthesia bag is recommended before the following treatment. **If 4-dimethyl aminophenol (4-DMAP) is available, the following method of treatment should be applied: Administer immediately 4-DMAP intravenously, usually in a dose of 3 to 5 mg/kg body weight (i.e. 1 ampule of 250 mg 4-DMAP in an adult).** **If 4-DMAP is not available, infuse sodium nitrite intravenously as soon as possible. The usual adult dose is 10 to 20 ml of a 3% solution infused over no less than 5 minutes.** Monitor blood pressure during sodium nitrite administration. Slow the rate of infusion if hypotension develops.

Next, after 4-DMAP as well as after sodium nitrite administration, infuse a 10% solution of sodium thiosulfate (100 mg/kg body weight). Do not treat methemoglobinemia, unless 4-DMAP or sodium nitrite was overdosed or the assumed diagnosis of cyanide poisoning is revised.
Sodium thiosulfate may also be administered to conscious but symptomatic patients with suspected cyanide poisoning. Please note that conscious patients should neither receive 4-DMAP nor sodium nitrite.
As an alternative to the combination of 4-DMAP / sodium nitrite and sodium thiosulfate the administration of high-dose hydroxycobalamin (which combines with cyanide to form non-toxic cyanocobalamin) is preferred in some countries. Hydroxycobalamin (70 mg/kg body weight; usually 5 g in an adult) has to be administered intravenously within 20-30 min. A second and third dose, but not more than 15 g in total, may be considered, in particular in case of refractory cardiac arrest or collapse

Further evaluation and treatment

After treatment with 4-DMAP or sodium nitrite, serum methemoglobin levels should be monitored and should not exceed 30 to 40%, given anaemia is not present. Cyanosis occurs with methemoglobin concentrations of approximately 15%. In cases of overdosage, treat the methemoglobinemia.
Whenever infusions of 4-DMAP or sodium nitrite have been used, the patient should be admitted to the intensive care unit.

Laboratory tests

The diagnosis of acute cyanide toxicity is primarily a clinical one, based on the rapid onset of CNS toxicity and cardiorespiratory collapse together with known or strongly suspected cyanide exposure. Laboratory testing is useful for monitoring the patient and evaluating complications. Routine laboratory studies include complete blood count, glucose, and electrolyte determinations. After treatment with 4-DMAP or sodium nitrite, serum methaemoglobin levels should be monitored.
Arterial blood gases should be performed to assess acid-base balance. Additional studies include ECG monitoring and determination of serum lactate. Pulse oximetry is not sufficient.
Correct metabolic acidosis with bicarbonate when blood pH falls below 7.15. Also evaluate and treat electrolyte imbalance (e.g. hyperkalemia, hypercalcemia).

Patient release/ follow-up instructions

Patients who remain **asymptomatic for 2 hours after exposure and have not received antidotes** and patients who have **received only sodium thiosulfate and no longer have any symptoms after 2 hours of observation as well as patients who have a normal clinical examination and no signs or symptoms of toxicity may be discharged after an appropriate observation period in the following circumstances:**

a) The evaluating physician is experienced in the evaluation of individuals with cyanide compounds exposure.
b) Information and recommendations for patients with follow-up instructions are provided verbally and in writing. Patients are advised to seek medical care promptly if symptoms develop or recur.
c) The physician is comfortable that the patient understands the health effects of cyanides and the provided follow-up instructions.
d) Site medical is notified, so that the patient may be contacted at regular intervals in the 24-hour period following release.
e) Heavy physical work should be precluded for 24 hours.
f) Exposure to cigarette smoke should be avoided for 72 hours; smoke may worsen the conditions of the lungs.

In this document BASF has made a diligent effort to ensure the accuracy and currency of the information presented but makes no claim that the document comprehensively addresses all possible situations related to this topic. This document is intended as an additional resource for doctors in assessing the condition and managing the treatment of patients exposed to cyanides. It is not, however, a substitute for the professional judgement of a doctor and must be interpreted in the light of specific information regarding the patient available to such a doctor and in conjunction with other sources of authority.

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