Course Learning Outcomes for Unit II

Upon completion of this unit, students should be able to:

4. Assess how terrorism, genetic engineering, biological warfare, and cyberterrorism may affect future prospects.
   - 4.1 Discuss the various forms of chemical explosives present in the world today and the efforts to prevent terrorists from using such devices against the U.S. infrastructure.
   - 4.2 Discuss the probability of terrorists crossing the U.S. borders and the strategies that may be employed to defeat them.

6. Evaluate the moral and ethical implications of using WMD.

8. Assess the capabilities of WMD to determine counteraction strategies.
   - 8.1 Discuss the capabilities of chemical and biological attacks against the U.S. infrastructure and the prevention strategies that may be employed against such attacks.

Reading Assignment

Chapter 2:
Chemical Agents

Unit Lesson

What are Chemical Weapons?

Chemical weapons (CW) use toxic properties of chemical substances to cause physical or psychological harm to an enemy. There are many different types of chemical weapons that we will discuss during the course. Some example including the following agents:

- Nerve agents: sarin, soman, tabun, cyclosarin, and V-series (VX, VR)
- Vesicating or blistering agents: mustard, lewisite, and phosgene-oxime (nettle agent)
- Choking agents: chlorine and phosgene.
- Blood agents: arsine (SA), hydrogen cyanide (AC), and cyanogen chloride (CK).
- Riot control agents: pepper gas, chlorobenzylidenemalononitrile (CS)
- Vomiting agents: adamsite (Centers for Disease Control and Prevention [CDC], n.d.-b)

What Makes an Effective Chemical Weapon?

Consider these effects concerning chemical weapons:

- cause psychological harm to the enemy;
- highly lethal;
- kill within minutes;
- can evaporate quickly or stick around a long time, depending on intent; and
- numerous kinds that are hard to protect against (Pichtel, 2011).

Ways to Disseminate Chemical Agents

Chemical agents can be delivered through numerous methods:

- bombs;
- rockets;
- artillery shells;
- sprayers;
- warheads; or
- dispersed as vapors, aerosols, solids, or liquids (Pichtel, 2011).

Toxicology and Exposure to Chemical Agents

- Routes of exposure
  - *Inhalation*: Chemicals in the form of vapors, gases, particulates, or mists enter the body through inhalation (breathing). Once chemicals are inhaled, chemicals can deposit in the respiratory tract, causing direct contact with tissue, diffusing into the bloodstream through the lung–blood interface.
  - *Skin or eye absorption*: Chemicals enter the body by crossing the skin or eye barrier and are absorbed into the bloodstream.
  - *Ingestion*: Chemicals enter the body through the mouth, are absorbed through the lining of the gastrointestinal tract, and are transported through the bloodstream to the internal organs.
  - *Injection*: Substances enter the body through penetration or puncture from an object contaminated with a chemical agent.
- Dose response relationship: Given the amount of chemicals entering the body, the route of exposure and the type of chemical will elicit a type and intensity of the response.
  - *Toxic dose low (TD_{LO})*: This is the lowest dose of substance introduced by absorption, ingestion, or injection over a period of time that produces toxic effects.
  - *Toxic concentration low (TC_{LO})*: This is the lowest concentration of a chemical substance introduced by inhalation to which humans/animals have been exposed to for a period of time that has produced toxic effects.
  - *Lethal dose low (LD_{LO})*: This is the lowest dose, other than LD_{50}, of a substance introduced by absorption, ingestion, or injection to cause death in humans or animals.
  - *Lethal dose fifty (LD_{50})*: This is a calculated dose of a substance introduced by absorption, ingestion, or injection that is expected to cause 50% of deaths in a population.
  - *Lethal concentration low (LC_{LO})*: This is the lowest concentration of a substance in the air introduced by inhalation, other than LC_{50}, to cause death in humans and animals.
  - *Lethal concentration fifty (LC_{50})*: This is the calculated concentration of a substance in the air introduced by inhalation that is expected to cause 50% of deaths in a population.
  - *Lethal concentration and time fifty (LCt50)*: This is the calculated concentration of a substance in the air introduced by inhalation for a specific length of time that is expected to cause 50% of deaths in a population (Pichtel, 2011; Interactive Learning Paradigms, n.d.).

It is easy to remember: doses = anything but inhalation, concentration = inhalation.

Brief history of chemical agents: As discussed in the previous unit, chemical agents have a long history of use throughout the ages. China's Song dynasty was notable for using arsenical smoke during battle. However, chemical weapons are most notable for being used during World War I. About 124,000 tons of chemical weapons were used during WWI, with over a million casualties and about 90,000 fatalities (Howard & Forest, 2008).

Other uses of chemical weapons have included Iraq's use of chemical weapons during the Iran-Iraq War in the 1980s. One of the saddest uses of chemical weapons was the slaughter of thousands of Kurds using these weapons in Halabja, Iraq.

Different types of chemical agents:

Choking agents: These cause respiratory damage and asphyxiation. Choking agents were responsible for 80% of deaths caused by chemical weapons during World War I. Choking agents are nonpersistent and disseminate quickly after an attack. They are delivered in the form of a gas or vapor cloud. Choking agents are heavier than air (Pichtel, 2011).

- chlorine
  - signs and symptoms
    - coughing

        - tightness of the chest
        - burning in the eyes, nose, and throat
        - watery eyes
        - blurry vision
        - nausea
        - vomiting
        - burning, redness, and blisters on skin
        - difficulty breathing
        - lungs filling up with fluid
    - most commonly manufactured chemical in United States for items like bleach, drinking water, and swimming pools
    - first used during World War I
    - heavier than air, found in low-lying areas (CDC, n.d.-d)
- phosgene
    - signs and symptoms
        - coughing
        - burning in throat and eyes
        - watery eyes
        - blurry vision
        - shortness of breath
        - nausea
        - vomiting
        - lungs filling up with fluid
        - skin lesions similar to frostbite
        - may have delayed effects not apparent for up to 48 hours after exposure
    - used during World War I as a choking pulmonary agent
    - not naturally found in environment
    - used to produce pesticides
    - heavier than air, found in low-lying areas (CDC, n.d.-f)

Blood agents: These prevent the transfer of oxygen to the cells, causing the body to asphyxiate. Blood agents are delivered in the form of a gas or vapor. They are not persistent and do not stick around very long after an attack. To remember the three main types of blood agents, spell SACK: "SA-AC-CK." This represents arsine (SA), hydrogen cyanide (AC), and cyanogen chloride (CK).

- arsine (SA) and stibine
    - signs and symptoms
        - confusion
        - drowsiness
        - fatigue
        - headache
        - muscle cramps
        - nausea, vomiting, and abdominal pain
        - rapid breathing
        - red urine
        - shortness of breath
        - yellow skin and eyes
        - severe symptoms—convulsions, loss of consciousness, paralysis, and death
    - arsine—colorless, flammable, and has mild garlic odor; vapor is heavier than air
    - stibine—has rotten-egg odor; never used on the battlefield (CDC, n.d.-a; CDC, n.d.-c)
- cyanide
    - mild symptoms
        - dizziness
        - headache
        - nausea
        - vomiting
        - rapid breathing and heart rate
        - restlessness
        - weakness

- severe symptoms
  - convulsions
  - coma
  - loss of consciousness
  - low blood pressure
  - lung problems and respiratory failure
  - slow heart rate
  - death
- rapidly acting
- exists in various forms
  - hydrogen cyanide (AC) and cyanogen chloride (CK): colorless gas
  - sodium cyanide (NACN) and potassium cyanide (KCN): crystal form
- described as a bitter almond smell, but does not always have an odor, some cannot detect the odor
- reports indicate use during the Iran–Iraq War
- specific antidotes for cyanide poisoning (CDC, n.d.-e)

Other blood agents include carbon monoxide and sodium monofluoroacetate. Information about these agents can be found through the CDC.

Nerve agents: Nerve agents require smaller quantities than blood, choking, or blister agents. Nerve agents attack the nervous system when inhaled, ingested, or absorbed, resulting in loss of muscle control, respiratory failure, and eventually death. Nerve agents are classified as G-series or V-series agents. Nerve agents can come in liquid, solid, powder, vapor, and gas form. Nerve agents are very persistent and last much longer than other types of agents (Pichtel, 2011). Some signs and symptoms of nerve agents are listed below:

- runny nose;
- watery eyes;
- pinpointing of the pupils;
- blurry vision and eye pain;
- drooling;
- excessive sweating;
- cough;
- tightness of the chest;
- rapid breathing;
- headache;
- nausea;
- confusion;
- slow or fast heart rate and high or low blood pressure; and
- severe symptoms—vomiting, diarrhea, convulsions, defecation, urination, coma, or death (Pichtel, 2011).

There are some treatments for nerve agents:

- *ATNAA (antidote treatment nerve agent autoinjector)*: This is a combination of atropine and pralidoxime chloride in a single-delivery system through a shot.
- *Mark 1 NAAK (nerve agent antidote kit)*: This is two separate injections of two anti-nerve agent drugs, atropine sulfate and pralidoxime chloride. Both kits can be used in conjunction with the convulsive antidote nerve agent kit (CANA). CANA is diazepam or valium to help stop convulsions caused by the administration of the injections.
- *Pyridostigmine bromide tablets (P-Tabs)*: These are only effective against Soman. P-tabs are a preventative measure to protect against nerve agent exposure dependent on threat conditions. One must start taking P-tabs at least eight hours prior to exposure (Pichtel, 2011).

Some nerve agent classifications and details are provided below:

G-series agents:

- sarin (GB)
  - human-made chemical
  - developed by Germany in 1938 as a pesticide
  - clear, colorless, tasteless, and no odor in pure form
  - used in terrorist attacks in Japan in 1994 and 1995
  - exposure through inhalation, ingestion, or absorption (Pichtel, 2011)
- soman (GD)
  - human-made
  - developed as an insecticide by Germany in 1944
  - clear, colorless, tasteless liquid
  - smells like camphor or rotten fruit
  - can become a vapor if heated up
  - possibly used during the Iran-Iraq War (Pichtel, 2011)
- tabun (GA)
  - human-made chemical
  - developed as a pesticide in Germany in 1936
  - color-less to brown liquid, can become a vapor when heated up
  - tasteless
  - faint fruit odor
  - possibly used during the Iran-Iraq War (Pichtel, 2011)
- cyclo-sarin (GF)
  - similar to sarin
  - Iraq reportedly developed field munitions with mixture of sarin and cyclosarin
  - cost more to create than sarin
  - difficult to disperse in air due to low volatility (Pichtel, 2011)

V-series agents:

- VX
  - human made
  - developed in the United Kingdom in the early 1950s
  - odorless and tasteless
  - amber in color
  - liquid that is very persistent and slow to evaporate; evaporates at the rate of motor oil.
  - used in Iran-Iraq War
  - United States agreed to destroy all stockpiles of VX during United Nations International Chemical Weapons Convention Treaty (Pichtel, 2011)
- VR (R-33)
  - human made, developed by Russians
  - nicknamed “the Russian version of VX” or “Russian VX”
  - closely related to VX with same symptoms and properties
  - USSR supposedly produced 15,557 tons
  - treatment window for VR exposure significantly shorter than for VX
  - symptom onset much quicker than for VX (Pichtel, 2011)

Vesicants/blister agents: These are delivered in a liquid or vapor form. Blister agents burn skin, eyes, lungs, and stick to damp, moist areas of the body (Pichtel, 2011).

- Lewisite
  - signs and symptoms
    - pain and irritation of skin, eyes, and respiratory tract within seconds to minutes
    - redness appearing within 15 to 20 minutes
    - blisters forming within several hours
  - oily, colorless liquid, appearing amber to black in color
  - odor smells like geraniums
  - produced in 1918 for use in World War I but was not used
  - heavier than air in vapor form
  - very persistent in liquid form (Pichtel, 2011; U.S. National Response Team [NRT], n.d.)

- nitrogen mustard
  - signs and symptoms
    - pain and irritation of the skin, eyes, respiratory tract developing within several hours
    - blisters forming within 6 to 12 hours
    - may also cause seizures and tremors
  - oily, clear, pale amber, or yellow color in liquid or solid form
  - odor smells fishy, musty, soapy, or fruity
  - produced in 1920s and 1930s
  - heavier than air in vapor form
  - very persistent in liquid form (Pichtel, 2011; NRT, n.d.)
- phosgene oxime
  - signs and symptoms
    - burning occurs within a few seconds
    - whitening of skin surrounded by red rings within 30 seconds
    - hives within 15 minutes
    - after 24 hours, white areas brown and die
    - shortness of breath and coughing if inhaled
    - produces intense itching and rash
  - corrosive agent
  - produced in 1929 but never used in war
  - colorless in solid form and yellow-brown in liquid form (Pichtel, 2011; NRT, n.d.)
- sulfur mustard
  - signs and symptoms
    - not usually fatal if medical care is received
    - symptoms do not immediately occur, may take up to 24 hours
    - redness and itching between 2 and 48 hours
    - eye swelling between 3 and 12 hours
    - runny nose, sneezing, sinus pain, and cough between 12 to 24 hours and between two to four hours with severe exposure
  - smells like garlic or onions but sometimes has no odor
  - can be vapor (gas form of the liquid substance), liquid, or solid
  - introduced in WWI as a chemical agent
  - historically used as treatment for psoriasis
  - yellow or brown in liquid and solid form (Pichtel, 2011; NRT, n.d.)

Riot control agents:

- referred to as *tear gas*
- irritant to eyes, mouth and throat
- used by law enforcement agencies
- liquids and solids released in the air as particles and droplets
- signs and symptoms
  - excessive tearing, burning, and redness
  - runny nose
  - drooling
  - coughing and choking sensation
  - severe symptoms: may cause vomiting, blindness, and death from chemical burns to lungs (Pichtel, 2011)

Vomiting agents (adamsite):

- crystal or solid form
- disseminated as aerosols
- insoluble in water
- may smell like garlic or almonds
- developed between 1915 and 1919 for the purpose of riot-control
- emesis-inducing (vomiting) agent to promote removal of personal protective gear (Pichtel, 2011)

Proliferation of Chemical Agents

The following countries are suspected to have offensive chemical weapons or agents, biological research programs, or capabilities:

- declared CW stockpiles (slated for destruction, not riot control)
  - Albania (16 metric tons)
  - Libya (26 metric tons of chemical agents)
  - Russia (30,400 metric tons of chemical agents)
  - United States (27,771 metric tons of chemical agents) (Arms Control Association, 2014)
- countries that destroyed stockpiles (not riot control)
  - Japan (started destruction in 2010) (Nuclear Threat Initiative, n.d.)
  - India (completed in March 2009) (Arms Control Association, 2014)
  - South Korea (unknown quantity, all destroyed in 2008) (Arms Control Association, 2014)
- suspected chemical weapon programs
  - Syria (Arms Control Association, 2014)
  - Angola (Pohturaju, n.d.)
  - China (Arms Control Association, 2014)
  - Egypt (Arms Control Association, 2014)
  - Iraq (Arms Control Association, 2014)
  - Iran (Arms Control Association, 2014)
  - North Korea (Arms Control Association, 2014)
- Geneva Convention and Chemical Weapons Convention (CWC)
  - signatories agreed to destroy all chemical weapons and facilities
  - Countries that have not joined CWC: Angola, Egypt, North Korea, Somalia, and Syria
  - Israel, China, and Iran signed CWC, but suspected of having secret CW programs; Israel never ratified CWC, alleging enemies refused to ratify (Arms Control Association, 2014)

References

Arms Control Association. (2014). Chemical and biological weapons status at a glance. Retrieved from https://www.armscontrol.org/factsheets/cbwprolif

Centers for Disease Control and Prevention. (n.d.-a). Arsine (and stibine). Retrieved from http://www.bt.cdc.gov/agent/arsine/

Centers for Disease Control and Prevention. (n.d.-b). Bioterrorism agents/diseases. Retrieved from http://emergency.cdc.gov/agent/agentlist.asp

Centers for Disease Control and Prevention. (n.d.-c). Blood agents. Retrieved from http://www.bt.cdc.gov/agent/blood/

Centers for Disease Control and Prevention. (n.d.-d). Chlorine. Retrieved from http://www.bt.cdc.gov/agent/chlorine/

Centers for Disease Control and Prevention. (n.d.-e). Cyanide. Retrieved from http://www.bt.cdc.gov/agent/cyanide/

Centers for Disease Control and Prevention. (n.d.-f). Phosgene. Retrieved from http://www.bt.cdc.gov/agent/phosgene/

Howard, R. D., & Forest, J. (2008). *Weapons of mass destruction and terrorism.* New York, NY: McGraw-Hill.

Interactive Learning Paradigms. (n.d.). LC_{LO}, lowest lethal concentration. Retrieved from http://www.ilpi.com/msds/ref/lclo.html

Nuclear Threat Initiative. (n.d.). China. Retrieved from http://www.nti.org/country-profiles/china/chemical/

Pichtel, J. (2011). *Terrorism and WMDs: Awareness and response*. Boca Raton, FL: CRC Press.

Pohturaju, B. (n.d.). Chemical weapons profile of Angola. *CBW Magazine*. Retrieved from http://www.idsa.in/cbwmagazine/ChemicalWeaponsProfileofAngola_BabjeePothuraju

U.S. National Response Team. (n.d.). Chemicals: Chemical quick reference guide. Retrieved from http://www.nrt.org/production/NRT/NRTWeb.nsf/PagesByLevelCat/Level3ChemicalHazards?Opendocument

Suggested Reading

The following CDC websites further explain the chemical agents as discussed in the lesson. You are encouraged to view this information.

Centers for Disease Control and Prevention. (n.d.). Arsine (and stibine). Retrieved from http://emergency.cdc.gov/agent/arsine/

Centers for Disease Control and Prevention. (n.d.). Bioterrorism agents/diseases. Retrieved from http://emergency.cdc.gov/agent/agentlist.asp

Centers for Disease Control and Prevention. (n.d.). Blister agents/vesicants. Retrieved from http://emergency.cdc.gov/agent/vesicants/

Centers for Disease Control and Prevention. (n.d.). Blood agents. Retrieved from http://emergency.cdc.gov/agent/blood/

Centers for Disease Control and Prevention. (n.d.). Chlorine. Retrieved from http://emergency.cdc.gov/agent/chlorine/

Centers for Disease Control and Prevention. (n.d.). Cyanide. Retrieved from http://emergency.cdc.gov/agent/cyanide/

Centers for Disease Control and Prevention. (n.d.). Lewisite. Retrieved from http://emergency.cdc.gov/agent/lewisite/

Centers for Disease Control and Prevention. (n.d.). Nitrogen mustard. Retrieved from http://emergency.cdc.gov/agent/nitrogenmustard/

Centers for Disease Control and Prevention. (n.d.). Phosgene. Retrieved from http://emergency.cdc.gov/agent/phosgene/

Centers for Disease Control and Prevention. (n.d.). Phosgene oxime. Retrieved from http://emergency.cdc.gov/agent/phosgene-oxime/

Centers for Disease Control and Prevention. (n.d.). Riot control agents. Retrieved from http://emergency.cdc.gov/agent/riotcontrol/

Centers for Disease Control and Prevention. (n.d.). Sarin (GB). Retrieved from http://emergency.cdc.gov/agent/sarin/

Centers for Disease Control and Prevention. (n.d.). Sulfur mustard (mustard gas). Retrieved from http://emergency.cdc.gov/agent/sulfurmustard/

Centers for Disease Control and Prevention. (n.d.). Tabun (GA). Retrieved from http://emergency.cdc.gov/agent/tabun/

Centers for Disease Control and Prevention. (n.d.). VX. Retrieved from http://emergency.cdc.gov/agent/vx/

Medscape. (n.d.). CBRNE-vomiting agents-Dm, Da, Dc. Retrieved from http://emedicine.medscape.com/article/833391-overview

Occupational Safety and Health Administration. (n.d.). Toxic industrial chemicals (TICs) guide. Retrieved from https://www.osha.gov/SLTC/emergencypreparedness/guides/chemical.html

Learning Activities (Non-Graded)

You may complete one, two, or all of these activities.

1. Determine the classification of the chemical known as napalm and the use of that chemical during the Vietnam War. Why has that chemical not been employed in recent wars?

2. Research and compare the sarin gas attacks against the Tokyo mass transit systems in 1995 with the sarin gas attacks unleashed in Syria in 2013 in the following article:

   Johnston, W. R. (n.d.). Summary of historical attacks using chemical or biological weapons. Retrieved from http://www.johnstonsarchive.net/terrorism/chembioattacks.html

3. View this video about the Kurdish massacre in Halabja. *(*This video is graphic; please only watch at your discretion.)

   OoKurdawaroO. (2009, September 11). *Bloody Friday of Halabja on March16th, 1988* [Video file]. Retrieved from https://www.youtube.com/watch?v=Ux2ez7TPxVw

4. View this University of Nottingham video on chemical weapons.

   Haran, B. [Periodic Videos]. (2013, September 2). *Chemical weapons (Sarin gas) – Periodic table of videos* [Video file]. University of Nottingham. Retrieved from https://www.youtube.com/watch?v=jozozH09XSs&feature=youtu.be

Non-graded Learning Activities are provided to aid students in their course of study. You do not have to submit them. If you have questions, contact your instructor for further guidance and information.