



# CHEMICAL AGENTS



# CHEMICAL AGENTS



## GOAL OF THIS SECTION

To provide details on chemical agents that could be used by terrorists.

### WHAT THIS SECTION INCLUDES

› Categories of agents are provided with examples from each category. The U.S. Department of Health and Human Services' (HHS) Centers for Disease Control and Prevention (CDC) use the impact that chemical agents have on the human body to categorize them. For example, nerve agents affect the central nervous system, while choking agents affect breathing.

### WHAT THIS SECTION DOES NOT INCLUDE AND WHY

› All possible chemical agents that could be used in an attack are not included here. This section provides one or two examples of four major types of chemical agents. A detailed description of more chemical agents can be found on CDC's Web site, (<http://www.bt.cdc.gov/agent/agentlistchem.asp>).

› This section will not focus on the specific amounts of an agent that will make people sick. There are too many variables in how a chemical weapon could be delivered. However, this section will address exposure and treatment in more general terms.

› Detailed information on toxic industrial chemicals are not included. Though a terrorist may use toxic industrial chemicals in an attack (e.g., by causing a truck containing toxic chemicals to explode, or by attacking a chemical plant), any one of thousands of industrial chemicals could be used in this way. However, the federal response to an attack or accident involving industrial chemicals will be similar to the federal response to the chemical agents as described in this guide (see p. 141).

› Ricin and other biological toxins are not covered in this section. Ricin is classified as a chemical agent, as well as a biological agent, because it is a toxin but it has a biological source (unlike sarin or other chemical agents). Details on ricin can be found in the "Biological Agents" section (see p. 39).

Please note: Information on the use of personal protective equipment (e.g., biohazard suits and masks) can be found in the "Self-Care for Media" section (see p. 157).

## BASIC FACTS

This section discusses four major types of chemical agents, grouped according to how they affect the human body:

- › Blister (e.g., mustards)
- › Blood (e.g., cyanides)
- › Choking (e.g., chlorine)
- › Nerve (e.g., sarin, VX agents)

Other categories of chemicals include:

- › Biotoxins
- › Caustics (acids)
- › Incapacitating agents

- › Long-acting anticoagulants
- › Metals
- › Organic solvents
- › Riot control agents/tear gas
- › Toxic alcohols
- › Vomiting agents

For more information on these other chemical categories, please see <http://www.bt.cdc.gov>.

› Chemical agents can come in the form of poisonous gases, liquids, or solids.



- › These agents are usually fast acting and toxic to people, animals, or plants. (Note: A major exception is mustard agents for which symptoms appear several hours after exposure.)
- › Poisoning by chemicals is not contagious. However, if residual chemical agents or vapors are on the skin, clothing, hair, or in biologic fluids (such as vomit), others can be exposed and affected. Once the agent is removed (e.g., by removing clothing and showering), the illness caused by a chemical agent cannot be spread.

## CHEMICAL AGENT HISTORIC TIMELINE

**1914–1918 (World War I):** Mustard gas, phosgene, and chlorine are introduced for chemical warfare.

**1939–1945 (World War II):** Germans use hydrogen cyanide as a genocidal agent. Germans use chlorine in World War II as a chemical weapon.

**1980s:** Iraq uses cyanide against Kurds in Northern Iraq.

**1981–1988:** Iraq uses mustard gas and nerve agents in the Iran-Iraq war.

**1995:** Aum Shinrikyo cult in Japan releases sarin in Tokyo subway.

## ASSESSING THE RISK

- › Because certain chemical agents are used in industry and household products, they are **highly available**.
- › After an outdoor release, the dangers associated with many chemical agents **decrease over time** because the chemical gets diluted as it spreads over a given area.
- › Terrorists could be **minimally skilled** to launch a limited chemical attack. A more widespread attack would require more expertise.
- › How **lethal** an attack is depends on several factors, including amount and type of agent used, route of exposure, time elapsed before decontamination, and access to medical care.

## CHEMICAL AGENTS AS WEAPONS

- › Sufficient quantities must be used for chemical weapons to be effective.
- › Weather factors have an impact on the effectiveness of an open-air release. These factors include:

- Temperature
- Wind speed and direction
- Humidity and air stability
- › Chemical agents are typically more deadly in confined or crowded areas, such as buildings, subways, or battlefields, where evacuation options are limited.
- › Chemical agents can be deployed in five ways:
  - Spraying the chemical with wet or dry aerosol sprayers (e.g., crop dusters, handheld spraying devices)
  - Using a heat source to vaporize the chemical for release
  - Using an explosive device to disperse the chemical
  - Pouring the chemical on a specific site (e.g., building floor, sidewalk, subway platform)
  - Contamination of food, water, or pharmaceuticals (such as the 1982 intentional contamination of acetaminophen products with cyanide)

## IDENTIFYING AN ATTACK

- › A chemical release may result in environmental clues, including:
  - Dead plants, animals, or insects
  - Pungent odor
  - Unusual clouds, vapors, or droplets
  - Discoloration of surfaces
- › Some common immediate physical symptoms from an airborne attack may include:
  - Tightness in chest and difficulty breathing
  - Nausea and vomiting
  - Watery eyes and blurry vision
- › A chemical attack is different from a biological attack in the following ways:
  - It is often an easily identifiable incident (e.g., chemical release from a fire at an industrial manufacturing facility)
  - Signs and symptoms appear rapidly after exposure (usually within minutes)
  - Victims are not contagious, although rescue workers can become ill if there is still residual chemical on the patient's clothes or skin, or in biologic fluids, and they are exposed to these agents without proper personal protective equipment (e.g., gloves and masks)



## LESSENING THE IMPACT OF EXPOSURE (TO CHEMICAL AGENTS IN GENERAL)

- › Follow the instructions of emergency workers, if possible.
- › Move away from the site of release (if known) during an outdoor release or go indoors.
- › Shelter-in-place if indoors near an outdoor release.
- › Evacuate the affected building during an indoor release.
- › If exposed, remove contaminated clothing and place in a plastic bag.
- › Wash with soap and water (when appropriate).
- › Flush eyes with water (when appropriate).
- › Seek medical attention if you have breathed in chemical fumes or if chemicals have touched your skin.
- › Patients should be decontaminated if they have chemicals on their clothes and/or skin (when appropriate).
- › If medically indicated and available, get appropriate antidote(s).
- › Consider using protective masks and clothing to minimize exposure.
- › Whenever possible, get emergency personnel in protective gear to assist in the removal of contaminated clothing.

## INSTRUCTIONS TO SHELTER-IN-PLACE AND SEAL THE ROOM DUE TO CHEMICAL INCIDENTS

### If you have been exposed:

- › Remove contaminated clothing if coming from outside and seal it in a plastic bag
- › Shower and wash with soap, if possible

### To shelter-in-place and seal the room:

- › Find a room with as few windows and doors as possible
- › Go to the *highest* level possible
- › Turn off the air conditioner, heater, and fans
- › Close the fireplace damper
- › Fill sinks and tubs with water
- › Turn on the radio for instructions
- › Keep a telephone handy
- › To seal the room, tape plastic over windows and doors; seal with duct tape. Tape over vents and electrical outlets (and any other openings)\*

\* Within a few hours, the plastic and tape may need to be removed to allow fresh air to enter the room to prevent suffocation. *Follow the instructions of emergency workers and/or public health officials.*

## SHELTER-IN-PLACE\* SUPPLY LIST (Maintain enough for 3 days; check supplies every 6 months)

- › Food
- › Bottled water (1 gallon per day per person, plus water for pets)
- › Change of clothing (including undergarments)
- › Shoes
- › First aid kit
- › Paper goods and plastic utensils
- › Plastic garbage bags
- › Bedding
- › Battery-operated radio
- › Batteries
- › Flashlight
- › Medicines
- › Toiletries
- › Telephone (hard-wired phones are best)
- › Emergency-contact phone list
- › Extra eyeglasses or contact lenses
- › Baby formula
- › Pet food
- › Plastic sheeting
- › Duct tape

\* More extensive emergency supply checklists can be found in appendices F and G (see pp. 241–244).



## CHEMICAL AGENT BREAKDOWN\*

BLISTER AGENTS	BLOOD AGENTS	CHOKING AGENTS	NERVE AGENTS
<p><b>Mustard agents:</b> Distilled mustard (HD), Mustard gas (H) (sulfur mustard), Mustard/lewisite (HL), Mustard/T, Nitrogen mustard (HN-1, HN-2, HN-3), Sesqui mustard, Sulfur mustard (H) (mustard gas)</p> <p><b>Lewisites/chloroarsine agents:</b> Lewisite (L, L-1, L-2, L-3), Mustard/lewisite (HL), Phosgene oxime (CX)</p>	<p>Arsine (SA)</p> <p><b>Cyanide agents:</b> Cyanogen chloride (CK), Hydrogen cyanide (AC), Potassium cyanide (KCN), Sodium cyanide (NaCN)</p>	<p>Ammonia (NH-3)</p> <p>Chlorine (CL)</p> <p>Hydrogen chloride (HCl)</p> <p><b>Phosgene agents:</b> Diphosgene (DP), Phosphine, Phosphorus (elemental, white, or yellow)</p>	<p><b>G agents:</b> Sarin (GB), Soman (GD), Tabun (GA)</p> <p><b>V agents:</b> VX</p>

\* This list is not all inclusive. For information on additional chemicals, see <http://www.bt.cdc.gov>.



# BLISTER AGENTS

## OVERVIEW

This family of chemical agents is also called vesicant agents:

- › Mustards (e.g., sulfur mustard)
- › Lewisites/chloroarsine agents
- › Phosgene oxime

Mustards and lewisites cause blistering on the skin after exposure. Mustard gas is the best-known example. A lesser-known but possible threat is lewisite.

## MUSTARD GAS

### **Basic Facts**

- › Mustard agent, in some forms, can be a colorless, oily, odorless liquid.
- › Mustard agent can be vaporized to form a gas, if heated.
- › In some quantities, this agent may have a slight garlic odor and a yellowish-to-brownish tint.

### **Mustard Gas as a Weapon**

- › The agent may be persistent in the soil for weeks but generally only remains on materials after release for days to hours. This is highly dependent on the air temperature and purity of the compound.
- › It can still be harmful if it settles in the ground.
- › It was introduced as a weapon in World War I.

### **Mustard Gas Illness**

- › The agent enters the body through inhalation or contact with skin or eyes.
- › The agent can cause skin damage on contact, especially on hot, humid days or in tropical climates.
- › Signs and symptoms may not occur immediately. Depending on the severity of the exposure, symptoms may not occur for 2–24 hours.

› Symptoms include:

- Skin burns, in which blisters surface within a few days; blisters become large and may be yellowish-brown in color
- Eyes burning and swelling, which can cause blindness (lasting up to 10 days)
- If gas is inhaled, may result in coughing, bronchitis, long-term respiratory disease, and cancer in the airways and lungs later in life

### **Mustard Gas Diagnosis and Treatment**

- › No effective medical test exists.
- › Urine tests can be inconclusive.
- › No specific antidote or treatment exists.
- › Supportive medical care is given to the victim to minimize the effects of exposure.

### **Lessening the Impact of Mustard Gas Exposure**

- › Move away from the site of exposure immediately and go to higher ground for fresh air.
- › Remove outer layer of clothing, place in a plastic bag, and seal as soon as possible.
- › Immediately wash body thoroughly with soap and water.
- › Flush irritated eyes with plain water for 10–15 minutes.
- › Blisters should be treated as burns.
- › If mustard agents have been swallowed, do not induce vomiting. Give milk to drink.
- › Seek medical attention immediately.

## LEWISITE

### **Basic Facts**

- › Lewisite is also known as L.
- › This agent is a chemical warfare agent that causes immediate blistering of the skin and damage to the respiratory system.
- › Lewisite is an oily liquid that can be colorless or can appear amber to black.
- › This agent smells like geraniums and could be confused with the smell of ammonia.
- › Lewisite contains arsenic.





- › Lewisite is not found naturally in the environment; when released there, however, it can last for days.

### **Lewisite as a Weapon**

- › Lewisite was developed for use in World War I by the United States but was produced too late to be used.
- › Lewisite has no other uses except as a chemical warfare agent.
- › In a vapor state, lewisite can be released into the air.
- › The liquid form of lewisite could possibly be used to poison water or food.
- › People are exposed to lewisite by breathing in or ingesting it, or if it comes into contact with their skin or eyes.

### **Lewisite Illness**

- › Lewisite causes immediate damage to the skin, eyes, and respiratory (breathing) tract.
- › In addition to its irritative effects, the effects of lewisite exposure are similar to those of arsenic poisoning, including stomach ailments and low blood pressure.
- › Lewisite causes the following symptoms (all health information was gathered from animal studies, since there are no known cases of human exposure):

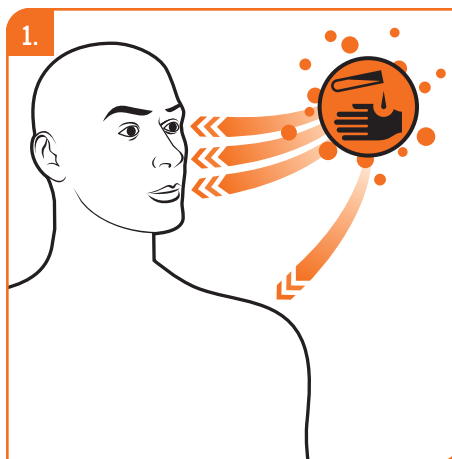
#### **Seconds to minutes:**

- Skin pain and irritation
- Immediate eye irritation, pain, swelling, and tearing
- Runny nose, sneezing, hoarseness, bloody nose, sinus pain, shortness of breath, and cough

#### **15–30 minutes:**

- Skin redness

**FIGURE 4-1: BLISTER AGENTS**



Blister agent inhaled or absorbed through skin or eyes.

#### **Within hours:**

- Blisters
- Diarrhea, nausea, and vomiting
- Low blood pressure or “lewisite shock”

#### **Within days:**

- Blisters form lesions

#### **Within weeks:**

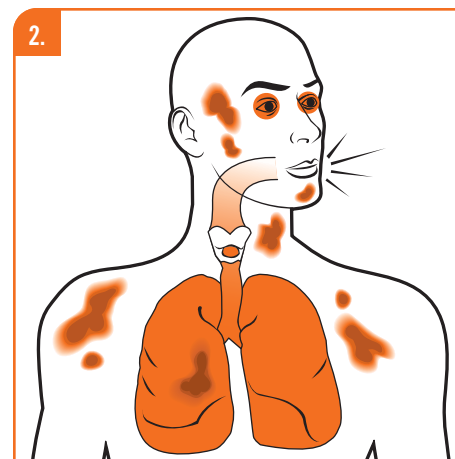
- Discoloration of the skin

- › Lewisite may cause the following long-term health effects after prolonged exposure or in the case of exposure to high doses:

- Skin burning
- Chronic respiratory disease
- Permanent blindness

### **Lewisite Diagnosis and Treatment**

- › The smell of lewisite may signal a release.



Symptoms include blisters or burns on skin or lungs, eye irritation, coughing, and respiratory irritation.

- › Diagnosis is confirmed from people's symptoms.

- › British-Anti-Lewisite is the preferred antidote and is most effective if given immediately after exposure.

### **Lessening the Impact of Lewisite Exposure**

- › Move away from the site of exposure immediately and go to higher ground for fresh air.
- › Remove outer layer of clothing, place in a plastic bag, and seal as soon as possible.
- › Immediately wash body thoroughly with soap and water.
- › Flush irritated eyes with plain water for 10–15 minutes.
- › If lewisite has been swallowed, do not induce vomiting or drink fluids.
- › Seek medical attention immediately.



# BLOOD AGENTS

## OVERVIEW

**Blood agents include:**

- › Arsinine
- › Cyanide

**These agents deprive the blood and organs of oxygen.**

## ARSINE

### **Basic Facts**

- › Arsinine is a colorless toxic gas.
- › Arsinine has a mild garlic odor that can be detected only at levels greater than those necessary to cause poisoning.
- › Accidental formation of arsinine in the workplace is the most common route of exposure.

### **Arsinine as a Weapon**

- › Arsinine was explored for chemical warfare in World War II by the British but was never used.
- › Arsinine is relatively easy to create for a deliberate release into the air because it is most commonly used in the semiconductor and metals refining industries and is readily available.

### **Arsinine Illness**

- › The severity of arsinine poisoning depends on the amount and duration of exposure.
- › Arsinine enters the bloodstream and damages red blood cells.
- › Exposure to low or moderate doses of arsinine causes symptoms within 2–24 hours, including:
  - Weakness
  - Fatigue
  - Headache

- Drowsiness
- Confusion
- Shortness of breath
- Rapid breathing
- Nausea, vomiting, and/or abdominal pain
- Red or dark urine
- Yellow skin and eyes (jaundice)
- Muscle cramps
- › Exposure to high doses of arsinine can cause:
  - Loss of consciousness
  - Convulsions
  - Paralysis
  - Respiratory failure possibly leading to death
- › Long-term side effects of exposure include:
  - Kidney damage
  - Numbness and pain in the extremities
  - Memory loss or confusion

### **Arsinine Diagnosis and Treatment**

- › A release is confirmed when people start exhibiting symptoms.
- › Only during a large release will arsinine's garlic odor be prevalent.
- › There is no antidote for arsinine poisoning.

### **Lessening the Impact of Arsinine Exposure**

- › Move away from the site of exposure and get fresh air immediately.
- › Remove outer layer of clothing, place in a plastic bag, and seal as soon as possible.
- › Immediately wash body thoroughly with soap and water.
- › Flush irritated eyes with plain water for 10–15 minutes.
- › Seek medical attention immediately.





## CYANIDE

### Basic Facts

- › Cyanide can come in many different forms, however, the following four types are more likely to be seen:
  - Hydrogen cyanide
  - Cyanogen chloride
  - Potassium cyanide
  - Sodium cyanide
- › Legitimate uses of cyanide compounds include manufacturing applications, such as metal refining and photography.
- › In gas form, the agent is colorless and may have a slight almond odor.

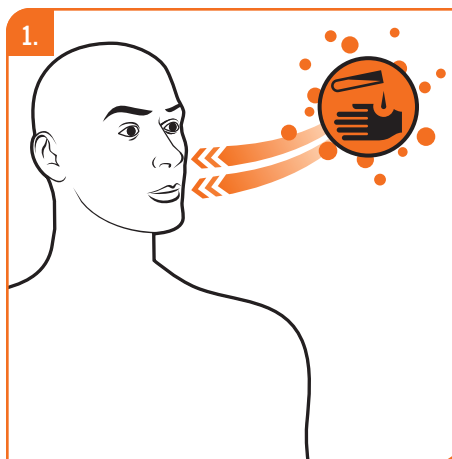
### Cyanide as a Weapon

- › The agent can be released into the air, soil, drinking water, or food supply.
- › Cyanide is fast acting.
- › Breathing in and ingesting cyanide are the most harmful routes of exposure.
- › Cyanide is most dangerous in enclosed spaces.
- › Cyanide evaporates quickly in open areas.
- › Cyanide is relatively easy to obtain and release.

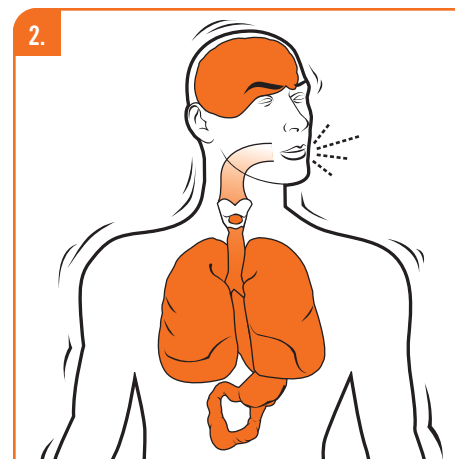
### Cyanide Illness

- › Cyanide deprives the body's cells from using oxygen.
- › The agent is most harmful to the heart and brain, which rely heavily on oxygen.

FIGURE 4-2: BLOOD AGENTS



Blood agent inhaled or ingested.



Chemical deprives cells and tissues of oxygen causing rapid breathing, nausea, convulsions, and loss of consciousness.

- › Symptoms include:
  - Rapid breathing, restlessness, dizziness, weakness, and headache
  - Nausea, vomiting, and convulsions
  - Loss of consciousness, injury to the lungs, and respiratory failure
  - Permanent heart and brain damage
  - Rapid progression to coma and death

### Cyanide Diagnosis and Treatment

- › Environmental testing can confirm a release.
- › Blood tests can confirm individual exposure.
- › Immediate medical attention is recommended.
- › Preferred antidotes are a nitrite or a thiosulfate compound.

### Lessening the Impact of Cyanide Exposure

- › Move away from the site of exposure and get fresh air immediately.
- › Remove outer layer of clothing, place in a plastic bag, and seal as soon as possible.
- › Immediately wash body thoroughly with soap and water.
- › Flush irritated eyes with plain water for 10–15 minutes.
- › Seek medical attention immediately.



# CHOKING AGENTS

## OVERVIEW

Choking agents include:

- › Ammonia
- › Chlorine
- › Hydrogen chloride
- › Phosgene
- › Phosphine
- › Phosphorus (certain forms)

These agents attack the respiratory system, making it difficult to breathe.

## CHLORINE

### **Basic Facts**

- › Chlorine is used in industry and is found in bleach and other common household products.
- › Chlorine can take a gas or yellow-green liquid form.
- › Chlorine emits a strong odor, which is like the odor of bleach, and can become explosive and flammable when mixed with other chemicals.

### **Chlorine as a Weapon**

- › Chlorine is most likely to be released as a gas.
- › It can be released into the air and spreads rapidly.
- › Chlorine settles close to the ground.
- › In liquid form, it can be released into the water or food supply.
- › Chlorine was used in World War II as a chemical weapon.
- › Terrorists may attempt to access large quantities stored at water treatment facilities, swimming pool complexes, and industrial sites.

### **Chlorine Illness**

Symptoms of exposure include:

- › Coughing and tightness in the chest
- › Burning eyes, nose, and throat
- › Blurred vision, nausea, and vomiting
- › Blistered skin
- › Shortness of breath and fluid in the lungs
- › Long-term complications, including pneumonia and chronic bronchitis

### **Chlorine Diagnosis and Treatment**

- › Air sampling is conducted to confirm a release.
- › No antidote exists.
- › Supplemental oxygen should be given as needed.
- › Immediate medical treatment is essential.

### **Lessening the Impact of Chlorine Exposure**

- › Move away from the site of exposure immediately and move to higher ground for fresh air.
- › Remove outer layer of clothing, place in a plastic bag, and seal as soon as possible.
- › Immediately wash body thoroughly with soap and water.
- › Flush irritated eyes with plain water for 10–15 minutes.
- › If you have ingested chlorine, do not induce vomiting or drink fluids.
- › Seek medical attention immediately.

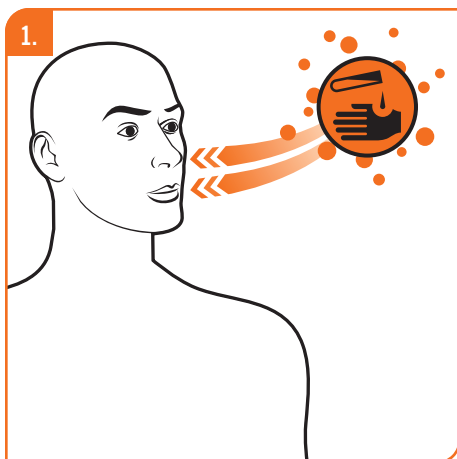
## PHOSGENE

### **Basic Facts**

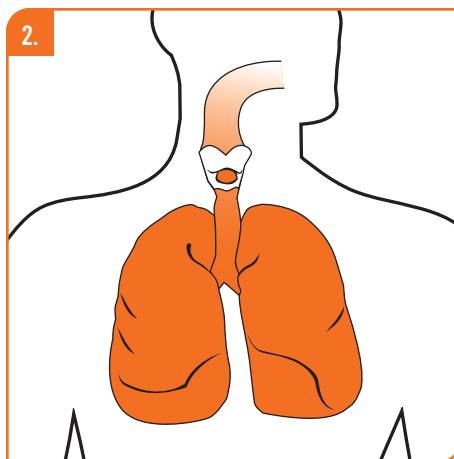
- › Phosgene is also known as CG.
- › Phosgene is an industrial chemical used to make plastics and pesticides.
- › Phosgene is a poisonous gas at room temperature.
- › When cooled, phosgene is converted into liquid form.



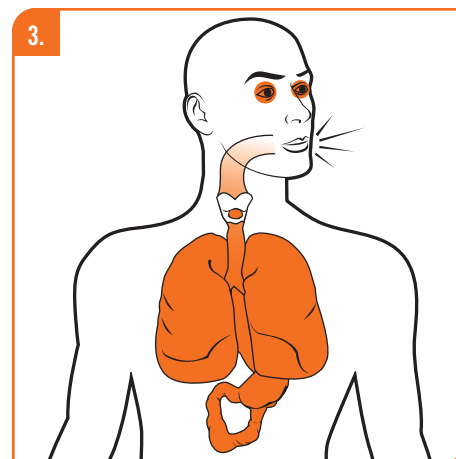
**FIGURE 4-3: CHOKING AGENTS**



Choking agent inhaled.



Chemical attacks respiratory system.



Symptoms include coughing, burning eyes or throat, nausea, fluid in lungs, and difficulty breathing.

- › In a liquid release or spill, phosgene changes to gas and stays close to the ground.
- › Phosgene may appear colorless, or as a white or pale yellow cloud.
- › In low concentrations, phosgene smells like newly mown hay.
- › In high doses, phosgene has a strong unpleasant odor.
- › Phosgene can cause flammable substances to burn but is not flammable itself.
- › Phosgene is not found naturally in the environment.
- › Phosgene may be relatively easy to obtain since it is used in industry.

### **Phosgene as a Weapon**

- › Phosgene was used extensively during World War I, by both German and Allied armies, causing many deaths.

- › Phosgene could be released into the air.
- › Phosgene liquid could be released into water to expose those who drink it or touch it.
- › Phosgene could be used in liquid form to poison food.

### **Phosgene Illness**

- › In gas or liquid form, phosgene can damage the skin, eyes, nose, throat, and lungs.
- › Proximity to a release and the length of exposure determine how serious the phosgene illness is.
- › Symptoms may occur immediately after exposure if doses are extremely high. These include:
  - Coughing
  - Burning sensation in the throat and eyes
  - Watery eyes

- Blurred vision
- Difficulty breathing or shortness of breath
- Nausea and vomiting
- With skin contact, possible development of lesions similar to those from frostbite or burns
- Within 2–6 hours after exposure to high doses of phosgene, possible development of fluid in the lungs (pulmonary edema)
- › Exposure to low or moderate concentrations of phosgene may have few early clinical findings. Development of worsening signs and symptoms may occur 12–24 hours after the initial exposure. Delayed symptoms may surface up to 48 hours after exposure. These include:
  - Difficulty breathing
  - Coughing up white- to pink-tinged fluid and developing fluid in the lungs (pulmonary edema)



- Low blood pressure
- Heart failure
- Severe respiratory distress

### ***Phosgene Diagnosis and Treatment***

- › There is no known antidote.
- › Quickly moving away from the source of exposure is most important.
- › Supplemental oxygen should be given as needed.
- › People should be monitored for up to 48 hours for delayed symptoms.
- › Most people exposed recover, but high doses can result in chronic bronchitis and emphysema.

### ***Lessening the Impact of Phosgene Exposure***

- › Move away from the site of exposure immediately and move to higher ground for fresh air.
- › Remove outer layer of clothing, place in a plastic bag, and seal as soon as possible.
- › Immediately wash body thoroughly with soap and water.
- › Flush irritated eyes with plain water for 10–15 minutes.
- › If you have ingested phosgene, do not induce vomiting or drink fluids.
- › Seek medical attention immediately.



## **A REAL-LIFE EXAMPLE OF HOW STATE, LOCAL, AND FEDERAL AGENCIES COLLABORATED ON AN ACCIDENTAL CHEMICAL RELEASE IN THE UNITED STATES: GRANITEVILLE, SOUTH CAROLINA**

Although this case study only provides a snapshot of a highly complex event, it does provide some insight for what the response to a chemical release may look like and how health officials at the local, state, and federal levels work together and with many other agencies to respond to such an event.

At approximately 2:40 a.m. on January 6, 2005, two freight trains collided in Graniteville, South Carolina, releasing an estimated 11,500 gallons of chlorine gas, which caused nine deaths and sent at least 529 persons seeking medical treatment for possible chlorine exposure. Because of the potential for death and injury, local emergency management officials initially issued a shelter-in-place order for a 1-mile radius around the site. At noon, South Carolina declared a state of emergency and local officials issued a mandatory evacuation for over 5,000 residents within this 1-mile radius. Area schools and businesses were closed.

Hazardous materials teams worked together to contain the chlorine exposure and remove it from the site—including personnel from the local fire departments, the U.S. Environmental Protection Agency (EPA), the U.S. Department of Energy's Savannah River Site Fire Department, and state response teams. Meanwhile, federal responders from the CDC, EPA, and the U.S. Coast Guard arrived to assist local and state officials in sampling air in factories, homes, and schools within the 1-mile radius. Additional free inspections were offered to residents and business owners with continued concerns.

Local law enforcement personnel enforced a curfew and the mandatory evacuation. Local, state, and federal agencies assisted in perimeter security, investigations, and coordination. The Federal Bureau of Investigation, National Transportation Safety Board, and the Federal Railroad Administration conducted investigations into the train derailment.

Starting January 13, residents were allowed to return to their homes gradually as air quality was deemed safe, depending on where their homes were located in relation to the release. Residents were also provided with HHS guidance about what to do when returning home (e.g., what to do with existing food and medicine, what to do about pets that were left in the evacuation area).

A rapid epidemiological assessment indicated that out of 511 persons examined in emergency rooms after the exposure, 69 were hospitalized in seven area hospitals. An ongoing assessment began to examine the public health impact associated with exposure to chlorine gas. Those exposed were interviewed about their symptoms, the location and duration of their exposures, and demographic information needed to monitor long-term health effects.

### Sources:

Centers for Disease Control and Prevention. (2005). Public health consequences from hazardous substances acutely released during rail transit—South Carolina, 2005; selected states, 1999–2004. *Morbidity and Mortality Weekly Report*, 54(3), 64–67. <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5403a2.htm>.

U.S. Environmental Protection Agency. (2005). Norfolk Southern Graniteville derailment. <http://www.epa.gov/Region4/graniteville/index.htm>.



# NERVE AGENTS

## OVERVIEW

Nerve agents do damage by affecting the nervous system of victims. These agents are of the greatest concern because of the low amounts needed to produce significant symptoms and even death. These agents include:

- › Sarin
- › Soman
- › Tabun
- › VX

## SARIN

### **Basic Facts**

- › Sarin is a manufactured compound that is colorless, odorless, and tasteless.
- › Sarin can take a gas or liquid form and is highly volatile and lethal.
- › Sarin is absorbed through the skin or respiratory tract and causes severe respiratory damage.
- › Even very small amounts can kill people.
- › Vaporized sarin stays near the ground.
- › Sarin remains deadly in warm, dry temperatures but can degrade in humidity.

### **Sarin as a Weapon**

- › Sarin can be released into the air and expose people through ingestion or contact with the skin or eyes.
- › Sarin can be released into water and expose people who touch or drink the contaminated water.
- › Sarin can be used to contaminate food.
- › Sarin is most dangerous in enclosed spaces.
- › Victims need only be exposed to a small amount to become ill.
- › Sarin was used by Aum Shinrikyo, a Japanese cult, in a 1995 Tokyo subway attack, which demonstrated to the world that it could be used as a terrorist weapon.

## **Sarin Illness**

Symptoms include:

- › Difficulty breathing, tightness in chest, and respiratory arrest
- › Nausea, drowsiness, vomiting, and diarrhea
- › Confusion and seizures
- › Drooling, runny nose, eye irritation, and tearing
- › Severe muscle weakness

## **Sarin Diagnosis and Treatment**

- › With large doses, death can occur within seconds to minutes after exposure.
- › Rapid recognition after a suspected attack is the key to successful treatment.
- › Atropine and pralidoxime are the preferred antidotes but must be used quickly to be effective.
- › Oxygen should be administered to those having difficulty breathing.

## **Lessening the Impact of Sarin Exposure**

- › Move away from the site of exposure immediately and move to higher ground for fresh air.
- › Remove outer layer of clothing, place in a plastic bag, and seal as soon as possible.
- › Immediately wash body thoroughly with soap and water.
- › Flush irritated eyes with plain water for 10–15 minutes.
- › If you have ingested sarin, do not induce vomiting or drink fluids.
- › Seek medical attention immediately.

## SOMAN

### **Basic Facts**

- › Soman is also known as GD.
- › Soman is a clear, colorless, tasteless liquid that can smell fruity or like oil of camphor.
- › Soman can be heated into a vapor form.
- › Soman is not found naturally in the environment.





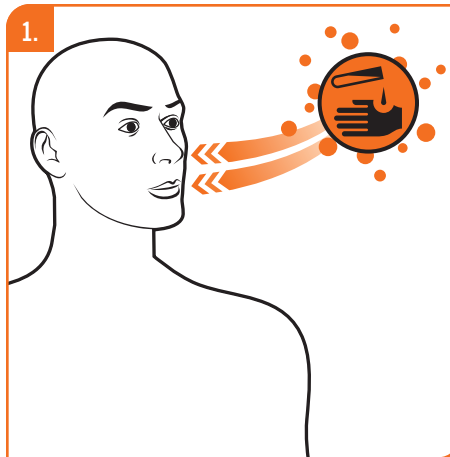
## Soman as a Weapon

- › Soman is a human-made chemical warfare agent.
- › Germany developed soman as an insecticide in 1944.
- › Soman is suspected of being used during the Iran-Iraq war in the 1980s.
- › Soman can be released into the air in vapor form.
- › Soman could be used in liquid form to poison water or food.

## Soman Illness

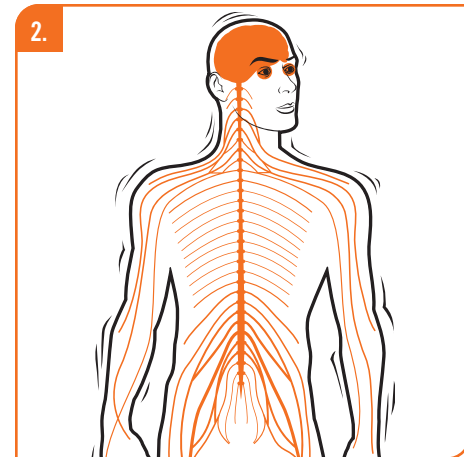
- › People can get sick after inhaling soman or by absorbing it through skin or eye contact.
- › People can get sick by drinking poisoned water or swimming in contaminated water.
- › Illness can follow eating food contaminated with soman.
- › Symptoms will appear within a few seconds after exposure to the vapor form of soman.
- › In liquid form, soman produces symptoms within a few minutes or up to 18 hours after exposure.
- › Even a tiny drop of the nerve agent on the skin can cause sweating and muscle twitching at the site of contact.
- › Low or moderate doses of soman cause the following symptoms:
  - Runny nose
  - Watery eyes
  - Small, pinpoint pupils
  - Eye pain
  - Blurred vision
  - Drooling and excessive sweating

FIGURE 4-4: NERVE AGENTS



Nerve agent inhaled.

- Cough
- Chest tightness
- Rapid breathing
- Diarrhea
- Increased urination
- Confusion
- Drowsiness
- Weakness
- Headache
- Nausea, vomiting, and/or abdominal pain
- Slow or fast heart rate
- Abnormally low or high blood pressure
- › Exposure to a large dose of soman, by any route, may result in these additional health effects:
  - Loss of consciousness
  - Convulsions
  - Paralysis



Chemical affects the nervous system creating seizures, eye irritation, and muscle weakness.

- Respiratory failure, possibly leading to death
- › Vapors can be trapped on a person's clothing and can expose others.

## Soman Diagnosis and Treatment

- › The odor of soman may be a signal of a release.
- › Treatment of soman poisoning with antidotes (atropine and pralidoxime) is recommended as soon as possible (ideally within minutes).
- › Long-term supportive health care may be necessary.
- › Mild or moderately poisoned people who are treated both rapidly and adequately usually recover completely.
- › Severely exposed people or those victims who are ineffectively treated may not survive.



### ***Lessening the Impact of Soman Exposure***

- › Move away from the site of exposure immediately and move to higher ground for fresh air.
- › Remove outer layer of clothing, place in a plastic bag, and seal as soon as possible.
- › Immediately wash body thoroughly with soap and water.
- › Flush irritated eyes with plain water for 10–15 minutes.
- › If you have ingested soman, do not induce vomiting or drink fluids.
- › Seek medical attention immediately.

### **TABUN**

#### ***Basic Facts***

- › Tabun is also known as GA.
- › Tabun is a clear, colorless, tasteless liquid with a faint fruity odor.
- › Tabun can become a vapor, if heated.
- › Tabun is not found naturally in the environment.
- › Tabun is toxic and affects the body rapidly.

#### ***Tabun as a Weapon***

- › Tabun is human-made for chemical warfare.
- › Tabun was originally developed by Germany in 1936 as a pesticide.
- › Tabun was possibly used in the 1980s during the Iran-Iraq war.
- › Tabun could be released through the air.
- › Tabun could be used to poison water.
- › Tabun could be used to contaminate food.

#### ***Tabun Illness***

- › People can become ill after breathing in tabun, ingesting it, or through contact with skin or eyes.
- › People can get sick by eating food contaminated with tabun, by drinking contaminated water, or by coming into contact with contaminated water.
- › After exposure to tabun in vapor form, symptoms should appear within a few seconds.

- › Exposure to tabun in liquid form produces symptoms within a few minutes or up to 18 hours later.
- › Tabun can remain active on a person's clothing, leading to exposure of others.
- › A tiny drop of this nerve agent on the skin can cause sweating and muscle twitching at the site of contact.
- › People exposed to a low or moderate dose of tabun may experience some or all of the following symptoms within seconds to hours after exposure:
  - Runny nose
  - Watery eyes
  - Small, pinpoint pupils
  - Eye pain
  - Blurred vision
  - Drooling and excessive sweating
  - Cough
  - Chest tightness
  - Rapid breathing
  - Diarrhea
  - Increased urination
  - Confusion
  - Drowsiness
  - Weakness
  - Headache
  - Nausea, vomiting, and/or abdominal pain
  - Slow or fast heart rate
  - Abnormally low or high blood pressure
- › Exposure to a large dose of tabun may result in:
  - Loss of consciousness
  - Convulsions
  - Paralysis
  - Respiratory failure, possibly leading to death



### ***Tabun Diagnosis and Treatment***

- › The fruity odor of tabun may provide warning of a release.
- › Atropine and pralidoxime are antidotes which can be given for poisoning. They should be administered ideally as soon as possible.
- › Other supportive care in a hospital setting should be given as needed (such as oxygen, assistance with breathing, etc.).
- › A complete recovery is likely for those with mild or moderate poisoning who are treated both rapidly and adequately.
- › Those who inhale or are contaminated with large amounts of tabun or those who are ineffectively treated can die.
- › Repeated exposure to tabun can result in long-term damage to the body.

### ***Lessening the Impact of Tabun Exposure***

- › Move away from the site of exposure immediately and move to higher ground for fresh air.
- › Remove outer layer of clothing, place in a plastic bag, and seal as soon as possible.
- › Immediately wash body thoroughly with soap and water.
- › Flush irritated eyes with plain water for 10–15 minutes.
- › If you have ingested tabun, do not induce vomiting or drink fluids.
- › Seek medical attention immediately.

## **VX**

### ***Basic Facts***

- › VX can be heated to create a vapor form, but only in small amounts.
- › The agent is stable in the environment.
- › In average weather, VX can last on objects for days.
- › In extremely cold weather, VX can sustain its potency for months.
- › VX can be a long-term hazard on surfaces.
- › VX is considered more toxic than other nerve agents.

### ***VX as a Weapon***

- › VX is a human-made chemical warfare agent.
- › The agent was originally developed in the United Kingdom in the early 1950s.
- › VX may have been used in the Iran-Iraq war in the 1980s.
- › VX is primarily used in liquid form to contaminate water or food.

### ***VX Illness***

- › People are exposed to VX by ingesting it, breathing in a VX mist, or by coming into contact with it through skin or eyes.
- › The vapor form of VX can produce symptoms within seconds after exposure.
- › In liquid form, VX produces symptoms within a few minutes or up to 18 hours after exposure.
- › Unless washed off immediately, VX liquid on the skin can be lethal.
- › Even a tiny drop of nerve agent on the skin can cause sweating and muscle twitching at the site of contact.
- › VX remains potent on a person's clothing, meaning that others can be exposed.
- › Within seconds or hours of moderate exposure to VX, symptoms include:
  - Runny nose
  - Watery eyes
  - Small, pinpoint pupils
  - Eye pain
  - Blurred vision
  - Drooling and excessive sweating
  - Cough
  - Chest tightness
  - Rapid breathing
  - Diarrhea
  - Increased urination
  - Confusion
  - Drowsiness



- Weakness
- Headache
- Nausea, vomiting, and/or abdominal pain
- Slow or fast heart rate
- Abnormally low or high blood pressure
- › Exposure to a large dose of VX may cause:
  - Loss of consciousness
  - Convulsions
  - Paralysis
  - Respiratory failure possibly leading to death

### **VX Diagnosis and Treatment**

- › A release may not be easy to detect because VX has no odor.
- › A release is confirmed by the symptoms of those exposed.
- › Atropine is the preferred antidote and must be given quickly after exposure.
- › People can recover completely from mild or moderate poisoning that is both rapidly and effectively treated.
- › Those exposed to large doses of VX or those people ineffectively treated may not survive.
- › Prolonged exposure (e.g., in a war setting) can result in long-term damage to the body.

### **Lessening the Impact of VX Exposure**

- › Move away from the site of exposure immediately and move to higher ground for fresh air.
- › Remove outer layer of clothing, place in a plastic bag, and seal as soon as possible.
- › Immediately wash body thoroughly with soap and water.
- › Flush irritated eyes with plain water for 10–15 minutes.
- › If you have ingested VX, do not induce vomiting or drink fluids.
- › Seek medical attention immediately.
- › Rescue personnel should wear the highest level of protection in a release area until testing can be completed and the safety of lower levels of protection is confirmed.

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