

Pre-Hospital Guidelines

for

The Emergency Treatment of

Deliberate or Accidental Release of Hydrogen Cyanide

STANDARD OF CARE

Deliberate or accidental release of hydrogen cyanide (HCN)

(CSMNA - 003)

This standard of care has been developed to ensure that the NHS Ambulance Services offer an appropriate standard of care to patients in the event of a deliberate or accidental release of hydrogen cyanide.

1:0 Introduction

- ❖ Hydrogen cyanide (HCN) is widely used as an industrial chemical in the production of synthetic fibres, plastics and nitrites and as a fumigant and rodenticide. It is released by the combustion of nitrogen containing plastics, such as polyurethane. It is an extremely toxic compound, rapidly producing symptoms, including dyspnoea, headache, dizziness, hyperventilation, loss of consciousness, convulsions, cardiac arrest and death.
- ❖ Protective clothing and full respiratory protection must be worn in contaminated areas (warm zone) or when handling casualties contaminated with liquid agents. Off-gassing of cyanide from casualties may be sufficient to cause symptoms. Casualties should be decontaminated before being transported to a care facility.
- ❖ Exposure is typically by inhalation of HCN vapour. Ingestion and ocular absorption do not occur unless individuals are in contact with HCN liquid or contaminated water. Liquid is also rapidly absorbed across the skin.

- ❖ Unless otherwise stated, all figures, values and reference numbers relate to hydrogen cyanide (HCN) only. Although cyanide salts are toxic, most inhalational poisoning results from exposure to HCN. Other cyanide compounds may also produce cyanide poisoning and some may be intensely irritating e.g. cyanogen chloride.

2:0 Physical and Chemical Properties of Hydrogen Cyanide

- ❖ At normal temperature and pressure, HCN is a volatile, colourless gas or a yellow brown liquid. It has a boiling point of 26°C. It is less dense than air and, therefore, disperses rapidly. However, after rapid release of large quantities a 'cold cloud' effect may occur, delaying dispersion.
- ❖ Some people can detect a distinct odour of bitter almonds at concentrations between 0.6-4.4ppm. **The ability to detect the odour, however, is genetically determined and many people are unable to detect its presence. The capacity to detect the odour declines as exposure continues.**
- ❖ Potassium, sodium and calcium cyanides are white, deliquescent, non-combustible solids with faint bitter almond odour.

Cyanogen is colourless, flammable gas with a pungent almond odour. Cyanogen bromide is a colourless or white crystalline solid. Cyanogen chloride is either a colourless irritant gas or liquid.

Synonyms of Cyanide and Cyanide Compounds

Identification Numbers of Cyanide and Cyanide Compounds

Chemical / Compound	CAS	UN	NIOSH / RTECS
Calcium cyanide	592-01-8	1575	EW 0700000
Cyanide	57-12-5	1935	GS 7175000
Cyanogen	460-19-5	1026	GT 1925000
Cyanogen azide	764-05-6		
Cyanogen bromide	506-68-3	1889	GT 2100000
Cyanogen chloride	506-77-4	1589	GT 2275000
Cyanogen iodide	506-78-5		NN 1750000
Hydrogen cyanide	74-90-8	1051 (stabilised, anhydrous) 1613 (solution) 1614 (stabilised, anhydrous, absorbed)	MW 6825000
Potassium cyanide	151-50-8	1680	
Sodium cyanide	143-33-9 13998-03-3	1689	VZ 7525000
Zinc cyanide	557-21-1	1713	ZH 1575000

Cyanide salts are also used in metal cleaning, gardening, in ore-extracting processes, dyeing, printing, photography and in resin monomer production (e.g. acrylates).

3:0 Effects of Hydrogen Cyanide Poisoning

Hydrogen cyanide interferes with aerobic respiration at a cellular level by forming a reversible complex with members of the cytochrome oxidase enzyme system. The resultant inability to utilise oxygen results in accumulation of lactic acid and cell death from tissue anoxia. The central nervous system, and particularly the respiratory centre, is especially susceptible.

Absorption of hydrogen cyanide may take place by all routes: inhalation, ingestion, and through the skin. Typically by inhalation of hydrogen cyanide vapour, but liquid may also be rapidly absorbed across the skin. Ocular exposure and ingestion are unlikely unless an individual comes into contact with hydrogen cyanide liquid or contaminated water.

Ocular –

Liquid hydrogen cyanide may irritate the eyes. Any resultant absorption may produce systemic effects (see below).

Inhalation-

- The severity of poisoning is dependent on the concentration of hydrogen cyanide and the duration of exposure.
- Low concentrations may be associated with dyspnoea, headache, dizziness, anxiety, tachycardia, nausea and drowsiness. A metallic taste in the mouth has been reported. These symptoms may persist for several hours before complete recovery occurs.

Cyanide is rapidly detoxified in the body and any casualty who is fully conscious and breathing normally more than five minutes after removal from exposure of hydrogen cyanide will recover spontaneously and does not require antidotal treatment.

High concentrations of hydrogen cyanide produces hyperventilation within a few seconds followed by loss of consciousness, convulsions, fixed and unreactive pupils and death from respiratory and/or cardiac arrest can occur within minutes.

- a. The more rapidly the tissue cyanide levels build up, the more acute are the signs and symptoms of poisoning and the smaller is the total absorbed dose required to produce a given effect.
- b. In high concentrations there is an increase in the depth of respiration within a few seconds. This stimulation may be so powerful that a casualty cannot voluntarily hold his or her breath. Violent convulsions occur after 20 to 30 seconds with cessation of respiration within 1 minute. Cardiac failure follows within a few minutes.
- c. With lower concentrations, the early symptoms are weakness of the legs, vertigo, nausea and headache. These may be followed by convulsions and coma which may last for hours or days depending on the duration of exposure to the agent. If coma is prolonged, recovery may disclose residual damage to the central nervous system manifested by irrationality, altered reflexes and unsteady gait which may last for several weeks or longer; temporary or permanent nerve deafness has also been described. In mild cases there may be headache, vertigo and nausea for several hours before complete recovery.

4:0 Antidotes in the Treatment of Cyanide Poisoning

❖ Oxygen

- Any casualty who is fully conscious and breathing normally more than five minutes after removal from exposure should only require oxygen therapy.

❖ Dicobalt edetate

- Successful treatment for acute cyanide poisoning depends upon rapid fixation of the cyanide ion by cobalt compounds.

❖ Glucose

- Glucose is administered as an adjunct to, but not a substitute for, dicobalt edetate in the treatment of cyanide poisoning

The mainstay of treatment is early decontamination, respiratory support, and treatment with antidotes.

Death usually results from either respiratory or cardiac arrest.

5:0 Rescue and Decontamination

- ❖ Casualties must be removed from the exposed **Hot Zone** in the inner cordon to the **Warm Zone** decontamination area.
- ❖ Only in exceptional circumstances will ambulance staff or health service personnel enter the **Hot Zone**.
- ❖ Rescue and controlled movement to the **Warm Zone** is the role of the fire and rescue service, who will be fully self contained in regards to their personal protective equipment.
- ❖ Ambulance and Health Service Staff undertaking decontamination must be fully equipped and wearing class 'A' protective suits, and a minimum of a class '3' respiratory protection device.
- ❖ On arrival at the **Warm Zone** decontamination area, casualties will be triaged using the triage sieve to prioritize the most urgent casualties for decontamination.
- ❖ Decontamination will take place using the rinse, wipe, and rinse method. All clothing will be removed from contaminated casualties and strip sealed in a decontaminated waste bag.
- ❖ Where possible keys should be decontaminated and returned to their owner as soon as safe and practicable.

5:0 Rescue and Decontamination (Continued)

- ❖ Casualties who have been decontaminated should be dressed in paper suits and directed to the **Cold Zone** by the decontamination-marshalling officer.

- ❖ Only immediate and necessary life saving first aid will be undertaken in the **Warm Zone**.

- ❖ After decontamination, casualties will be taken to the **Cold Zone** for emergency pre-hospital treatment.

6:0 Emergency Pre-Hospital Treatment of Patients Poisoned with Cyanide

❖ Airway

- Secure the airway using basic or advanced airway management methods as appropriate.

❖ Breathing

- Administer 85% O₂ via a non-rebreathing oxygen mask.
- If respiratory depression or hypoventilation exist, ventilate with bag-valve-mask/ET tube with supplemental oxygen at 10 litres per minute.
- Do not use mouth-to-mouth, or mouth-to-nose techniques of expired air resuscitation. Pocket masks must have a one-way valve if used to ventilate patients.

❖ Circulation

- Gain immediate IV access with a wide bore cannula. Take blood to fill tubes supplied in the toxicological sample box where available, then flush the cannula with 5ml of 0.9% sodium chloride.

Resuscitation, though possible, is not likely to be helpful in the absence of drug treatment.

❖ For confirmed cyanide poisoning:

- **Cyanide is rapidly detoxified in the body and any casualty who is fully conscious and breathing normally more than five minutes after removal from exposure of hydrogen cyanide will recover spontaneously with oxygen therapy and does not require antidotal treatment.**
- **Dicobalt edetate can be extremely toxic in the absence of cyanide ions. IT MUST ONLY BE GIVEN WHEN POISONING IS SEVERE (i.e. coma and respiratory depression are present). Equipment for tracheal intubation should be available.**

6:0 Emergency Pre-Hospital Treatment of Patients Poisoned with Cyanide (Continued)

- **Administer Dicobalt edetate**

- ❖ Where there is a clinical diagnosis of severe poisoning with hydrogen cyanide or cyanide salts. The patient must have respiratory depression and impaired consciousness e.g. Glasgow coma score of less than eight.
- ❖ Dose:
 - *Adults:* One 300mg ampoule administered intravenously at regular rate over one minute followed by 50ml glucose intravenous infusion 50%(500g/l). Glucose 50% is irritant and should be administered through a large bore cannula avoiding extravasation.
 - *Adults: ongoing therapy:* If the patient shows an inadequate response a second dose of Dicobalt edetate 300mg may be administered followed by 50ml glucose intravenous infusion 50%(500g/l)
 - *Children:* There is no clinical experience with the use of Dicobalt edetate in children. As with adults the dose required will be related to the quantity of cyanide absorbed into the body. An initial dose of 0.5ml/kg of the 15mg/ml solution for injection (7.5mg/kg body weight) has been suggested.
 - This must be followed by 2.5ml glucose 50% for each ml of Dicobalt edetate given. Glucose 50% is irritant and should be administered through a large bore cannula avoiding extravasation.
 - Normally maintenance doses will be administered in the hospital environment.

- ❖ **Disability**

- Assess neurological disability initially using AVPU.
- Pupillary size and reactivity should be assessed and recorded.
- Glasgow Coma Scoring should be applied in the secondary survey phase.

Treatment for the Deliberate or Accidental Release of Hydrogen Cyanide

DICOBALT EDETATE – (CSNAM - 003)

The principle clinical objective is to administer sufficient Dicobalt edetate to reduce tissue anoxia through rapid fixation of the cyanide ion with this cobalt compound. It must be administered as a priority when there is evidence of cyanide poisoning. Dicobalt edetate may be life-saving in severe cyanide poisoning however:

Dicobalt edetate can be extremely toxic in the absence of cyanide ions.

**IT MUST ONLY BE GIVEN WHEN POISONING IS SEVERE
(i.e. coma and respiratory depression are present).
Equipment for tracheal intubation should be available.**

Clinical diagnosis

Clinical diagnosis of cyanide poisoning is suggested by the characteristic features of cyanide poisoning, associated with a history of exposure.

Mild or early Cyanide poisoning symptoms

- 1 General weakness, heaviness of the arms and legs.
- 2 Difficulty breathing.
- 3 Headache, giddiness, nausea, vomiting.
- 4 Breath may smell of bitter almonds.
- 5 Irritation of the nose, mouth and throat.

Severe Cyanide poisoning symptoms

- 1 Nausea and vomiting
- 2 Respiratory depression
- 3 Loss of consciousness
- 4 Convulsions

Presentation

Dicobalt edetate solution for injection 300mg (15mg/ml).

Each 20ml ampoule contains 300mg dicobalt edetate.

Indication

- ❖ Dicobalt edetate should be administered if clinical features are consistent with the clinical diagnosis of severe poisoning with hydrogen cyanide or cyanide salts, and must include one or more of the following:
 - Respiratory depression.
 - Impaired consciousness e.g. Glasgow coma score less than eight

Contra-indications

- ❖ Hypersensitivity to dicobalt edetate.
- ❖ There are no other absolute criteria for the exclusion from administration of dicobalt edetate as the consequence of not instituting prompt treatment in severely poisoned patients will usually outweigh the risks associated with treatment.

Side effects

- ❖ The initial effects of dicobalt edetate are vomiting, a fall in blood pressure and compensatory tachycardia.
- ❖ Signs and symptoms may be due to cobalt toxicity or to an anaphylactic type reaction which may be severe. Facial, laryngeal and pulmonary oedema, vomiting, chest pain, sweating, hypotension, cardiac irregularities and rashes may occur.
- ❖ Anaphylaxis should be treated in the usual way

Dosage

- ❖ Where severe cyanide poisoning is present, administer dicobalt edetate.
- ❖ *Adults:* One 300mg ampoule administered intravenously at regular rate over one minute followed by 50ml glucose intravenous infusion 50%(500g/l). Glucose 50% is irritant and should be administered through a large bore cannula avoiding extravasation.

- ❖ *Adults: ongoing therapy:* If the patient shows an inadequate response a second dose of Dicobalt edetate 300mg may be administered followed by 50ml glucose intravenous infusion 50%(500g/l)
- ❖ *Children:* There is no clinical experience with the use of Dicobalt edetate in children. As with adults the dose required will be related to the quantity of cyanide absorbed into the body. An initial dose of 0.5ml/kg of the 15mg/ml solution for injection (7.5mg/kg body weight) has been suggested.
- ❖ This must be followed by 2.5ml glucose 50% for each ml of Dicobalt edetate given. Glucose 50% is irritant and should be administered through a large bore cannula avoiding extravasation.
- ❖ Normally maintenance doses will be administered in the hospital environment.

Administration routes

- ❖ Intravenous (IV)

Additional notes

- ❖ Maintain oxygenation by airway management, administration of 85% O₂, and ventilation as necessary.
- ❖ Treatment should be administered in the cold zone to casualties that have been decontaminated.
- ❖ Only universal precautions are necessary for personal protection of staff managing these casualties in this zone.

Treatment for the Deliberate or Accidental Release of Hydrogen Cyanide

GLUCOSE INJECTION BP 50% – (CSNAM - 004)

Glucose injection 50% is administered as an adjunct to, but not substitute for, dicobalt edetate in the treatment of cyanide poisoning. The hypertonic glucose solution is administered immediately following each dose of dicobalt edetate.

Presentation

Sterile solution in 500ml infusion container. 50% solution.

(Contains anhydrous glucose 500g in one litre.)

Indication

- Adults and children with clinical diagnosis of life threatening poisoning with hydrogen cyanide or cyanide salts and who have been treated with dicobalt edetate

Contra-indications

- ❖ Patients who have not been treated with dicobalt edetate.

Side effects

- ❖ Glucose 50% is hypertonic and irritant. Phlebitis may occur.

Dosage

- ❖ *Adults:* 50ml Glucose 50% following administration of dicobalt edetate. (Volume to be drawn into 50 ml syringe from 500ml infusion container.)
- ❖ *Children:* 1.25ml Glucose 50% for each kilogram body weight. (2.5ml Glucose 50% for each ml of the 15mg/ml solution for injection of dicobalt edetate given).

Administration routes

- ❖ Intravenous (IV)
- ❖ Glucose 50% is irritant and should be administered through a large bore cannula avoiding extravasation.

Additional notes

- ❖ Maintain oxygenation by airway management, administration of 85% O₂, and ventilation as necessary.
- ❖ Treatment should be administered in the cold zone to casualties that have been decontaminated.
- ❖ Only universal precautions are necessary for personal protection of staff managing these casualties in this zone.