

## CHAPTER 6

### BLOOD AGENTS (CYANOGENS)

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#### 6-1. General

Blood agents produce their effects by interfering with oxygen utilization at the cellular level. Inhalation is the usual route of entry. Hydrogen cyanide (AC) and cyanogen chloride (CK) are the important agents in this group. Cyanogen chloride also has a choking effect (para 7-1). These agents can be dispersed by artillery shell, mortar shell, rocket, aircraft spray, and bomb. All blood agents are nonpersistent.

#### 6-2. Protection

The protective mask with a fresh filter gives protection against field concentrations of blood agent vapor. For protection, MOPP 4 is needed when exposed to or handling liquid AC.

#### 6-3. Properties

*a. Hydrogen Cyanide.* Hydrogen cyanide is a colorless, highly volatile liquid with a density 30 percent less than water. It boils at 70°F (26.5°C) and freezes at 7°F (-13.3°C). It is highly soluble and stable in water. It has a faint odor, somewhat like peach kernels or bitter almonds, and sometimes cannot be detected even in lethal concentrations. Because AC is highly volatile, in the gaseous state it dissipates quickly in the air.

*b. Cyanogen Chloride.* This is a colorless, highly volatile liquid with a density 18 percent greater than water. Cyanogen chloride boils at 59°F (12.5°C) and freezes at 20°F (-6.9°C). Although only slightly soluble in water, CK dissolves readily in organic solvents. The vapor of CK, heavier than air, is very irritating to the eyes and mucous membrane surfaces. The pungent, biting odor of CK is masked by its irritating and lacrimatory properties. Although non-persistent, CK vapor may remain in the jungle and forest for some time under suitable weather conditions.

#### 6-4. Pathology

*a. Hydrogen cyanide* is thought to act by combining with cytochrome oxidase (an enzyme essential for oxidative processes of the tissues) and blocking the electron transport system. This results in impairment of cellular oxygen use. The CNS (particularly the respiratory center) is especially susceptible to this effect, and respiratory failure is the usual cause of death. In high concentrations, the amount of AC inhaled in a few breaths may be enough

to cause immediate death without anatomical changes. After exposure to lower concentrations, there may be small areas of hemorrhage and softening in the brain which are more pronounced in delayed deaths. Death from AC leaves the blood well-oxygenated. Death from AC also causes the skin to have a pink color similar to that seen in carbon monoxide (CO) poisoning.

*b. Cyanogen chloride* acts in two ways. Its systemic effects are similar to those of AC, but it also has local irritant effects on the eyes, upper respiratory tract, and lungs. Cyanogen chloride damages the respiratory tract, resulting in severe inflammatory changes in the bronchioles and congestion and edema in the lungs. The fluid in the lungs may accumulate much faster than in CG poisoning. All concentrations of CK produce eye irritation and lacrimation.

#### 6-5. Symptoms

*a. The symptoms of AC* depend upon the agent concentration and the duration of exposure. Typically, either death occurs rapidly or recovery takes place within a few minutes after removal from the toxic atmosphere. In high concentrations, there is increased depth of respiration within a few seconds. This stimulation may be so powerful that casualties cannot voluntarily hold their breath. Violent convulsions occur after 20 to 30 seconds with cessation of respiration within one minute. Cardiac failure follows within a few minutes. Following moderate exposure, weakness of the legs, vertigo, nausea, and headache appear very early. 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 CNS. The CNS damage may be 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.

*b. The signs and symptoms of CK* are a combination of those produced by AC and a lung irritant. Initially, CK stimulates the respiratory center and then rapidly paralyzes it. In high concentrations, however, its local irritant action may be so great that dyspnea is produced. Exposure is followed by

immediate intense irritation of the nose, throat, and eyes, with coughing, tightness in the chest, and lacrimation. Afterwards, the exposed person may become dizzy and increasingly dyspneic. Unconsciousness is followed by failing respiration and death within a few minutes. Convulsions, retching, and involuntary urination and defecation may occur. If these effects are not fatal, the signs and symptoms of pulmonary edema may develop. There may be persistent cough with much frothy sputum, rales in the chest, severe dyspnea, and marked cyanosis.

### 6-6. Diagnosis

a. The diagnosis of AC poisoning is suggested by the history, the odor (if detected), the rapid onset of symptoms, and the pink color of the casualties' skin.

b. In casualties exposed to CK, the diagnosis is suggested by the intense irritation and the rapid onset of symptoms.

### 6-7. Prognosis

a. *Hydrogen Cyanide*. Usually death occurs rapidly or there is prompt recovery. Occasionally, when there is prolonged tissue anoxia, residual injury of the CNS may persist for weeks; some of the damage may be permanent.

b. *Cyanogen Chloride*. Recovery from the systemic effects is usually as prompt as in AC poisoning. However, a higher incidence of residual damage to the CNS is to be expected. Depending on the concentration of CK to which the casualty has been exposed, the pulmonary effects may develop immediately or may be delayed until the systemic effects have subsided. Thus, early prognosis must be guarded.

### 6-8. Self-Aid

a. *Hydrogen Cyanide*. If you get a sudden stimulation of breath or detect an odor like bitter almonds during a chemical attack, *put on your mask immediately*. Speed is absolutely essential, the effects of this agent are so rapid that within a few seconds you will not be able to put on your mask. Hold your breath until the mask is on, if at all possible. This

may be very difficult because of the agent's strong respiratory stimulation.

b. *Cyanogen Chloride*. *Put on your mask immediately* if you experience any irritation of the eyes, nose, or throat.

### 6-9. Buddy Aid

Service members not masked must put on their mask immediately if any vapors of AC or CK are present. Service members who are unable to mask should be masked by the nearest available person (buddy).

### 6-10. Treatment

a. In AC or CK poisoning, if the patient's respirations are feeble or have ceased, immediately administer assisted ventilation with oxygen and sodium nitrite and sodium thiosulfate (*b* below). Before the treatment is rendered, remove the patient from the contaminated environment. Continue assisted ventilation until spontaneous breathing returns or until 10 minutes after the last sign of heart activity has occurred.

b. Sodium nitrite and sodium thiosulfate must ONLY be administered by IV. Intravenously inject 10 ml of a 3 percent solution (300 mg) of sodium nitrite over a period of 3 minutes. Intravenously inject 50 ml of a 25 percent solution (12.5 gm) of sodium thiosulfate over a 10-minute period. The sodium nitrite is given to produce methemoglobin, thus sequestering the cyanide on the methemoglobin. The sodium thiosulfate combines with the sequestered cyanide to form thiocyanate which is excreted from the body.

c. The decrease in blood pressure following sodium nitrite injections is negligible unless the patient is allowed to get into an upright position. The development of a slight degree of cyanosis is evidence of a desirable degree of methemoglobin formation (methemoglobinemia). It is not anticipated that at the above dosages an extreme or injurious degree of methemoglobinemia will develop. If it does, however, it should be treated by 100 percent oxygen inhalation.

d. The lung irritant effects of CK are treated as in CG poisoning (para 5-9).