CHAPTER 23

MEDICAL ASPECTS OF CHEMICAL, BIOLOGICAL, AND RADILOGICAL WARFARE

INTRODUCTION

This chapter will outline a brief history of chemical, biological, and radiological (CBR) warfare along with the recognition and treatment of conditions resulting from CBR agents. The chapter is divided into sections by agent type. Each section provides signs and symptoms of CBR conditions along with the treatment and decontamination procedures.

CHEMICAL WARFARE AGENTS$^{30,31,32}$

LEARNING OBJECTIVE:

Identify signs and symptoms of chemical agent exposure and provide appropriate medical treatment.

HISTORY

Throughout history, chemical weapons have been used in one form or another. The earliest form of chemical warfare was the use of spears and arrows dipped in poison. The Spartan mixed pitch and sulphur and ignited it to create toxic fumes during battle in order to incapacitate the enemy. Other armies dipped cloth in poison and lit it on fire to create a toxic cloud over opposing armies. These were simple forms of chemical warfare that was not until recent history that it was used on a large-scale.

The first large-scale use of chemical agents came in World War I when, in 1915, the Germans released chlorine gas against the Allied positions at Ypres, Belgium. Over 5,000 casualties resulted. It is well documented that approximately one-third of all American casualties in this conflict were due to chemical agent attacks.

Chemical warfare during this time period was crude and often personnel were victims of their own chemical attacks, on both sides. During this time the development of gas masks began to protect forces against gas attacks.

During the interval between World Wars I and II, each of the major powers continued to develop its capability for chemical warfare, in spite of a ban by the Geneva Treaty. In isolated cases in the late 1930s, toxic chemicals were used. They were not used during World War II or authorized for use in Korea, Vietnam, or Desert Storm. Defoliants and riot-control agents were used with some degree of effectiveness in the jungles of Vietnam, as well as in tunnel and perimeter-clearing operations.

In recent history there has been documented use of chemical weapons used by other countries and terrorist groups. Iraq used mustard gas during the Iran-Iraq war in 1983. In 1984, Iraq used the nerve agent tabun during the same war. Iraq used chemical weapons in 1987 – 1988 against the Northern Kurds in their own county.

In 1995 a terrorist group in Japan, Aum Shinrikyo, produced and used sarin gas in a Tokyo subway. As a result a dozen people were killed and approximately 5,000 people were incapacitated or injured. The number of dead would have been higher if the agent was in a pure form.

Terrorist groups are adding a new twist to chemical warfare. There have been news reports and admissions by terrorist groups that they are actively developing chemical weapons. The production of chemical weapons on a small scale is not difficult. The space required to set-up a chemical agent lab is no larger than that of a narcotics drug lab (Fig. 23-1). The equipment necessary to produce chemical agents is available on the open market.
Vapors and droplets of liquids can be absorbed from the surface of the skin and mucous membranes. Toxic compounds that are harmful to the skin can produce their effects in liquid or solid state. Agents penetrating the skin may form temporary reservoirs under the skin; the vapors of some volatile liquids can penetrate the skin and cause adverse effects. See Table 23-1 for a list of common chemical weapons.

<table>
<thead>
<tr>
<th>Chemical Weapons</th>
<th>Symbol</th>
<th>Common Name</th>
<th>Class</th>
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<tbody>
<tr>
<td>AC</td>
<td>Hydrogen Cyanide</td>
<td>Blood Agent</td>
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<tr>
<td>CK</td>
<td>Cyanogen Chloride</td>
<td>Blood Agent</td>
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<td>CG</td>
<td>Phosgene</td>
<td>Pulmonary Agent</td>
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<td>Cl</td>
<td>Chlorine</td>
<td>Pulmonary Agent</td>
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<tr>
<td>CN</td>
<td>Mace</td>
<td>Riot Control</td>
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<tr>
<td>CR</td>
<td>dibenzoxazepine</td>
<td>Riot Control</td>
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<tr>
<td>CS</td>
<td>2-chlorobenzalmononitrile</td>
<td>Riot Control</td>
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<tr>
<td>CX</td>
<td>Phosgene Oxime</td>
<td>Blister Agent</td>
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<tr>
<td>DP</td>
<td>Diphosgene</td>
<td>Pulmonary Agent</td>
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<td>DM</td>
<td>Adamsite</td>
<td>Riot Control</td>
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<tr>
<td>GA</td>
<td>Tabun</td>
<td>Nerve Agent</td>
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<td>GB</td>
<td>Sarin</td>
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<td>GD</td>
<td>Soman</td>
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<td>GF</td>
<td>cyclosarin</td>
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<tr>
<td>H</td>
<td>Mustard</td>
<td>Blister Agent</td>
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<td>HD</td>
<td>Distilled Mustard</td>
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<td>HN</td>
<td>Nitrogen Mustard</td>
<td>Blister Agent</td>
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<td>L</td>
<td>Lewisite</td>
<td>Blister Agent</td>
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<td>OC</td>
<td>Oleoresin Capsicum</td>
<td>Riot Control</td>
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<tr>
<td>VX</td>
<td>S-2- (diisopropylamino)ethyl O-ethyl methylphosphonothioate</td>
<td>Nerve Agent</td>
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</table>

Table 23-1.—Names, Classes, and Symbols of Chemical Weapons

OVERVIEW

Chemical weapons are made with toxic chemicals and defined by the Chemical Warfare Convention as “any chemical which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans or animals.” It is also defined as toxic substances developed for the purpose to produce death, serious injury, or incapacitation through their toxicological effects on exposed humans or animals.

Chemical agents can be dispersed by several methods. Attacks can be accomplished with the use of aircraft, munitions, or dispersal devices. Aircraft can deliver a chemical attack by dropping bombs or launching rockets. Munitions that deliver chemical agents are missiles, rockets, and mortars. Terrorist attacks are more likely to be accomplished using dispersal devices such as commercial sprayers or smoke generators. It is unlikely that an attack against a naval vessel in open water will occur. A naval vessel may more likely be involved in a chemical agent incident while in port.

Chemical agents may enter the body by several routes and the nature and onset of signs and symptoms may vary accordingly. The agents can be disseminated as a vapor or aerosol under ambient conditions. Vapor and aerosol chemical agents often enter the body through the respiratory tract (inhalation injury). The agent may be absorbed by any part of the respiratory tract from the mucosa of the nose and mouth to the alveoli of the lungs.
Chemical agents can be broken down into general classes of agents. The following are the classes of chemical agents that will be covered in this section: Blood Agents; Pulmonary Agents; Blister Agents (Vesicants); Nerve Agents; and Riot Control Agents. They may also be classified as either lethal or nonlethal.

- **Nonlethal** agents that are not designed to kill you
- **Lethal** agents are those that result in a 10 percent or greater death rate among casualties

Chemical agents are further classified as persistent or non-persistent, dependent upon the length of time they retain their effectiveness after dissemination.

- **Persistent** agents continue to present a hazard for considerable periods (days) after delivery by remaining as a contact hazard, or by slowly vaporizing to produce a hazard an inhalation hazard
- **Non-persistent** agents disperse rapidly after release and present an immediate, short duration (hours) hazard. They are released as airborne particles, aerosols, and vapors

Meteorological conditions will influence the effectiveness and duration of chemical agents. Wind, temperature, and rain are major considerations when chemical agents are used as they will impact the length and intensity of exposure.

- Wind in an open area will disperse an agent quickly. Calm winds or protected areas (wooded areas, trenches, ditches, and urban areas) will allow an agent to stay in an area longer
- High temperatures decrease the persistency of agents and tend to cause higher vapor concentrations. This is especially true with the use of a Mustard agent
- Low temperatures increase the persistency of agents. Some agents may freeze, thus reducing the immediate contact hazard or vapor hazard. There is a danger of moving frozen agents, on clothing and equipment, into a warm building; when they warm-up there is a subsequent risk of toxic vapor being given off
- Rain washes away, dilutes, and promotes hydrolysis of agents. This reduces their effectiveness but does not make them harmless

**DETECTION EQUIPMENT**

There are several ways to detect the presence of chemical agents. Some detection methods are as simple as chemical reactive paper and as complex as electronic detection devices. Medical personnel should be familiar with three of the common detection methods.

The first method is M9 Chemical Agent Detector Paper. It is the most widely used method of detecting liquid chemical warfare agents. M9 paper indicates the presence of a nerve agent or a blister agent by turning a pink, red, reddish brown, purple color. It does not identify which agent gives the positive reading. The M-9 paper is self-adhesive and attaches to most surfaces.

The second method is the M8 Chemical Agent Detector Paper. It is used to test for the presents of liquid chemical agents. It can detect the presence of particular agents. When the paper touches a liquid agent, the paper will change color. The paper will turn Gold/Yellow for G class nerve agents and turns Olive or Verdana Green for VX. The paper turns red or purple when it comes in contact with blister agents.

**NOTE:**
Neither M8 nor M9 paper can detect chemical warfare agent vapor.
The M256A1 chemical agent detector kit is a portable kit that detects nerve gas, mustard gas, and cyanide. The kit contains a package of M8 paper, detailed instructions, and a vapor sampler (12 enzymatic tickets that contain laboratory filter paper for detecting chemical agent vapors). The vapor sampler uses wet chemistry technology, in which ampules containing different substrates are crushed so that the liquids interact with strips of filter paper, chromatographic media, and glass fiber filter. These substrates are exposed to the vapor under suspicion. The reaction causes a color change, alerting the user to the presence of a chemical agent. The reactions typically take 15 minutes to occur.

PERSONAL PROTECTION

In a chemical attack, the first priority is to ensure the HM's survival so that casualties can be treated. There are several items available to help HMs survive a chemical attack. Along with protective clothing, there is a protective mask, which should be put on at the first indication of a chemical attack. The mask will filter out all known chemical agents from the air and allow HMs to work in a chemically contaminated area.

If there is a known threat of possible chemical, biological, or radiological attack or personal need to enter known contaminated area, protective measures should be taken. Personal Protective Equipment (PPE) consists of the Joint Service Lightweight Integrated Suit Technology (JSLIST), Field M-40 Chemical/Biological Mask with hood, protective gloves, and protective boots.

Dependent upon the threat, forces may adopt a Mission-Orientated Protective Posture (MOPP) and there are five levels (Table 23-2). MOPP Gear consists of previously mentioned PPE to include an individual decontamination kit as well as antidotes. MOPP is a flexible system of protection against chemical, biological and radiological threats, which is used to facilitate mission accomplishment. MOPP does give the commander a range of choices regarding the level of chemical protection. Choices range from no protection at all to full protection.

<table>
<thead>
<tr>
<th>Mission-Oriented Protective Postures (MOPP)</th>
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<tbody>
<tr>
<td><strong>MOPP Level</strong></td>
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<tr>
<td>0</td>
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<tr>
<td>1</td>
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<td>2</td>
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<td>3</td>
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<td>4</td>
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</table>

This chart provides a quick reference of what equipment needs to be worn

* MOPP Level 0 -- Protective equipment should be within easy reach.

Table 23-2.—Mission-Oriented Protective Procedures (MOPP)
Chemical agents penetrate ordinary clothing rapidly. However, significant absorption through the skin requires a period of minutes. The effects of clothing penetration may be reduced by quickly removing the contaminated clothing and neutralizing the chemical agent on the skin by washing, blotting, or wiping it away. A chemical agent on the skin can be removed effectively by using the M291 skin decontamination kit (Fig. 23-2) or decontamination procedures associated with each agent.

![M291 Skin Decontamination Kit](image)

**Figure 23-2.—M291 Skin Decontamination Kit**
*Image provided by: NAVSEA Damage Control, Fire Protection Engineering and CBR-D.*

Prompt decontamination of the skin is imperative. Decontamination of chemical agents on the skin within 1 minute after contamination is perhaps 10 times more effective than if decontamination is delayed 5 minutes. Quick decontamination procedures are associated with each agent. Detailed instructions on the use of skin decontamination kits can be found in the NAVMED P-5041, Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries, and in the kits themselves.

**CHEMICAL AGENTS**

**NERVE AGENTS (VX, GA, GB, GD, GF)**

Nerve agents are of greatest concern as compared to all chemical agents. They produce their effect by interfering with normal transmission of nerve impulses in the parasympathetic autonomic nervous system. Pharmacologically, the nerve agents are cholinesterase inhibitors (interfering with normal transmission of nerve impulses in the nervous system). Their reaction with cholinesterase tends to be irreversible, and reaction time varies with the agent.

**Characteristics**

Physically, nerve agents are odorless, almost colorless liquids or vapors, varying greatly in viscosity and volatility. They are moderately soluble in water and fairly stable unless strong alkali or chlorinating compounds are added. They are very effective solvents, readily penetrating cloth either as a liquid or vapor. Other materials, including leather and wood, are fairly well penetrated. Butyl rubber and synthetics, such as polyesters, are much more resistant.

**Signs and Symptoms**

Nerve agents can enter the body through the eyes, respiratory tract, and skin. Symptoms vary dependent upon the patient being exposed to either vapor or liquid forms of a nerve agent. The onset of symptoms range from within seconds to 18 hours, dependent upon the form and amount of agent.

- **Vapor**
  - Small Exposure Level – Miosis (constricted pupils), rhinorrhea (runny nose), and mild difficulty breathing
  - Large Exposure Level – Miosis; sudden loss of consciousness; convulsions; apnea (no breathing); flaccid paralysis; copious secretions from the nose, mouth, and lungs
• Liquid
  o Small to Moderate Exposure – Localized sweating, nausea, vomiting, and weakness
  o Large Exposure Level - Sudden loss of consciousness; convulsions; apnea (no breathing); flaccid paralysis; and copious secretions from the nose, mouth, and lungs

Treatment

Immediate care and administration of an antidote can mean the difference between life and death of a patient exposed to a nerve agent. Atropine, an acetylcholine blocker, is the drug of choice for treating nerve agent poisoning. The second drug used for nerve agent poisoning is Pralidoxime Chloride (2-PAM CL). 2-PAM CL removes the nerve agent from the enzyme acetylcholinesterase within the synaptic cleft (the space between the nerve cells) of the nervous system. Convulsive Antidote, Nerve Agent (CANA) or Diazepam 10mg autoinjector is used to control convulsions in patients (Fig. 23-3).

The MARK 1 antidote kit (Fig. 23-4) consists of an autoinjector of Atropine 2mg and an autoinjector of 2-PAM CL 600mg. A new autoinjector called Autoinjector Treatment; Nerve Agent Antidote (ATNAA) will replace the MARK 1 kit. The ATNAA is a single autoinjector that has two chambers that deliver 2.1 mg of Atropine and 600mg of 2-PAM CL in a single injection. ATNAA is used in the same manner as a MARK 1 kit.

How to use an autoinjector

Firm pressure automatically triggers the coiled mechanism and plunges the needle through the clothing into the muscle and at the same time injects the antidote into the muscle tissue. Using a jabbing motion may result in an improper injection or injury.

Self-Aid/Buddy Aid

1. At the first signs of nerve-agent poisoning, don protective mask.
2. Administer one MARK 1 kit intramuscularly, into the lateral thigh muscle or buttocks of the patient.
3. Position the needle end of the injector against the injection site.
4. Make sure not to hit any buttons or other objects.
5. Apply firm and even pressure to the autoinjector until the needle pushes into the injection site.

6. Hold the injector firmly in place for at least 10 seconds.

**NOTE:**
Do NOT use a jabbing motion. This may result in improper injection of antidote and/or injury to the patient.

7. Wait for 10 to 15 minutes to see if the symptoms subside.

8. If symptoms continue, administer another autoinjector. Note - a total of three MARK 1 kits can be administered at 10 to 15 minute intervals by non-medical personnel.

9. Patients with severe symptoms, more than one system involvement (i.e., gastrointestinal and respiration) should be given all three MARK 1 kits and CANA immediately.

**NOTE:**
The HM will use the casualty’s autoinjector(s) when providing aid to the casualty. The HM must never use their autoinjector(s) on the casualty as this will limit the antidote available if needed for self-aid.

**Medical Personnel**

If symptoms continue after three autoinjectors have been administered, medical personnel may administer repeated Atropine (2mg) injections. Atropine can be injected at five to ten minute intervals and until there is a reduction of both secretions and breathing difficulty.

If severe symptoms still persist after one hour of giving the three MARK 1 kits (Atropine and 2-PAM CL), three additional autoinjectors of 2 PAM CL 600mg should be given. No more than six doses should be given of 2-PAM CL. Discontinue 2 PAM CL use after respiratory distress has decreased.

If convulsions continue after 10 minutes of initial injection of CANA (Diazepam), a second dose may be administered. Observe patient for 5 to 10 minutes after injection, if the patient is still convulsing a third dose may be administered. Medical officers may choose to give more diazepam either IM or IV, if they deem it necessary.

**Decontamination**

Decontamination of the patient should be done as soon as possible. This will eliminate the potential of continued absorption of never agents into the patient. Conduct decontamination in the following order:

- Face
- Neck Area
- Chest Area
- Abdomen
- Arms and Hands
- Other exposed skin areas

Decontamination of liquid nerve agent exposure consists of removing all contaminated clothing. A M291 kit may be used or copiously irrigating the area with water to physically remove the nerve agent. The skin is then washed with an alkaline solution of soap and water or 0.5% hypochlorite solution (made by diluting household bleach 1:10) to chemically neutralize the nerve agent. Avoid hot water, strong detergents, and vigorous scrubbing, since they tend to enhance nerve agent absorption.

**BLISTER AGENTS (H, HD, HN, L)**

Blister agents, or vesicants, exert their primary action on the skin, producing large and painful blisters that are incapacitating. Although vesicants are classed as nonlethal, high doses can cause death. Mustards (H, HD, and HN) constituted both a liquid and vapor threat. Mustard agents are a major concern due to large stockpiles it and the ease of production.
Characteristics

Each agent is chemically different and will cause significant specific symptoms. They are all similar in their physical characteristics and toxicity. H, HD, and HN are oily, colorless or pale yellow liquids, sparingly soluble in water. HN (Nitrogen Mustard) is less volatile and more persistent than HD (Distilled Mustard) but has the same blistering qualities. Lewisite (L) is an arsenical (an arsenic-based compound). This blistering compound is a light to dark brown liquid that vaporizes slowly. All blister agents have a relatively high vapor density; it is more likely to flow to low spots such as valleys, ditches, holes, and the ground or deck.

Signs and Symptoms

Mustards (Fig. 23-5) are particularly insidious as they do not manifest their symptoms for several hours after exposure. Blister agents attack the eyes and respiratory tract as well as the skin. Patients exposed to mustard may remember seeing an oily substance and smelling an odor of garlic, mustard, or horseradish. Patients exposed to Lewisite (L) may remember observing puddles of a brown liquid or of

The eyes are the most vulnerable part of the body to mustard gas. Contamination insufficient to cause injury elsewhere may produce eye inflammation. The eyes are the most sensitive part of the body. The first noticeable symptoms of mustard exposure will be pain and a gritting feeling in the eyes, accompanied by spastic blinking of the eyelids and photophobia. This may continue to develop with swelling of the eyelids, cornea damage, and moderate to severe pain.

The skin will develop erythema and blisters (Fig. 23-6). Typical blister agent cause blistering in about 12 hours but may be delayed for up to 48 hours, while Lewisite (L) causes intense pain upon contact. Areas affected the most will be in warm, sweaty areas of the body: the armpits, groin, and on the face and neck.

![Figure 23-6.—Blisters from Contact with a Mustard Agent](Image reprinted with permission from: U. S. Army Special Programs Division, Dugway Proving Grounds.)

smelling an odor similar to geranium.
Inhalation of the gas is followed in a few hours by sore throat, sinus pain, and hoarseness. This may progress to a hacking cough and then to a productive cough and shortness of breath. Breath sounds may be crackles and rales. Brochopneumonia is a frequent complication. The primary cause of death is massive edema or mechanical pulmonary obstruction. Due to the pain associated with Lewisite (L) exposure, patients are more likely to don their protective mask early. Thus limiting the respiratory injuries that may normally occur as a result of exposure.

**Treatment**

There is no specific antidotal treatment for mustard (H, HD, and HN) poisoning. Physically removing as much of the mustard as possible as soon as possible, is the only effective method for mitigating symptoms before they appear. All other treatment is symptomatic and supportive; the relief of pain and itching, and control of infection.

In cases of systemic involvement, British water to physically remove agents and then washing the skin with soap and water or 0.5% hypochlorite solution (made by diluting household bleach 1:10) to chemically neutralize the agent.

**BLOOD AGENTS (AC, CK)**

Blood agents or cyanides basic physical actions disrupt oxygen utilization at the cellular level causing cellular suffocation. They are rapid acting lethal agents that have limited military use. Cyanide is a common chemical and found widespread in chemical synthesis and is easy for terrorist to obtain and to potentially be used in a terrorist attack.

**Characteristics**

Anti-Lewisite (BAL) was developed as an antidote for Lewisite (L). BAL is used as a chelating agent that combines with the heavy metal to form a water-soluble, nontoxic complex that is excreted. However, BAL is somewhat toxic and an injection of more than 3 mg/kg will cause severe symptoms. Do not use on patients allergic to peanuts.

**Decontamination**

Early decontamination will reduce the affect of blister agents. Decontamination within two minutes will reduce the toxic effects by more than 50%. Decontamination consists of removing all contaminated clothing. A M291 kit may be used or copiously irrigating the area with
Cyanides are volatile and evaporate quickly to become vapors or gases. Hydrogen Cyanide (AC) has a bitter almonds smell. Although very deadly, they are non-persistent agents. Cyanides usually dissipate in less than 24 hours. Cyanide produces clinical effects by disrupting oxygen uptake by cells.

Signs and Symptoms

- **Moderate Exposure** (low concentrations)
  - Symptoms include transient increased rate and depth of breathing; dizziness; nausea and vomiting; headache; and eye irritation. Symptoms may progress to severe with continued exposure

- **High Exposure** (high concentrations)
  - The onset is rapid, often within minutes. Symptoms include transient increased rate and depth of breathing; convulsions (within 30 seconds); apnea; cardiac arrest (within a few minutes)

Treatment

Treatment begins with personnel protection by using a chemical protective mask. Remove the patient from the agent to fresh air. Treatment of cyanide poisoning is very effective if administered in a timely manner. Antidote treatment consists of a two step process:

1. Initial treatment of cyanides: two amyl nitrite ampules crushed and inhaled (every few minutes until eight ampules have been used) or intravenous sodium nitrate 300mg (a 300mg to 600mg dose given).
2. Administer intravenous sodium thiosulfate 12.5g (1 to 2 doses given).
3. Follow-up treatment consists of the two antidotes given at half the original dose if there is no response to the first dose.

The key to successful cyanide therapy is providing treatment early; cyanide acts rapidly on an essential enzyme system. The antidotes act rapidly to reverse this action.

If the specific antidote and artificial respiration are given early enough, the chance of survival is greatly enhanced.

Decontamination

Skin decontamination is usually not required as the agent evaporates quickly. Wet contaminate clothing should be removed and contained to prevent off gassing hazard. Skin should be cleaned by copiously irrigating the area with water to physically remove agents, and then washing the skin with soap and water.

**PULMONARY AGENTS (CG, CL, DP)**

Pulmonary agents damage the membranes in the lungs that separate the alveolar tissue resulting in fluid from the blood, known as plasma, to leak into the alveoli and fill them with fluid. This prevents necessary gas exchange within the alveoli causing hypoxia. This creates a condition known as pulmonary edema. This group includes phosgene (CG) and chlorine (CL); HC Smoke and Ammonia should also be included as a pulmonary agent. A terrorist threat may come from the release of chloroform or ammonia.

Characteristics

These agents are usually in vapor form, typically heavier than air, and travel close to the ground. They tend to evaporate and disburse very quickly, dependent upon temperature and wind. Chlorine and ammonia have very distinct smells. Phosgene is a colorless gas with a distinctive odor similar to that of new-mown hay or freshly cut grass.

Signs and Symptoms

Early symptoms may be irritation of the eyes, nose, and airway. At this stage it may be difficult to distinguish a pulmonary agent from a riot agent. Symptoms may progress to coughing, difficulty breathing, hoarseness talking, sneezing, wheezing, and a feeling of tightness in the chest. More often, however, there will be no symptoms for 2 to 6 hours after exposure.
Latent symptoms are rapid, shallow, and labored breathing; painful cough; cyanosis; frothy sputum; clammy skin; rapid, feeble pulse; and low blood pressure. Shock may develop, followed by death. Auscultation of the lungs will reveal crackles and rales, in the lower lobes initially and progress to be heard throughout all fields.

**Treatment**

Initial treatment is to remove the patient from the source. There is no antidote for pulmonary agents. Keep the patient at complete rest. Even a little exertion can increase the effects of the agent and speed up the progression of pulmonary edema. Provide supportive care as necessary and treat symptomatically. Patients with shortness of breath may require assisted respirations and/or oxygen.

**Decontamination**

- **Vapors**
  - Exposure to fresh air or ventilate the area

- **Liquids**
  - Remove contaminated clothing and rinse the affected area with copious amounts of water

**RIOT-CONTROL/HARASSMENT AGENTS (CN, CR, CS, DM, OC)**

"Riot-control agents" is the collective term used to describe a collection of chemical compounds, all having similar characteristics which, though relatively nontoxic, produce an immediate but temporary effect in very low concentrations. These agents are used to harass enemy personnel or to discourage riot actions thus the weapon of choice for police when managing riots.
Characteristics

Unlike most agents, which are liquids under temperate conditions, riot control agents are crystallized solids that are dispersed as fine particles or in solution(s). Dispersal devices include small handheld aerosol cans, large tanks, grenades, and bombs. These agents irritate the skin, mucosa membranes, and airway, causing people to become unable to perform their job due to discomfort. There are two classes of riot-control/harassment agents: lacrimators and vomiting agents.

- **Lacrimators** (or tear gases) are essentially local irritants that act primarily on the eyes.

- **Vomiting agents** comprise the second class of agents in the riot-control category and cause nausea, vomiting, and general malaise in victims.

Signs and Symptoms

The main effect of riot control agents is pain burning, and irritation to exposed skin and mucosa membranes. Other symptoms include salivation, increased nasal secretions, coughing, possible redness of skin, and possible shortness of breath. Lacrimators produce intense pain in the eyes with excessive tearing. Vomiting agents produce prolonged periods of nausea and vomiting. The symptoms following the most severe exposure to vapors seldom last over 2 hours. After moderate exposure, they last only a few minutes.

Treatment

At the first signs of exposure, don protective mask. It is of the utmost importance that the mask be worn in spite of coughing, sneezing, salivation, and nausea. If the mask is put on following exposure, symptoms will increase for several minutes in spite of adequate protection. As a consequence, victims may believe the mask is ineffective and remove it, further exposing themselves.

While the mask must be worn, it may be lifted from the face briefly, if necessary, to permit vomiting or to drain saliva from the face piece. Carry on duties as vigorously as possible. This will help to lessen and shorten the symptoms.

Generally, patients require no therapy; removal from the environment is sufficient to affect recovery in a short time. Exposure to fresh air and letting wind blow into wide-open eyes, held open if necessary, is sufficient for recovery in a short time. Talking can relieve any chest discomfort after CS exposure. Less than 1% of people develop severe symptoms. There is no antidote for these agents. Patients need to be treated according to their symptoms.

- **Eyes:** The eyes should be flushed with water or saline and impacted particles should be removed. General care consists of a topical solution to relieve the irritation and topical antibiotics. An ophthalmologist should be consulted for further evaluation and care.

- **Pulmonary:** These agents may exacerbate chronic disease or unmask latent disease. Bronchospasm with wheezing and mild distress continuing hours after exposure may occur in latent asthmatic people. More severe effects and respiratory distress may occur in one with chronic bronchitis or emphysema. Management includes oxygen administration and bronchodilators if bronchospasms are present.

- **Skin:** The early erythema requires reassurance, but no specific therapy is indicated unless severe and prolonged more than an hour or two. Treat symptoms with soothing compounds such as calamine. Small vesicles should be left intact, but larger ones will ultimately break. Large, oozing areas have responded to compresses containing substances such as colloidal oatmeal, Burrow's solution, and other dermatologic preparations.
Decontamination

An important point to remember is that this material adheres to clothing, and a change of clothing may be necessary. Do not forget the hair (both head and facial) as a potential source of recontamination. The crystals can be released from the hair, skin, and clothes by a fan, wind, or the patient flapping their arms and rubbing hair. Heavily exposed patients can be decontaminated by washing with soap and water. Areas can be rinsed with a continuous flow of water. OC can be removed by washing with baby shampoo, milk, or vegetable oil to break up the resin and neutralize the agent.

DECONTAMINATION

The guiding principle in personnel decontamination is to avoid spreading contamination to clean areas and to manage casualties without aggravating other injuries (Fig. 23-7). It can be accomplished by either removing or neutralizing the agent. The process can be very extensive, dependent upon the agent or materials that need to be removed.

Casualty Priorities

It may be necessary to decide whether to handle the surgical condition or the chemical hazard first. If the situation and the condition of the casualty permit, decontamination should be carried out first. The longer the chemical remains on the body, the greater the danger of spreading the chemical to other personnel and equipment.

The following order of priority for first aid and decontaminating casualties is recommended:

- Control of massive hemorrhage
- First aid for life-threatening shock and wounds
- Decontamination of exposed skin and eyes
- Removal of contaminated clothing and decontamination of body surfaces (if not in a toxic environment)
- Adjustment of the patient’s mask, if mask is necessary
- First aid for less severe shock and wounds

Decontamination Station Organization

In general, the decontamination station, or "dirty" area, receives casualties contaminated with a chemical agent. The arrangement of this area will vary with the site of the medical unit and the facilities available for decontamination. See Figure 23-8 for one decontamination site organization.

Figure 23-7.—Decontamination

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Each ship has a minimum of at least two decontamination stations, insofar as the hull design permits. The "dirty" areas should be topside or in some well-ventilated space. Personnel manning these areas should be provided with protective equipment.

In the "dirty" area, casualties will be decontaminated, undressed, showered, and passed along to clean areas. Both areas will be clearly marked as either "clean" or "contaminated," as appropriate. Decontamination kits, protective ointment, and an abundant supply of soap and water must be provided. In addition, standard first-aid items should be on hand. When possible, improvise supports (e.g., small boxes, blocks of wood, etc.) for stretchers to keep them raised off the deck.

Handling of Contaminated Casualties

The spread of contamination to uncontaminated personnel or to spaces not set aside to receive contamination must be avoided. Contaminated personnel, clothing, or equipment must be kept out of uncontaminated areas as the subsequent decontamination of such spaces is quite difficult. Contaminated clothing and gear must be placed in designated dump areas and, whenever practically possible, kept in metal cans with tightly fitting covers.

All casualties, after experiencing a chemical attack are to be considered contaminated unless there is certification of non-contamination. The initial management of a casualty contaminated by chemical agents will require removal of MOPP and decontamination with 0.5% hypochlorite before treatment.