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Public Health Journeyman

Volume 1. Deployed Disaster Relief/Medical Entomology

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THIS IS THE FIRST volume of CDC B4E051, *Public Health Journeyman.* It will cover deployed disaster relief and medical entomology. Unit 1 will introduce you to several lessons learned from past military engagements and the historical military impact. You will also learn about gathering information to help keep personnel safe while deployed. This unit will explain your role during contingency operations as well as provide information about nuclear, biological, chemeical agents and high yield explosives. Unit 2 will go into field sanitation, to include the many threats personnel can face during field conditions. Your responsibilities during contingency operations will be discussed along with maintaining safe food and water during contingency operations. The proper handling of human, garbage and medical waste are discussed in this unit as well. Medical entomology will be discussed in unit 3. The basic functions and responsibilities along with taxonomy and the Air Force pest management program are discussed as well. Mosquito biology, surveillance and control measures along with other arthropods and rodents will be the last topics discussed in this unit.

Volume 2 will discusss the Force Health Management program, Hazards and control measures, Public Health responsibilities in the Air Force Occupational and Environmental Safety, Fire Protection and Health program and the Hearing Conservation Program.

A glossary is included for your use.

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NOTE:

In this volume, the subject matter is divided into self-contained units. A unit menu begins each unit, identifying the lesson headings and numbers. After reading the unit menu page and unit introduction, study the section, answer the self-test questions, and compare your answers with those given at the end of the unit. Then complete the unit review exercises.

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Unit 1. Deployed Disaster Relief

THIS VOLUME EXPLAINS your very important role in deployed disaster relief operations. The first unit of this volume discusses contingency operations and the roles public health can fill within these operations. It will cover historical lessons learned and explain how planning helps prevent past problems from recurring. The planning process is described by explaining the overall duties of the public health team and the medical intelligence officer. The duties are not all inclusive; however, they will assist you in developing ways of preventing diseases in many readiness situations.

1–1. Contingency Operations History

Throughout past wars, there have been more personnel unable to perform their duties because of illnesses other than from combat injuries. This was due to overcrowding, poor camp hygiene, inadequate medical support, and the physical stresses of combat. Many people, when they think of war, picture many wounded casualties from the fighting. The thought of massive numbers of troops unable to fight because of disease probably does not cross many minds. Most sickness in prior wars could have been avoided if people had been educated on the principles of disease prevention. As the scope and mission of the Air Force changes, we’re finding ourselves involved in more peacekeeping functions and operations other than war. These operations are now referred to as operations other than war (OOTW).

This is where we fit in the picture. We need to educate people on how to prevent illness from draining our fighting strength. Of course, before you can educate others, you must educate yourself. First, you need to know how we developed some of our principles and see the importance of emphasizing compliance with these preventive medicine principles.

101. Public Health lessons

We have learned to improve medical readiness from many historical events. We’ll study just a few. As you read, try to think of how each situation could have been prevented.

Guadalcanal

In 1942, American forces took almost five months to gain control of Guadalcanal. During this time, there were almost 60,000 cases of malaria reported. Due to this disease, an entire division’s worth of forces was incapacitated and unable to fight. This disease outbreak jeopardized the mission and might have been prevented by protecting people from mosquitoes.

Japan

Another famous example was when Merrill's Marauders were fighting the Japanese in 1944. The Marauders started their mission with 2,750 men. By the eighth day of the campaign they had lost 45 men to combat injuries and 136 men to disease—primarily malaria and dysentery. This trend continued for 58 days. By the end of these 58 days, a total of 262 were disabled due to combat-related injuries and 438 were disabled or killed from disease. This unit was effective against the enemy until about 90 days into the campaign. By then, the rate of disease had grown to affect 100 people per day. There were 424 combat-related injuries, while disease-related casualties reached 1,898 people. The unit had to be disbanded due to the high rate of disease.

North African desert

In the North African desert where the Allies were fighting German General Rommel, there was a classic example of not learning from others' mistakes. At one location the Germans had a sanitation problem with exposed feces and garbage which led to a large increase in the fly population. The German unit moved out for rest and supplies. British and American troops moved into the abandoned site. The large fly population, along with poor sanitation, resulted in at least 1,000 British and American soldiers ending up sick with dysentery. The British and American troops had not adequately addressed the fly problem resulting in the unit's withdrawal due to the high rate of illness. Another unit eventually replaced them but they too had to withdraw due to illness.

Sicily

Shortly after the desert incident, our forces were to land on the shores of Sicily. When the 7th Army was being assembled for the invasion, the leadership had to leave about 4,000 people behind due to malaria. About 700 more troops contracted malaria aboard the ships while being transported to Sicily. This disease outbreak kept a total of 5,000 warfighters from the fight. After the 7th Army arrived in Sicily and began marching through villages, they encountered another significant disease vector—sand flies. Approximately 8,500 cases of sand fly fever were subsequently treated.

Vietnam

During the Vietnam conflict, approximately 10,000 troops per year were treated by our medical units for malaria and dengue fever. Almost all of the personnel affected with malaria, dengue fever, and sand fly fever could have been protected and these cases probably prevented.

Now, you probably can see the importance of educating personnel to prevent a repeat of these avoidable and often tragic events. Prevention of communicable diseases is not the only area where we have learned to prevent casualties.

102. Operations other than war

The Cold War created an artificial world stability that disappeared with the breakup of the Soviet Union. The loss of this world power resulted in a dramatic increase in ethnic and political tensions throughout the world, which was often manifested by open hostility, bloodshed, famines, and refugee situations. To cope with these situations, many peace operations were launched, some under the auspices of the United Nations and others as unilateral actions.

OOTW are military actions conducted which are not associated with sustained, large-scale combat operations. OOTWs typically involve the following:

- Peace building—posts conflict rebuilding of governments.
- Peace enforcement—compels compliance with resolutions.
- Peacekeeping—monitors and facilitates implementation of agreements.
- Humanitarian relief operations—sustained during peacetime, disaster relief and mercy missions.. Additionally, our forces may be called upon to respond to natural or man-made disasters anywhere in the world. These operations require us to change our way of doing

> business. Instead of solely providing preventive medicine support to our forces, we may be called upon to support the health and well-being of indigenous populations. This will require us to understand the physical, medical, and preventive medicine needs of displaced refugee populations. Items of concern include nutritional needs, medical priorities, shelter, food, water, sanitation, disease prevention, and restoration of the public health infrastructure.

We may work closely with nongovernmental organizations (NGO) or private volunteer organizations (PVO); which are private, nonprofit humanitarian assistance organizations involved in development and relief activities. They operate in most of the trouble spots around the world and should be looked to as a resource with vital experience. They also can provide valuable information on local customs, infrastructure, government, and situation assessments and can provide technical expertise such as disaster relief, development, feeding programs, agriculture, public health, water, nutrition, and sanitation. We must work with them as full partners for successful carry on the mission. Recent operations have included Iraq, Bosnia, Haiti, Guantanamo Bay Cuba, Rwanda, and Somalia.

103. Deployment planning guidance

The medical service is responsible for planning and providing medical support necessary to sustain maximum combat capability and effectiveness under all conditions. All other medical service missions are secondary.

The problems inherent in carrying out the medical mission are greatly increased by the complexities and destructiveness of modern warfare, natural disasters, and peacetime accidents. Consequently, plans are made in anticipation of war and disasters.

Air Force Instruction (AFI) 10–401, *Air Force Operations Planning and Execution*, provides guidance on Air Force unique planning aspects for all types of operations. This plan gives us a better understanding of how public health fits into the “big picture” of deployment planning. Air Force planning is completed in two ways—deliberate planning and crisis action planning. *Deliberate planning* is conducted principally in peacetime and is accomplished in prescribed cycles that complement other Department of Defense (DOD) planning cycles. One can only imagine the confusion that would be created if each military service were planning and executing procedures on its own. There will be times when advanced planning is impossible, and this is when *crisis action planning* takes place.

Guidance and procedures for each type of planning can be found in AFI 10–401. Deployment planning guidance is also received from the Joint Operation Planning and Execution System (JOPES), Time-Phased Force and Deployment Data (TPFDD), the USAF War and Mobilization Plan (WMP), unit type codes (UTC), and allowance standards (AS).

Joint Operation Planning and Execution System

JOPES is the DOD-directed, Joint Chiefs of Staff (JCS)—specified conventional command and control system for joint operation planning and execution. JOPES establishes the policy, procedures, and system to be used in both deliberate and crisis action planning of joint operations.

Time-Phased Force and Deployment Data

The TPFDD file is a collection of information required during planning. This includes information on the combat and support units along with equipment and supply support information. The combatant commander’s staff and the staff’s service components develop a detailed transportation-feasible flow of resources into the theater to support the concept. The process consists of several discrete phases that may be conducted sequentially or concurrently.

USAF War and Mobilization Plan

The WMP is a classified document that provides the Air Staff and Air Force commanders with current policies, planning factors, and forces for conducting and supporting wartime operations. It establishes requirements for developing mobilization and planning programs for industrial production to support sustained contingency operations of the programmed forces. It encompasses all basic functions necessary to match facilities, personnel, and materiel resources with planned wartime activity.

Unit type codes

A UTC is a five-character, alphanumeric code controlled by the JCS that uniquely identifies each type unit of the Armed Forces. The assignment of a UTC categorizes each type of organization into a class or kind of unit having common distinguishing characteristics. All Air Force UTCs approved for planning are found in the WMP. Each listed UTC contains the UTC's mission capability statement as well as deployment characteristics of the UTC in terms of personnel and cargo tonnage requiring transportation. For example, FFPM2 is one of the codes that helps make up a Preventive and Aerospace Medicine (PAM) Team.

Allowance standards

Allowance standards (AS) list the logistical requirements necessary to support each UTC in carrying out its mission. For example, AS 916E lists all equipment necessary for the FFPM4 (PAM) team to be able to do their job.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

101. Public Health lessons

1. What disease caused 60,000 casualties in 1942 during the war campaign in Guadalcanal?

2. What two major diseases led to disbanding Merrill's Marauders?

3. What problem incapacitated the Allied and American units when they moved into an abandoned German war camp in the North African desert?

4. What were the causes for losing over 13,000 people during the invasion of Sicily before and after the attack?

102. Operations other than war

1. What are OOTWs?

2. What are some of the conditions that lead to OOTWs?

103. Deployment planning guidance

1. What system is DOD-directed?

2. When resources are planned to be sent to the theater of operations in a transportation-feasible flow, what is the collection of information called?

3. What is the WMP?

1–2. Medical Intelligence

Why do we have historians? Why do we bother to keep track of what has happened throughout history? We try to learn from our mistakes; however, this means our mistakes must be recorded. This is where the area of intelligence fits in. We will concentrate on the area of medical intelligence even though the other areas of intelligence will also help the medical mission.

104. Gathering medical intelligence

Medical intelligence (MI) is that category of intelligence concerned with factors affecting a person's capability and well-being in a foreign environment.

Defining medical intelligence

MI is information about diseases, climatic conditions, and other health-related environmental factors. It also includes information about medical capabilities and research and development (R&D) activities of other countries. If our Armed Forces are called upon to fight in other parts of the world, prior knowledge of endemic diseases, health threats, and their countermeasures can mean the difference between winning and losing the battle. Furthermore, knowledge of the abilities and interests of both our friends and foes can influence how effective our forces are in combat. Finally, MI may help our own R&D activities if we know what our adversaries and allies are working on. For example, if we know another country has developed a new chemical warfare agent, we may want to begin development of an antidote. Also, if a good product is marketed by another country, we can save tremendous R&D costs by acquiring the already developed product. If MI is to be effective as a preventive measure, this information must be used prior to a unit's deployment.

The overall goal of MI is to prevent degradation of the mission due to endemic diseases; environmental factors; and hazardous insects, plants, and animals. Since MI involves so many different areas, it is not surprising that we get MI from many different sources.

Sources of medical intelligence

Most MI is obtained directly from people. Smaller amounts are obtained from scientific journals and other literature or from analysis of foreign medical material. These sources include unclassified intelligence reports, geography books, encyclopedias, and other commonly available reference materials, as well as, classified intelligence products.

The National Center for Medical Intelligence (NCMI) is operated by the Defense Intelligence Agency (DIA) and collects medical information from other countries. All AF members should recognize their potential to gather MI when overseas and pass on any pertinent items to their local intelligence office. Additionally, trained observers are sent to areas of special interest to gather MI for future use. Finally, some MI is gathered by persons living and working in these foreign countries. Articles published in foreign scientific journals may give clues to other countries' research interests. By analyzing captured medical material (e.g., chemical warfare antidote kits) we can determine an adversary's medical capabilities and plans. The medical intelligence officer is responsible for compiling MI for the specific mission at each base.

Gathering medical intelligence

When gathering MI information, the key is to have a focused approach with the objective clearly in mind.

First, start simple by using the resources that are readily available in your office, unit, or base library. Examples of good sources are other people, newspapers, magazines, encyclopedias, atlases, maps, travel agencies, and professional entomologists. As you begin gathering this preliminary data, you'll see your objective starting to take shape.

Second, talk to the professionals that are working within the Air Force and DOD who are trained to specialize in key aspects of MI. Some good sources are the Armed Forces Pest Management Board (AFPMB), NCMI and Travax. In addition, these organizations publish several documents that have proven to be very helpful when gathering MI:

- AFPMB—The Disease Vector Ecology Profile (DVEP).
- AFPMB—Technical information bulletins/manuals.
- NCMI—Infectious Disease Alerts.
- NCMI—Infectious Disease Risk Assessments.
- NCMI—Environmental Health Risk Assessments.
- NCMI—Force Health Protection Recommendations.
- MEDIC CD—available from NCMI to use when away from Internet connection

Third, use civilian sources such as the Centers for Disease Control (CDC), Morbidity, Mortality Weekly Report (MMWR), and the World Health Organization.

After Action Report

An After Action Report (AAR) is a tool used by the military and businesses to better answer questions after an event has taken place. Every deploying member is required to fill out an AAR after each deployment and provide a synopsis of what occurred on the deployment. Topics to be included are what situations helped them complete their mission, what situations made mission completion more difficult, and what resources were available while deployed. Every AAR is reviewed and a large-scale picture of the deployment is compiled. From this picture, changes can be made to better use resources and tactics to more effectively complete our mission.

We as Public Health can review AARs to refine our MI briefings. If we see many people describing certain conditions like high temperatures, large amounts of biting insects, high rates of gastrointestinal illness (GI) issues from a specific dining location or repeated mention of a local threat, we can educate members to prevent them from being affected by those issues. AARs are yet another tool to prevent diseases and injuries.

Health Threat Briefing

Once all the work has been done gathering the medical intelligence, Public Health must educate members on their deployments. This is usually conducted at the home station before deploying, and in theatre. At a minimum, the below topics should be included.

- Country profile—educate members on the location, size and geography.
- Environmental factors—brief on the climate, altitude, topography, air pollution and water pollution they may encounter in theatre.

- Endemic diseases—educate on diseases endemic to that location. If the population has a high rate of human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS), the member should be aware of that fact. When you educate the member, make sure you discuss the ways those diseases are spread, how dangerous they are, and how to prevent those diseases.
- Vectorborne diseases—educate the member on any vectorborne diseases and how to protect/prevent their spread.
- Hazardous plants and zoonotic diseases—discuss hazardous animal and plant life. Topics to discuss are snakes, large reptiles, large mammals, and so forth. Also include predominant plant life that may pose a contact hazard or damage to equipment.
- Occupational health—remind members that just because they are deploying, occupational hazards don't stay at home. This is one of the biggest concerns in the deployed environment.

This list is by no means comprehensive. Each deployed location should have its own briefing. Avoid the temptation to create a mass briefing that attempts to educate everyone on his or her own deployments. Take the time to make sure deploying members are fully educated and prepared for the hazards they may face while trying to complete their mission. Establishing rapport with deploying members will pay dividends down the road as you build a network of individuals that can help you improve your health threat briefings as they return home.

105. Medical intelligence officer

The medical treatment facility (MTF) commander appoints a medical intelligence officer (MIO). AFI 41–106, *Medical Readiness Program Management*, states a public health officer should fill this position; however, in his or her absence, a 4E0X1 noncommissioned officer (NCO) with appropriate experience may be appointed. The MIO will use many sources of information to assess the threat a unit faces and the capabilities they will require. The MIO has many responsibilities. These are described in the following table:

MIO Responsibilities	
When	**Responsibility**
Before deployments	• Works with line intelligence to prepare the medical threat assessment and to ensure that medical risks are included in the final threat brief. • Briefs the medical unit commander and deploying medical and line personnel on medical risks and unit individual countermeasures. • Verifies predeployment medical screening and immunization requirements for deploying personnel are identified and completed.
Upon arrival at location	It is important for the MIO to assist the unit commander in selecting the site for facility setup. It is always easier to prevent problems than correct them after they occur.
During deployment	• Incidences of disease, illnesses, injuries, or any other degradation of human performance must be recorded and analyzed. • The MIO verifies and documents corrective actions taken, and informs the MTF commander of any new medical threats throughout the deployment. This way the medical threat to personnel can be communicated and corrective measures can be taken.

MIO Responsibilities	
When	**Responsibility**
Following deployment	• Compile AARs during the following situations: WRM supplies are used, personnel UTCs are deployed, involvement in higher headquarters or JCS exercises, national emergency, natural disaster, and armed conflict. • Detail the MI issues encountered, addressing areas such as terminal chemoprophylaxis, tuberculosis skin testing required and follow-up actions. This way, a summary of the conditions encountered is documented and may be used in the future to prevent any recurrence. • These AARs are due to the major command (MAJCOM) 30 days after return, and the MAJCOM will provide the response format.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

104. Gathering medical intelligence

1. Define medical intelligence.

2. What are the methods of collecting medical intelligence?

105. Medical intelligence officer

1. In the absence of an officer in the public health office, who may be appointed as the MIO?

2. At what times should an MIO either recommend measures or report findings when a unit is scheduled for a deployment?

1–3. Contingency Operations

This unit explains the need and purpose for contingency operations in wartime. You'll study nuclear, biological, chemical, and explosive agents.

106. Public Health's role in contingency operations

The Air Force must be prepared to fight a war if necessary. We're all part of that mission even if we only support those who fight. We are Air Force members first, medical personnel second, and Public Health personnel third. However, this does not decrease our responsibilities for completing the public health mission. This section covers our wartime duties and responsibilities.

Contingency operations purpose

Your medical unit must be prepared to carry out its assigned wartime mission. This preparation is completed through effective planning and training. The medical mission is actually twofold:

1. Return sick or injured combatants back to duty as quickly as possible.
2. To ensure the more seriously injured gets evacuated to safer areas for convalescence and treatment.

Public Health's mission in wartime is to prevent personnel from becoming patients due to illness. During a conflict, medical units will be placed within theaters or areas of combat operations (e.g., European theater and the Pacific theater).

Deployment teams

In support of contingency operations of medical care and the need to sustain operations, the Air Force has recognized the need for deployable teams. Deployable teams are the smaller elements or UTCs that make up the larger medical echelons. Each of these teams serves a specific purpose and role, providing medical care to deployed personnel. Examples or deployable teams include the patient decontamination team, FFGLB (2E mobile decontamination unit), and the FFGLA (equipment package to form the 19-person patient decontamination team).

Terrorism

In this age of political unrest, terrorism has become a very real threat throughout the world. It would not be unrealistic for a base's water or food supply to be the target of a terrorist attack using nuclear, biological, or chemical (NBC) means. As in a natural disaster, you must be ready to handle these situations as they arise, including the evaluation of food or water supplies. You should make recommendations for the decontamination or disposition or food and assist bioenvironmental engineering (BE) services with the decontamination or disposition or water supplies in accordance with this unit.

107. Nuclear, biological, chemical, and explosive events

Each time a nation attains the technology for producing, chemical, biological, radiological, nuclear, and explosive (CBRNE) weapons, the threat of NBC agent use continues to grow. You must know about the effects of these agents and develop a plan for medical management of casualties. In this lesson, we'll study the effects of CBRNE agents. There have been many CBRNE incidents in history—both in peace and war—that stress the importance of being *medically* ready. You must use these historical events to train your personnel on their duties in real-life situations, and you must hold exercises to practice your skills and test your knowledge.

Nuclear events

Information about the effects of nuclear warfare is limited because nuclear weapons have been used only twice in war. There have been several peacetime incidents that provide us tremendous knowledge for medical readiness operations. A few examples of both wartime and peacetime nuclear incidents follow:

World War II

The United States Army Air Corps was the first to use a nuclear weapon in warfare. This occurred at 0840 hours on 6 August 1945. The B–29 Enola Gay dropped a 15-kiloton atomic (little boy) bomb on the Japanese island of Hiroshima, 140,000 people were killed. On 9 August 1945, the B–29 Boxcar dropped a 15-kiloton atomic bomb on the Japanese island of Nagasaki, instantly killing 73,000 people. Lessons learned from Hiroshima and Nagasaki still serve us well today. In both cases generations have suffered the long-term mutagenic and teratogenic effects of radiation exposure.

Goldsboro, North Carolina

On 23 January 1961 a B–52 bomber crashed carrying two 24-megaton weapons. Both weapons were removed intact and without detonation.

Palomores, Spain

On 17 January 1966 another B–52 bomber crashed. Four 20–25 megaton hydrogen bombs fell out of the aircraft. Two of the bombs were recovered undamaged, although the underwater search for one took almost three months. The other two bombs exploded conventionally (non-nuclear detonation) spreading plutonium over a wide area of grassland. Approximately 1,750 tons of radioactive soil and vegetation were eventually removed.

Thule, Greenland

On 21 January 1968 a B–52 with several four-megaton bombs on board crashed into Thule Bay. The mass of the wreckage, both bombs and aircraft, melted through the thick ice and sank into the bay. Some bomb fragments were found, and several tons of contaminated snow was removed.

Three Mile Island, Pennsylvania

A nuclear accident occurred at a nuclear power plant releasing low-level radioactive material into the atmosphere. Radiation experts did not consider the amount of radiation released to be immediately dangerous to the surrounding area; however, there is great concern about the long-term effects on people and the food chain. There are research projects still being conducted to determine the exact effects of radiation.

Chernobyl, Union of Soviet Socialist Republicans

On 26 April 1986, in the Union of Soviet Socialist Republicans (USSR), a nuclear accident occurred at a nuclear power plant, releasing large amounts of radioactive material. Thirty-one people were killed and 137 experienced acute radiation syndrome. Hundreds of thousands were evacuated, and some permanently removed from their homes. According to the Environmental Protection Agency (EPA), more radioactive material was released into the atmosphere from this accident than from all nuclear tests conducted throughout history. This caused panic throughout the world and exposed 17 million people to radiation.

Fukushima, Japan

On 11 March 2011 a tsunami flooded and damaged the five active reactor plants drowning two workers. Loss of backup electrical power led to overheating, meltdowns, and evacuations. There were no immediate deaths due to direct radiation exposures, but six workers have exceeded lifetime legal limits for radiation and more than 300 have received significant radiation doses.

We did not go into great detail on these situations; however, we have gained knowledge in medical readiness from these incidents. You must take the information gained from past experiences and develop ways to prevent them from happening again. Some of the primary concerns after a nuclear incident are a safe food and water supply and the protection of personnel from radioactive fallout. Also, ways to handle, protect, and decontaminate patients, materials, and equipment must be developed.

Biological events

You have seen how diseases occurring naturally can impact a military operation. Can you imagine the effect of disease-producing microorganisms being planted—intentionally? Biological warfare has been around a long time: used in the Middle Ages and during the French and Indian Wars. The threat of biological weapons being used against US military forces is broader and more likely than at any point in our history. Therefore, awareness of this potential threat and education of our troops and medical personnel are crucial.

World War II

From 1937 to 1945 Japan had an ambitious biological warfare program in Manchuria. In a laboratory complex code named “Unit 731” the Japanese conducted biological warfare agent experiments on prisoners of war (POW). Over 3,000 POWs died as a result of the experiments. The Japanese dropped plague-infected fleas over China and Manchuria, causing epidemics of the disease. Later during WWII, the Nazi underground placed people in the food canning industry in New York. In 1939, the Federal Bureau of Investigation (FBI) caught the group introducing *Clostridium botulinum* into food destined for British troops. The cans arrived swollen and leaking; however, none of our troops reported ill, but a tremendous amount of food was lost.

Desert Storm

In 1995 it was revealed by United Nations inspectors that Iraq had a sophisticated biological warfare (BW) program in place during Operation Desert Storm in 1991. Iraq’s total BW arsenal consisted of 19,000 liters of concentrated botulinum toxin (10,000 liters in munitions), 8,500 liters of concentrated anthrax (6,500 liters in munitions) and 2,200 liters of aflatoxin (1,580 liters filled into munitions). Even when confronted with defeat, Sadam Hussein chose not to use his arsenal, probably due to fear of nuclear retaliation.

Modern-day terrorism

In the mid–1980s the Rashneesh religious clan sickened almost 1,000 people in the small town of Antelope, Oregon by sprinkling salad bars with Salmonella organisms to influence the results of a local vote. Their goal was to keep people away from the polls on Election Day. Today, there are opportunities for terrorists to contaminate our personnel or food using disease agents. The terrorist threat is a real concern that affects all military members.

On 18 September 2001 and for a few days thereafter, several letters were received by members of the US Congress and American media outlets which contained intentionally prepared anthrax spores; the attack sickened at least 22 people of whom five died. The identity of the bioterrorist remained unknown until 2008, when an official suspect, who had committed suicide, was named.

Haitian Cholera outbreak

In mid-October 2010, a cholera outbreak happened in the earthquake ravished country of Haiti. According to the Haitian Health Ministry, as of August 2012, the outbreak had caused 7,490 deaths and caused 586,625 people to fall ill. The outbreak was attributed to United Nation peacekeepers from Nepal. Also, the blame for the outbreak was from improper handling of sewage which contaminated a local river.

Chemical events

The use of chemical weapons dated from at least 423 BC when, during the Peloponnesian War, allies of Sparta took an Athenian-held fort. They directed smoke from lighted coals, sulfur, and pitch through a hollowed-out beam into the fort.

World War I

On 14 April 1915 in Yepres (Belgium), German units released 130 tons of chlorine gas from 6,000 cylinders. The attack killed less than 800 troops by asphyxiation, but was more psychologically devastating to more than 15,000 allied troops, who promptly retreated. Again on 12 July 1917, in Yepres, German artillery shells delivered a new kind of chemical agent, sulfur mustard, which caused 20,000 casualties. This new “blister” agent caused burns to the skin, eyes, and lungs of affected troops.

Bhopal, India

Early one morning in December 1984, there was an accidental release of methyl isocyanate gas into the atmosphere. With a slight breeze, the gas cloud spread to the surrounding areas, killing more than 2,000 people and injuring hundreds of thousands more.

Transportation accidents

The EPA reported that an average, one barge accident occurs every day, worldwide, where hazardous materials are the cargo. This agency also reported that between 1980 and 1985, 135 people died and 4,717 were injured in chemical accidents. One-quarter of these deaths and injuries were related to the transportation of hazardous chemicals.

Iran-Iraq

In February 1986, it was reported in several news sources that chemical agents, specifically mustard and nerve agents, were used to stop the Iranian military advances. In March 1997 near Kamisiyah, Iraq, US troops blew up a stockpile of Iraqi chemical weapons containing the nerve agent Sarin and “blister agent” mustard gas. Over 21,000 coalition troops were within a 30-mile radius. Investigations continue to see if this event is related to the “Gulf War Syndrome” of illnesses affecting many Gulf War veterans.

Japan

In March 1995, the Japanese doomsday cult called the “Supreme Truth Sect” unleashed the toxic nerve agent Sarin into five Tokyo subways, killing 12 people and injuring 5,500 more. This incident highlights the potential threat of NBC agents being used by terrorist groups.

108. Nuclear agents

There are three types of injuries associated with a nuclear weapon detonation. Each of the following injuries are unique, but can lead to fatal consequences:

1. Blast.
2. Thermal.
3. Radiation.

Blast

About 50 percent of the total energy in a nuclear explosion is released in the form of a blast. The rapidly expanding fireball produces a blast wave that travels from the site of the explosion. It is composed of static and dynamic components that are capable of producing medical injuries and structural damage. The static component is more commonly known as blast wave or static overpressure. The dynamic component is known as blast wind. It is produced by and proportional to difference between the blast wave pressure and the ambient atmospheric pressure. Both occur simultaneously, and the resultant effects are synergistic.

Blast wave injuries

The blast wave is a wall of compressed air that exerts a crushing effect on objects in its path. Normal atmospheric pressure is 14.7 pounds per square inch. Near ground zero, it may be several times normal. Exposure to this high pressure produces primarily internal injuries—ruptured eardrums, chest injuries, pulmonary rupture, hemorrhage and air embolisms (gas bubble), and other internal organ damage.

Blast wind injuries

The blast wind that accompanies the blast wave may exceed 200 mph. Depending on the wind speed and object size, debris carried by the wind may cause missile injuries (e.g., lacerations, contusions, fractures) and blunt trauma. Also, wind velocity of 100 miles per hour (mph) will displace a person, which can cause lacerations, contusions, and fractures from tumbling across the ground and being thrown into stationary objects.

Thermal

Scientists have stated that about one-third of the total energy in a nuclear explosion is in the form of heat radiation. The fireball yields heat estimated to be millions of degrees in temperature. At

Hiroshima the heat energy ignited clothing, grass, and dry wood up to 3,500 feet from ground zero. The following two types of fires result from a nuclear explosion:

1. Primary fires—ignited by the initial heat wave of the detonation.
2. Secondary fires—caused indirectly by the blast (e.g., from overturned stoves, broken gas pipes, electrical short circuits).

Results

The number of fires varies according to the season, atmospheric conditions, type of terrain, type of burst, weapon yield or size, and many other equally important factors. It is speculated, however, that with one-half mile from ground zero of a 20 kiloton explosion that will be an area of nearly complete destruction where mass fires may be expected in the first hour. In a 20 kiloton detonation, anticipate many fires within one mile of ground zero. Of course, the effects of higher yielding weapons are greater.

Injuries

The following types of injuries result from thermal energy. Burns and eye injuries can result from a multitude of incidents, such as the following:

- Burns—flash burns and flame burns.
- Eye injuries—flash blindness and retinal burns.

The severity of these injuries is directly related to the distance from the detonation. The initial thermal flash and heat wave travels in a straight line at the speed of light (186,000 miles per second). Initial injuries will be flash blindness temporarily caused by light overwhelming the eyes retinal rods and cones. Intense heat or light may cause retinal burns, resulting in permanent blindness. The thermal wave also causes flash burns to the skin from high-intensity low-duration heat exposure. As objects in the environment heat up and begin to burn, massive fires and firestorms result. Burn victims experience first, second, and third degree burns.

Radiation

About 15 percent of the energy released from a nuclear weapon is radiation. Radiation makes normally stable elements radioactive. Generally, there are two types of radiation associated with a nuclear detonation—initial and residual.

Initial

Initial radiation consists of neutrons and gamma rays produced within the first minute after detonation. The main hazard associated with initial radiation is acute external whole-body irradiation by neutrons and gamma rays (ionizing radiation). When this occurs, high electromagnetic wave energy passes through the body. It displaces electrons from neutral molecules producing positive and negative ions. These new chemicals, ions, cause damage to the cells and produce biological effects.

Residual

Residual radiation primarily includes gamma rays, beta particles, and alpha particles. They are produced by the decay of the radioactive materials, bomb components, and surface materials made radioactive from the detonation. We call this radioactive debris “fallout.” The heavy, local fallout is usually visible as a dust-like deposit on surfaces. The biological hazards of fallout include whole-body irradiation from fallout on the ground, beta particles on the skin, and internal damage caused from ingested or inhaled alpha and beta particles. Late effects of radiation exposure in survivors include some cataracts, genetic mutations, birth defects, and cancer.

Upon a nuclear detonation, these radioactive contaminants are spread over great distances; however, the type of nuclear detonation affects the spread of the radioactive materials.

The three most common types of nuclear detonations are:

1. Air bursts.
2. Surface bursts.
3. Subsurface bursts.

Air burst

The air burst is a detonation in the atmosphere where the fireball does not touch the ground. It causes the least radiological hazard because most of the radioactive contamination is spread throughout the atmosphere with less reaching the ground. However, this type of burst can affect personnel by the radioactive contamination attaching to rain droplets and falling to the ground where it may enter the food chain. One consequence of a high-altitude nuclear detonation is electromagnetic pulse (EMP) or the release of high energy. Electromagnetic waves from the detonation overwhelm the circuitry of all mechanisms using electricity, destroying or disabling them. Can you imagine the impact of no electricity or communication capabilities in a wartime environment?

Surface burst

The surface burst is a detonation at ground level where the fireball contacts the ground. It is the most hazardous type of nuclear detonation. The burst directly contaminates the area around the blast with high levels of radioactivity. In addition, the surface burst causes massive amounts of radioactive debris to be drawn up into the atmosphere. Later, this radioactive material rains as fallout many miles away resulting in a direct radioactive hazard or may indirectly threaten us by entering the food chain.

Subsurface burst

A subsurface burst is a detonation below ground or water. The subsurface burst is considered less hazardous. It contaminates the soil and ground water in the area of the blast. However, there’s little fallout because not much debris is drawn up into the atmosphere. This method is generally used to test nuclear weapons.

Roles and responsibilities

Public Health diligently conducts syndromic surveillance to identify any abnormal occurrences that could lead to the identification of a nuclear or radiological event. Additionally, we team with BE, fire and emergency services, explosive ordinance disposal and weather personnel to establish a plan of action, ensuring all threats are considered and appropriate resources are used.

109. Biological warfare agents

BW is the use of microorganisms or toxins derived from living organisms to produce death, disease, or toxicity in humans, animals, or plants.

Types

We will cover three basic types of biological agents and they are shown in the following table. They are bacteria, viruses, and toxins. Adversaries could attempt to weaponize either of them to do harm to personnel.

Types of Biological Warfare Agents		
Type	**Description**	**Examples**
Bacteria	Can cause diseases in humans and animals in two ways: invading tissues and by producing poisons (toxins).	• Bacillus anthracis (anthrax) • Yersinia pestis (plague) Francisella tularensis (tularemia) Coxiella burnetii (Q fever)

Types of Biological Warfare Agents		
Type	**Description**	**Examples**
Viruses	Simplest type of microorganisms that require a host cell to live and multiply	• Smallpox (orthopoxvirus) • Venezuelan equine encephalitis (e.g., VEE alphavirus) • Viral hemorrhagic fevers (e.g., ebola, Rift Valley fever, Lassa fever and Congo-Crimean hemorrhagic fever)
Toxins	Any toxic substance of natural origin produced by animals, plants, or microbes	• Botulinum toxin • Staphylococcal enterotoxin B (SEB) • Ricin • Aflatoxins • T–2 mycotoxins

Methods of delivery

The primary object of a BW attack is people. BW agents are designed to kill or incapacitate our troops to gain a tactical advantage over our forces. The attack is either direct or indirect through air, food, water, or natural vectors. BW does not affect such things as buildings, housing, or factories; therefore, it is advantageous for the enemy to use a BW agent to incapacitate personnel—then they can move in to take over intact facilities. BW agents may be released from mortar and artillery shells, bombs, airplane spray, missiles, or by various methods of sabotage. They may appear in the form of powder, vapor, aerosol, liquid, or liquid droplets having the appearance of rain or dew. These agents may have little or no color, and they may be odorless.

Use of vectors and hosts

Living vectors can be used in biological operations. In volume two you learned how flies, mosquitoes, fleas, ticks, and lice carry diseases. Some vectors need intermediate hosts for disease to develop. These animals could be intentionally infected with a disease and placed near the enemy. If the proper vector is present, it is possible to start an epidemic in the enemy population.

Other methods

Other ways of introducing BW agents are listed below. Each of the following methods, if effectively used by adversaries, could lead to mission failure:

- Small dusting or spraying devices could be used to introduce agent material into ventilating systems of large office buildings, auditoriums, and theaters with little danger of detection.
- Infective microbes and toxins could be pumped directly into city water distribution systems.
- Enemy personnel working in food establishments might be in a position to contaminate foods.
- Effective measures might also be developed to distribute pathogens on currency, stamps, envelopes, and in cosmetics, shaving soap, chewing gum, candy, and other articles.

Characteristics of BW agents

Biological agents can definitely affect your forces' ability to continue fighting; therefore, we must be able to detect and identify these agents so that we can protect others and ourselves. Most BW agents, particularly the pathogenic microorganisms and toxins, have certain properties not possessed in general by other weapons.

Incubation period

Some BW agents have a delayed action. Often days must elapse from the time the victim is exposed until development of clinical signs. BW agents such as toxins (e.g., botulinum and saxitoxins) have immediate effects while others are more delayed in their manifestations.

Difficult identification

Identification of agents currently is difficult and slow because their presence cannot be detected by unaided senses. BW agent detectors are now being developed and field-tested, but for now you must depend on epidemiology and laboratory tests for identification. It takes hours, usually days, for agents to develop in an artificial medium or in animals, and for necessary tests of the suspected material to be made. Too much time may lapse between identifying the agent and finding a cure or recommending treatment. In the meantime, many of our troops may suffer or die.

Unlike other warfare agents

In contrast to other agents of warfare, the microorganisms are living agents. Under favorable conditions, pathogenic microorganisms can reproduce and multiply in the host. Therefore, small numbers of pathogens may in time constitute a grave risk to health or perhaps to life. Some contagious pathogens spread from individual to individual and cause epidemics. Most are also quite selective, attacking only certain species of animals or plants. Theoretically, a given weight of biological agent may be many times more dangerous than equal amounts of the most effective chemical agent. From a practical standpoint, the biological agent’s activity or effectiveness is strictly limited by its ability to overcome the resistance of the target host and the environment. Biological agents lend themselves well to covert use because only small amounts need to be used, and they are easily concealed, transported, and used in sabotage operations. Because of the small amounts required, costs of biological agents may be much less than other agents or weapons.

Roles and responsibilities

As with all CBRNE agent, conducting syndromic surveillance will help identify if BW agents have been used on our personnel. This is especially critical with BW agents because of the fact that personnel seeking treatment for symptoms may be your first indication that BW agents have been used. BW agents have the potential to incapacitate large numbers of forces because exposed personnel may be spreading disease before they even know they were exposed. Your surveillance should focus on any clinical findings from clinic visits that could be due to BW exposure, any unusual illnesses and any unusual or increase in animal or plant death. Additionally, your food vulnerability assessments will help identify any weaknesses in your food defenses, helping prevent BW attack. Lastly, you can help protect troops from illnesses by ensuring that personnel are up to date on any vaccines required to guard against BW agents.

110. Chemical warfare agents

Chemical warfare (CW) agents are substances (i.e., gaseous, liquid, or solid) which might be used because of their direct effects on man, animals, and plants. The key to protection from the effects of chemical weapons lies in knowledge of the various agents involved.

Toxic chemicals are present in everyday industrial operations. Those used in CW are similar in many respects to those that are already familiar to you. The difference is the strength of the agent, the large area of coverage, and the fact you are a target rather than a casual bystander. Chemical agents attack the body and depending on the kind of agent used produce specific damage.

There are different types of chemical agents, and you should know how each of them affects the human body. The types of agents we will discuss are:

- Pulmonary agents.
- Cyanogens.

- Vesicants.
- Nerve.
- Incapacitating.

Pulmonary agents

Pulmonary agents were developed from dye fixatives used in the textile industry. The early signs and symptoms of exposure to pulmonary agents are generally limited to eye, nose, and throat irritation, with tearing and coughing. If the exposure is light and terminated quickly, these symptoms will subside in 15 to 30 minutes. However, if the exposure is severe, prolonged, or repeated lung problems will develop. Upon contact with moisture in the lungs, pulmonary agents convert to various acid compounds, which decrease the ability of the lung tissue to absorb oxygen. This is followed by inter and intracellular fluids filling the lungs, which is called pulmonary edema (dry land drowning). Even if properly managed, this condition may lead to death.

Cyanogens

Cyanogens have been used in metallurgy for centuries and in the acrylic and plastics industry since their beginning. Cyanides stop tissue respiration. Cyanides were not effective in WWI. The delivery systems of the day could not place enough cyanigen chloride, the blood agent used, in an area rapidly enough to derive the desired effects. Modern systems can now do this. Signs and symptoms are very rapid in onset, and death can occur in six to eight minutes. Headache, dizziness, confusion, labored and violent breathing, dilated pupils, and protruding eyes are early indications. These symptoms are followed by reddening of the skin, particularly the fingernail beds, violent convulsions, paralysis, coma, and respiratory arrest preceding death.

Vesicants

Vesicants in either liquid or vapor form are readily absorbed by both external and internal parts of the body. These agents cause inflammation, blisters, and general destruction of tissue. They can be effective in small amounts. A drop the size of a pinhead produces a blister the size of a quarter. Vesicants are most effective in hot weather because sweating increases the effect. These agents produce damage quickly, although blisters may not appear for hours or even days after exposure. Speed in performing first aid and decontamination is essential.

Damage to the eyes may be worse than the effects on the skin. At first, there may be no pain, but in a few hours eyes become painful, inflamed, and sensitive to light. Tears and intense pain follow, possibly leading to permanent injury. If breathed into the lungs, vesicants inflame the throat and windpipe and produce a harsh cough. Serious exposure may produce pneumonia and death. Systemic poisoning by vesicants changes the process of oxygen and nutrient transfer to outlying tissues causing necrosis (death of tissue), gangrene, and sloughing of the tissue. This kind of poisoning also suppresses white blood cells (WBC) and red blood cells (RBC), which causes infection and then death. Quick detection of vesicants, plus protection against entry into the eyes, lungs, or on the skin is vital. Mustards, phosgene oxime, and lewisite are a few types of vesicants.

Nerve agents

Nerve agents can be found in the fertilizer and insecticide industries. The nerve agents are esters of organophosphorus compounds. They inhibit the cholinesterase enzyme system causing an accumulation of acetycholine, which causes the biological effects associated with nerve agents. The onset of symptoms is rapid, beginning with pinpointing of the pupils. These symptoms are followed by difficulty in focusing eyes, headaches, general weakness, profuse sweating, muscle tremors, tearing, and salivation. Later, nausea, vomiting, and loss of bladder control occur, resulting in severe dehydration. If untreated, violent convulsions, coma, and death may result. It is imperative that nerve agents are rapidly absorbed by the eyes and through cuts in the skin. They are absorbed through unbroken skin somewhat more slowly. Clothing contaminated with nerve agent must not be allowed to remain in contact with the skin. Speed in detection, masking, giving the alarm, and in self-aid is paramount. It may save your life.

Incapacitating agents

Incapacitating agents are any type of material that will keep people from doing their job, thus detrimentally affecting the mission. The number of these agents is so numerous and varied in effect that they cannot be covered adequately in this course. As their name implies, they are usually not intended to cause death—only temporarily incapacitate. Based on the types of injury they cause, incapacitating agents fall into the following three groups:

1. Agents that produce temporary visual, mental, and physical disabilities (e.g., blindness or deafness.
2. Agents that produce temporary mental aberrations (e.g., confusion and hallucinations).
3. Agents that produce physical aberrations (e.g., paralysis, low blood pressure, vomiting, diarrhea, dizziness, and an abnormally high body temperature—hyperthermia).

These agents may cause an individual to become confused, disoriented, sleepy, excited, irritable, or unconscious. The tear gas you were exposed to in your mask confidence chamber is classified as an incapacitating agent.

Roles and responsibilities

Your responsibilities with regards to CW agents will mirror what you do for BW agents. Short of disease being spread person to person your response will basically be the same. You will still protect personnel by conducting syndromic surveillance and food vulnerability assessments. While there may not be vaccines to prevent illness and injury from CW attacks, you do have your antidote kits (antidote treatment, nerve agent auto injector [ATNAA] and convulsant antidote for nerve agent [CANA] as well as chemoprophylaxis [P-tabs]) to protect against nerve agent exposure. You need to make sure your personnel are educating deployers at risk of how to properly use these items to ensure maximum protection.

111. High-yield explosives

As a Public Health technician, high-yield explosives are not a direct responsibility of your career field; however, the use of such explosives can cause some concerns (e.g., contaminates the explosion creates). You will need to be familiar with the use and delivery methods to better assist health care providers.

High-yield explosives are any conventional weapon or devise that is capable of a high order of destruction or disruption and/or of being used in such a manner as to kill or injure large number of people. These weapons can be classified into two categories: high explosive (HE) and low-order explosive (LE).

HE produces a defining supersonic over-pressurization shock wave. Examples of HE include trinitrotoluene (TNT), C–4, Semtex, nitroglycerin, dynamite, and ammonium nitrate fuel oil (ANFO). LE creates a subsonic explosion and lack HE’s over-pressurization wave. Examples of LE include pipe bombs, gunpowder, and most pure petroleum-based bombs such as Molotov cocktails or aircraft improvised as guided missiles. HE and LE cause different injury patterns. Explosive and incendiary (fire) bombs are further characterized based on their source. “Manufactured” implies standard military-issued, mass produced, and quality-tested weapons. “Improvised” describes weapons produced in small quantities, or use of a device outside its intended purpose, such as converting a commercial aircraft into a guided missile. Manufactured (military) explosive weapons are exclusively HE-based. Terrorists will use whatever is available (illegally obtained manufactured weapons or improvised explosive devices [also known as IEDs] that may be composed of HE, LE, or both). Manufactured and improvised bombs cause markedly different injuries.

Injuries

Explosions produce unique patterns of personnel injury. Blast injuries are characterized by anatomical and physiological changes from the direct or reflective over-pressurization force impacting the body's surface. Some examples of blast injuries are as follows.

Lung injury—

"Blast lung" is a direct consequence of the HE over-pressurization wave. It is the most common fatal primary blast injury among initial survivors. Signs of blast lung are usually present at the time of initial evaluation, but they have been reported as late as 48 hours after the explosion. Blast lung is characterized by the clinical triad of apnea, bradycardia, and hypotension. Pulmonary injuries vary from scattered petechae to confluent hemorrhages. Blast lung should be suspected for anyone with dyspnea, cough, hemoptysis, or chest pain following blast exposure. Blast lung produces a characteristic "butterfly" pattern on chest X-ray. A chest X-ray is recommended for all exposed persons and a prophylactic chest tube (thoracostomy) is recommended before general anesthesia or air transport is indicated if blast lung is suspected.

Ear injury

Primary blast injuries of the auditory system cause significant morbidity, but are easily overlooked. Injury is dependent on the orientation of the ear to the blast. Tympanic membrane (TM) perforation is the most common injury to the middle ear. Signs of ear injury are usually present at time of initial evaluation and should be suspected for anyone presenting with hearing loss, tinnitus, otalgia, vertigo, bleeding from the external canal, TM rupture, or mucopurulent otorhea. All patients exposed to blast should have an otologic assessment and audiometry.

Abdominal injury

Gas-containing sections of the GI tract are most vulnerable to primary blast effect. This can cause immediate bowel perforation, hemorrhage (ranging from small petechiae to large hematomas), mesenteric shear injuries, solid organ lacerations, and testicular rupture. Blast abdominal injury should be suspected in anyone exposed to an explosion with abdominal pain, nausea, vomiting, hematemesis, rectal pain, tenesmus, testicular pain, unexplained hypovolemia, or any findings suggestive of an acute abdomen. Clinical findings may be absent until the onset of complications.

Brain injury

Primary blast waves can cause concussions or mild traumatic brain injury (MTBI) without a direct blow to the head. Consider the proximity of the victim to the blast particularly when given complaints of headache, fatigue, poor concentration, lethargy, depression, anxiety, insomnia, or other constitutional symptoms. The symptoms of concussion and post-traumatic stress disorder can be similar.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

106. Public Health's role in contingency operations

1. What is the twofold purpose of the medical mission in wartime?

2. What are UTCs?

107. Nuclear, biological, chemical, and explosive events

1. How can we effectively use the historical information from nuclear, biological, and chemical events?

2. The nuclear accident at Three Mile Island caused no immediate danger to radiation, but what concerns do experts have about the accident?

3. In 1995 it was revealed that Iraq had sophisticated biological warfare agents. What were they?

4. When was the first recorded use of chemical weapons?

5. What accident occurred in Russia on 26 April 1986?

6. What NBC agents were used by Iraq in 1986?

108. Nuclear agents

1. What causes most of the destruction during a nuclear weapon detonation?

2. Blast injuries are caused by which two blast components?

3. What type of fires would be caused by a nuclear weapon detonation?

4. What are the biological hazards from “fallout?”

5. What type of radiation presents the greatest inhalation hazard?

6. How much of an immediate radiological hazard would an air blast produce on the ground?

7. How does a nuclear burst result in radioactive contamination?

8. What type of nuclear detonation occurs where the fireball contacts the ground?

9. Which type of burst is the most hazardous nuclear detonation?

109. Biological warfare agents

1. Why is the use of biological warfare agents advantageous?

2. How may biological agents be released into the environment?

3. What are the characteristics of biological warfare agents?

4. What determines the effectiveness of biological agents?

110. Chemical warfare agents

1. What chemical agent was developed from dye fixatives in the textile industry?

2. How do cyanogens affect the body?

3. In what type of weather are vesicants most effective?

4. What are the three examples of vesicants?

5. What is probably the first effect you will notice in a person exposed to nerve agents?

6. What are the effects of incapacitating agents?

111. High-yield explosives

1. What are high-yield explosives?

2. What are the two categories of high-yield explosives?

3. What are some examples of high-explosives?

4. What are some examples of low-order explosives?

Answers to Self-Test Questions

101

1. Malaria.
2. Malaria and dysentery.
3. Sanitation was so poor that fecal material and garbage caused a fly infestation so large that there were about 1,000 casualties with dysentery.
4. Malaria and sand fly fever.

102

1. Military actions conducted which are not associated with sustained, large-scale combat operations.
2. Peace building (post-conflict rebuilding of governments), peace enforcement (compel compliance with resolutions), peacekeeping (monitor and facilitate implementation of agreements) and humanitarian relief operations.

103

1. Joint Operation Planning and Execution System.
2. Time-Phased Force and Deployment Data.
3. A classified document which provides commanders current policies, planning factors, and forces for conducting and supporting wartime operations.

104

1. Information about diseases, climatic conditions, and other health-related environmental factors. It also includes information about medical capabilities and R&D activities of other countries.
2. Most intelligence is gathered from human sources; however, some is gathered from scientific journals and other literature or from analysis of foreign medical material. These sources include unclassified intelligence reports, geography books, encyclopedias, and other commonly available reference materials, as well as, classified intelligence products.

105

1. A 4E0X1 or an NCO with appropriate experience.
2. Before deployments, upon arrival at a deployment location, during the deployment, and following a deployment.

106

1. Return sick or injured combatants back to duty as quickly as possible and to ensure the more seriously injured get evacuated to safer areas for convalescence and treatment.
2. Unit-type codes (e.g., deployable teams are the smaller elements that make up the larger medical echelons).

107

1. To train our personnel on their duties in real-life situations and we must hold exercises to practice your skills and test your knowledge.
2. Long-term effects on people and the food chain.
3. Botulinum toxin, anthrax, and aflatoxin.
4. 423 BC during the Peloponnesian War.
5. An explosion at a nuclear power plant at Chernobyl caused large amounts of radioactive material to be released into the atmosphere.
6. Chemical agents, specifically mustard and nerve.

108

1. Blast wave.
2. Blast wave and blast wind.
3. (1) Primary fires—ignited by the initial heat wave of the detonation.
   (2) Secondary fires—caused indirectly by the blast (e.g., from overturned stoves, broken gas pipes, electrical short circuits).
4. Whole-body irradiation from fallout on the ground, beta particles on the skin, and internal damage from ingested or inhaled alpha and beta particles.
5. Alpha and beta particles.
6. The air burst causes the least radiological hazard because most of the radioactive contamination is spread throughout the atmosphere, with less reaching the ground.
7. The radioactive particles from the burst attach themselves to larger dust or rain falling to the ground where it may enter the food chain.
8. Surface burst.
9. Surface.

109

1. Only personnel are affected, so the enemy can move in and take over the facilities intact.
2. From mortar and artillery shells, bombs, airplane spray, missiles, or by various methods of sabotage. Additionally vectors may carry the infective organism.
3. Incubation period, difficult identification, and unlike other warfare agents.
4. The ability of the agent to overcome the resistance of the host.

110

1. Pulmonary agents.
2. Stop tissue respiration.
3. Hot weather.
4. Mustards, lewisite, and phosgene oxime.
5. Pinpoint pupils.
6. Temporary visual, mental, and physical disabilities; temporary mental aberrations; and physical aberrations.

111

1. Any conventional weapon or devise that is capable of a high order of destruction or disruption and/or of being used in such a manner as to kill or injure large number of people.
2. High-explosive and low-order explosive.
3. TNT, C–4, Semtex, nitroglycerin, dynamite, and ANFO.
4. Pipe bombs, gunpowder, and most pure petroleum-based bombs such as Molotov cocktails or aircraft improvised as guided missiles.

Do the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field Scoring Answer Sheet.

Do not return your answer sheet to Air Force Career Development Academy (AFCDA).

1. (101) During World War II, why did two Allied units withdraw from positions previously occupied by Germans in the North African Desert?
   a. Dengue Fever infected the camp.
   b. Malaria infected one-half of the camp.
   c. Flies spread disease from the exposed feces.
   d. Heat stroke affected the leaders in the desert.

2. (102) Operations other than war (OOTW) are defined as
   a. military actions associated with combat operations.
   b. peacekeeping actions associated with large-scale combat operations.
   c. peacekeeping and military actions in conjunction with regional combat operations.
   d. military actions conducted which are not associated with large-scale combat operations.

3. (102) Recent operations other than war (OOTW) have been seen in Bosnia,
   a. Rwanda, Iraq, and Haiti.
   b. Rwanda, and Oklahoma City.
   c. Iraq, and Homestead, Florida.
   d. Iraq, Haiti, Somalia, and China.

4. (103) The allowance standard (AS) that lists equipment to support the FFPM4 (PAM) team mission is
   a. AS 115P.
   b. AS 116P.
   c. AS 916E.
   d. AS 917E.

5. (104) Medical intelligence (MI) is information about diseases,
   a. and climatic conditions.
   b. climatic conditions and gross national product.
   c. climatic conditions and other health-related environmental factors.
   d. climatic conditions, health-related environmental factors, and key government figures.

6. (104) How is *most* medical intelligence (MI) obtained?
   a. Espionage activities.
   b. Directly from people.
   c. Medical journals and newspapers.
   d. Hands-on experience and through the grapevine.

7. (104) When must medical intelligence (MI) be used as a preventive measure to be effective?
   a. Upon appointment of a medical intelligence (MIO).
   b. During training sessions with medical personnel.
   c. After a unit returns from a deployment.
   d. Prior to a unit's deployment.

8. (105) Who appoints the base medical intelligence officer?
   a. Base commander.
   b. Chief, public health.
   c. Medical treatment facility commander.
   d. Commander, aerospace medicine council.

9. (105) In the absence of the public health officer, who is normally appointed as the medical intelligence officer?
   a. 4E0X1 NCO with appropriate experience.
   b. Infection control officer.
   c. Medical supply officer.
   d. Senior 4M0X1.

10. (106) The twofold purpose of the medical mission is to return sick or injured combatants back to duty as quickly as possible and to
    a. ensure the mission is not affected for medical reasons.
    b. provide injured combatants an area for convalescence.
    c. ensure the more seriously injured gets evacuated to safer areas for convalescence and treatment.
    d. provide the more seriously injured with their choice of convalescence and treatment locations through Tricare.

11. (107) The first country to use a nuclear weapon in warfare was
    a. the Union of Soviet Socialist Republicans.
    b. the United States of America.
    c. Japan.
    d. China.

12. (107) According to the Environmental Protection Agency (EPA), which nuclear accident resulted in more radioactive material being released into the atmosphere than from all nuclear tests conducted throughout history?
    a. Palomores, Spain.
    b. Fukushima, Japan.
    c. Three Mile Island, Pennsylvania.
    d. Chernobyl, Union of Soviet Socialist Republicans (USSR).

13. (107) What nerve agent was unleashed on a subway station in Tokyo by a Japanese cult?
    a. Tabun.
    b. Soman.
    c. Sarin.
    d. Cyclosarin.

14. (108) A person in the vicinity of a nuclear blast will be displaced if the wind velocity exceeds how many miles per hour (mph)?
    a. 120.
    b. 100.
    c. 150.
    d. 200.

15. (109) What is the *most* likely reason that many military members suffer or die as a result of a biological attack?
    a. Inadequate immunizations.
    b. Terrorists are creative with their delivery.
    c. Beliefs that biological warfare would cause great epidemics in military populations.
    d. Too much time between agent identification and cure/treatment recommendations.

16. (109) What primarily determines the effectiveness of a biological agent?
    a. Ability of the organism to overcome resistance of the target host.
    b. Method of application of the agent with regard to wind direction.
    c. Type of organism.
    d. Average temperature.

17. (109) Which statement is *not* a characteristic of a biological agent?
    a. Identification of the organism is often difficult.
    b. Agent's presence cannot be detected by our senses.
    c. All agents are rapid in action from time of exposure to symptoms.
    d. Some agents have a delayed action because of the incubation period.

18. (110) Which is *not* one of the three primary substances comprising chemical warfare agents?
    a. Gaseous.
    b. Plasma.
    c. Liquid.
    d. Solid.

19. (110) Antidote kits, such as antidote treatment, nerve agent autoinjector (ATNAA) and convulsant antidote for nerve agent (CANA), treat symptoms of which type of chemical warfare agent exposure?
    a. Nerve agents.
    b. Vesicants.
    c. Cyanogens.
    d. Incapacitating agents.

20. (111) Trinitrotoluene (TNT), C–4, and nitroglycerin are all examples of what category of explosives?
    a. Low-order explosive.
    b. High explosive.
    c. Incendiary.
    d. Improvised.

21. (111) What does a low-order explosive lack compared to high explosives?
    a. Ability to inflict injury.
    b. Ability to cause death.
    c. Subsonic vacuum pressure.
    d. Over-pressurization shock wave.

Please read the unit menu for unit 2 and continue ➔

Unit 2. Field Sanitation

PUBLIC HEALTH STRIVES TO PREVENT disease and injury (DI). As you learned in Unit 1, DI has severely taken its toll on troops throughout history. You can significantly reduce the amount of DI in contingency operations by preparing, equipping, and educating deploying personnel. Personnel must be given a predeployment review that includes medical and immunizations records. Personnel must be medically fit to deploy; otherwise, they may jeopardize the mission if there is a loss of manpower due to illness. All personnel should be up-to-date on mobility immunizations as required by Air Force Joint Instruction (AFJI) 48–110, *Immunizations and Chemoprophylaxis for the Prevention of Infectious Diseases* to ensure protection against disease. You must use the knowledge you've gained through previous experiences and put it to work when you are living under field conditions. This unit focuses on disease prevention under field conditions—safe food and water, controlling wastes properly, and protecting personnel from environmental injuries. Remember that there are no clear-cut answers to problems you encounter in the field, but you can reduce DI if people are trained and educated in disease prevention.

2–1. Preventive Medicine in Field Conditions

Disease and injury causes the greatest loss of manpower through disability and time lost from duty. If you are to carry out your objectives, personnel must be in a constant state of readiness. To maintain this desired state of readiness in a field situation, proper sanitation and hygiene are essential. You will have the opportunity to take everything you've learned, adapt it, and use it in field situations to help maintain the health and welfare of unit personnel.

112. Public health threats under field conditions

Previously, you have learned how diseases spread and how they affect humans. You know diseases can be transmitted from person to person or from animals to people through direct contact, inhalation or airborne droplets, contaminated food or water, and vectors. The information provided in the next few lessons will prepare you to better identify public health concerns for Air Force personnel deploying throughout the world.

Disease types and countermeasures

There are many types of diseases that your personnel may encounter in the field. It is your job, through medical intelligence information gathering, to educate deploying forces on methods of preventing them from becoming victim to diseases throughout the world.

Disease statistics show there are four types of diseases that occur frequently in contingency operations; they are as follows:

1. Diarrheal.
2. Upper respiratory illness (URI).
3. Skin.
4. Vectorborne.

In addition to these diseases, there are many other factors you must consider that may adversely impact the effectiveness of your forces in the field.

Diarrheal disease

There is nothing worse than living in field conditions and having a bad case of diarrhea. Travelers' diarrhea, giardia, shigella, and typhoid are all examples of diarrheal diseases that can occur during contingency operations. Public health's responsibility is to educate deployed personnel prior to, and during a deployment on the types of diarrheal diseases they may encounter and what they can do to prevent themselves from becoming affected. Diarrheal diseases are introduced as a result of a breakdown in personal hygiene, sanitation, food preparation, or water treatment. Food or water becomes contaminated by direct contact with the infectious agent or by contact with a mechanical vector such as flies, rodents, and so forth. Good personal hygiene and proper handwashing cannot be overemphasized. Good sanitation, ensuring that immunizations are kept up to date, and using only approved sources of food and water will reduce your chances of getting a diarrheal disease.

Upper respiratory illness

Diseases of the respiratory tract are caused by direct contact or inhalation of infectious microorganisms that are carried on airborne droplets or dust particles. Respiratory infections (e.g., influenza, colds, sore throats, tuberculosis, and meningococcal disease) can be highly contagious, particularly in crowded conditions. Additionally, tuberculosis infections are increasing rapidly in many areas of the world, and can be a significant threat to personnel in close contact with indigenous populations. These pathogens may also be indirectly transmitted through ingestion by the use of common cups, food utensils, cigarettes, and so forth. Countermeasures to prevent respiratory diseases in the field consist of immunizations, living areas with adequate space and ventilation, head-to-foot sleeping arrangements, and frequent handwashing to reduce droplet and aerosol spread of respiratory diseases. Also, remind deploying personnel to always cover their mouths if they cough or sneeze, and to immediately wash their hands so they will not pass the germs to someone else.

Skin disease

Breakdowns in basic personal hygiene and sanitation are the number one causes of skin disease in the field. Situations that cause us to deploy can often send our troops into a harsh environment with minimal amounts of safe bathing water. If only small amounts of water are available, deployed personnel cannot maintain good personal hygiene. Good personal hygiene is important in preventing skin diseases such as fungus infections, dermatitis, and even parasites. Good personal hygiene is the most important countermeasure against skin disease; therefore, personnel must plan to make provisions for bathing. If a daily shower is not available, personnel should be encouraged to clean (dip bathe) the five areas (5 Fs) most important to ensure good personal hygiene—face, fingers, feet, fanny, and front. While deployed, your personnel should be encouraged to limit the use of cologne or perfumes since they contain alcohol, which opens pores, inviting infection and attracting insects.

Vectorborne disease

You may be deployed to exotic locations (e.g., Rwanda, Panama, or even Colombia). What do all of these locations have in common? The answer is vectors and the potential for vectorborne disease. Your deployed personnel run the risk of being exposed to a variety of exotic arthropods and arachnids all over the world. You must educate your personnel and provide them with the tools necessary to protect themselves against vectorborne diseases. Immunizations, chemoprophylaxis, avoidance, personal hygiene, and personal protection are all countermeasures you can take in the field to prevent vectorborne diseases. We will discuss these countermeasures in detail later. It is up to us to ensure all units practice these countermeasures to reduce the incidence of vectorborne disease in the field.

Other public health threats and countermeasures

Like the diseases mentioned above, there are many other public health threats that may adversely affect Air Force personnel throughout the world. Some of the other threats are hazardous flora (plants) and hazardous fauna (animals) and the environmental conditions.

Hazardous flora and fauna

Each part of the world has its own indigenous fauna and flora. Many of these can cause serious injury or illness to your personnel. Some examples of these are rattlesnakes, cobras, bushmasters, scorpions, centipedes, black widows, poison sumac, and manchineel trees. Hazardous flora and fauna are especially dangerous when personnel are deployed to areas where they are not familiar with the indigenous species. For example:

- A person from the United States who enjoys seashell collecting in the shallows of our shoreline could receive a life-threatening sting from a Geographer Cone shell, *Conus geographus*, when in the South Pacific or Indian oceans.
- While waiting for aircraft in Somalia, US armed forces personnel found a “green snake” behind the PAX terminal. One member decided to pick up the snake since it looked like the nonvenomous, green garden snake here in the United States. Fortunately, one of our public health officers was there to educate the person about the green mamba, *Dendraspis angusticeps*, being handled. Green mambas may look like a garden snake; however, they are one of the most dangerous snakes. The green mamba is very aggressive and carries a highly potent neurotoxin in its venom.

In most cases, the indigenous fauna have no desire to be anywhere near humans; however, when inadvertently trapped or when they feel threatened, they will defend themselves. The usual exposure occurs when the cold-blooded creature (e.g., snake or scorpion) is looking for a warm place (e.g., your boot or bedding), and upon meeting, casualty can occur.

Other often-overlooked threats in the field are bees and wasps. Bees and wasps kill more Americans each year than all snake, spider, scorpion, and centipede bites combined. The primary reason is anaphylactic shock, which occurs when an individual has a hypersensitivity to stings. Hypersensitivity may be hereditary or acquired, and it can range from local swelling to a systemic reaction, which can constrict breathing and rapidly stop the heart. Personnel susceptible to anaphylactic shock should be identified prior to deployment and issued (by a doctor’s prescription) epinephrine (epi) kits. The latest epi kit is the Epi Pen, which is easy to use and may save the individual’s life if stung far away from medical care.

It’s up to you, as a public health journeyman, to protect personnel from becoming a liability for the operation by educating them about the dangerous indigenous species found around the world. Your recommendations and suggested countermeasures should stress prevention and avoidance unless personnel are specially trained to handle such exotic plants and animals.

It is not possible to educate personnel on all species in an area of operation. Your educational efforts should focus on the major threats. The keys to working in areas with hazardous flora and fauna are recognition, avoidance, and antivenins.

Recognition

Before you can make a recommendation on what to avoid or how to prevent injury, you must research and be able to recognize the hazardous species indigenous to the area of operation.

There are numerous species dangerous to man in the world, and there are numerous sources of information to research. The AFPMB–Living Hazards Database, gives you the ability to search by country for all poisonous snakes and arthropods present in a specific area. This site provides detailed descriptions and color pictures of each threat. There are many other sources available online to find information as well.

Avoidance

It's extremely important you inform personnel about avoiding poisonous snakes and arthropods at all cost. The mission can be severely hampered if personnel are bitten by a poisonous snake or arthropod. The basics for avoiding snakes, arthropods, and plants in your area of responsibility (AOR) are as follows:

- Mow back vegetation around the deployed location so that contact is minimized.
- Wear gloves when reaching under things if you cannot see what's under them while in the field.
- When you take your boots off at night, cover them by rolling socks over the tops, or keep them inside your bed-net.
- Shake out your bedding before getting in to scare away any unwanted visitors.
- Shake out your clothing before putting it on.
- Roll down sleeves and flip up collars before entering brush to maximize your protection.
- Apply and use the personal protective equipment that you will learn about in your entomology unit.

Antivenins

Another public health concern in deployment planning is antivenins. Work with pharmacy personnel to ensure they know what types of hazardous flora and fauna are indigenous to your area of deployment and what antivenins are available. By educating personnel about the indigenous threats around the world, you may be able to prevent serious injury and in some cases prevent death.

Environmental injuries

To perform effectively in any climate, personnel must first become acclimatized to the new climate. Troops living and working in extreme temperatures must recognize the hazards associated with heat and cold. Our personnel must know what measures to take to prevent thermal stress problems. For cold temperatures, individuals should wear extra clothes in loose fitting layers. In the heat, personnel should recognize the need for water consumption to prevent heat injury. High altitude is another environmental element that can cause injuries (e.g., high altitude pulmonary edema) starting at altitudes above 8,000 feet. Commanders and their troops must be educated on acclimatization and prevention of environmental injury. Heat and cold injuries will be discussed in detail in section 2–4 of this volume.

Personal hygiene

Personnel can reduce their chances of getting a disease by practicing good personal hygiene. When in the field, scrupulous personal hygiene is a must. Diarrheal, upper respiratory, skin, and vectorborne diseases can result from one common problem—poor personal hygiene. One of the most important countermeasures in the field is good personal hygiene. Good personal hygiene is carried out through proper handwashing, practicing good oral hygiene, showering, and foot care. By keeping your hands, skin, hair, and clothing clean, you are preventing an invasion of bacteria, fungus, and even parasites.

Handwashing

Personal hygiene, especially handwashing, is critical in preventing the spread of disease during field operations. Handwashing after visiting the latrine must become an unfailing habit. Your job is to educate all deploying personnel on the importance of handwashing in the field. You need to ensure that handwashing stations are available for the site population. Handwashing facilities and latrines may be primitive or nonexistent, and water may be scarce and/or contaminated. All of these things must be taken into consideration if diseases are going to be controlled in the field. At a minimum, handwashing stations must be located near latrines, at the entrances of food, and in medical treatment facilities. Handwashing cannot be overemphasized in the field to prevent the spread of disease.

Showering

Filth and disease go hand-in-hand. Unwashed skin can be an open invitation for infection or fungus. Dirty clothing worn for a prolonged period of time and unwashed hair are open invitations to body or head lice. Personal hygiene in the field should be strictly enforced and promoted by providing shower/bathing facilities to reduce the daily spread of disease. Deployed personnel must bathe at least once a week while in the field and frequently change to clean clothing to reduce the health hazard associated with body lice. Shower shoes should be encouraged to prevent foot fungus. All shower facilities must have a soakage pit underneath them to prevent water from collecting and forming pools. Camp work details should be formed and instructed to clean and disinfect latrines and showers with 100-ppm (parts per million) chlorine on a daily basis. Shower facilities should be evaluated on a routine basis for cleanliness and insect infestation. Experience in Desert Storm showed field showers provide an optimum environment for insect breeding due to the accumulation of moisture, dead skin, and hair. If this occurs, the facility should be disassembled, thoroughly cleaned, and treated for infestation.

Foot care

Dirty, sweaty socks may cause the feet to be more susceptible to disease. In boots, your feet are more prone to sweating than other parts of the body. Moisture in the socks will reduce their insulating quality and can lead to foot problems. Feet should be massaged daily, toenails trimmed (not too short), and blisters cleaned and protected. Moleskin (a padded bandage) is an excellent way to keep reddened areas on feet from becoming blisters. Foot care must be given extra attention during field operations. Deploying personnel should be encouraged to do the following:

- Bring at least the minimum number of boot socks required by current mobility guidance.
- Keep socks clean and dry.
- Change wet or damp socks as soon as possible.
- Wash feet daily, if possible, and allow them to dry thoroughly before putting socks and boots back on.
- Avoid tight socks and boots, as they limit air circulation and evaporation of sweat.
- Use antiperspirants containing aluminum chlorhydrate or foot powder to help control the sweating of feet.

113. Public Health responsibilities during contingency operations

There are many different situations that require using good field sanitation practices (e.g., field exercises, shelter exercises, mobility deployments, operations other than war, and/or actual warfare). In each situation, it is extremely important for us to educate personnel about conditions and practices conducive to good health and personal hygiene. Without education, many more patients will be seen at the medical treatment facility. To be effective, public health must be part of the planning process and site selection process when setting up a “bare base.” Your responsibilities may vary from deployment to deployment; but as a minimum, public health must be included in the following:

- Site selection.
- Development of the overall site setup including disease surveillance and prevention.
- Continuing training for deployed personnel to ensure public health threats are minimized.

Through effective planning, your forces can rapidly deploy to bases and be capable of supporting and launching sustained combat operations with the same independence as we're accustomed to in fixed facilities.

Site selection

As the Air Force downsizes and your operations tempo increases, you find more and more personnel on deployment to remote locations. Sometimes all there is to begin the operation is a landing strip that must be transformed into an operational base. This is the premise of the "bare base" concept. With today's mobility concepts, there are hundreds of potential bare bases in foreign nations that possess runways, taxiways, and air terminal facilities that could be used by our forces during contingencies. As a public health journeyman, you must be involved in the planning process to select a site that will sustain good health and evade disease. If not included in the planning process, you or your officer in charge/noncommissioned officer in charge (OIC/NCOIC) should request to be included. Failure to plan is planning to fail.

You should select a site that is relatively free of vector breeding areas, has a good water source, has proper drainage, and will facilitate breaking the chain of infection for disease. Information gathering at this point becomes critical. Most of your information gathering will occur during your medical intelligence research, which you learned earlier in this volume. Your involvement in the site selection process is your best chance to apply all of the skills and knowledge of public health. You can apply all of the knowledge that you have gained from your medical intelligence gathering to increase the effectiveness of the troops in support of the overall mission. Don't assume all your site selection research can be done before you deploy. Some critical decision making will only take place once you have boots on the ground and eyes on the situation. Areas to consider in site selection include the following:

- Topography/climate data.
- Water sources.
- Vectors.

Topography/climate data

Topography and climatic conditions should reveal prevailing wind direction and expected velocity, temperature extremes, annual rainfall, humidity, natural slope of the terrain, soil characteristics, and latitude and longitude of the site. Some questions you may want to answer are listed below.

Question	Information to Consider
What season of the year is it (e.g., rainy, typhoon)?	If you are deployed during the winter months and plan to stay through spring, will your site still be frozen or will you end up in the middle of a marsh or swamp?
What are the average temperature ranges throughout the projected length of the deployment?	Knowing the temperature extremes that you may be exposed to will help you make better decisions about the kinds of items to bring. This information is also helpful to properly site sewage lagoons downwind, determine air-conditioning or heating requirements, set up facilities away from natural drainage or flooding areas, and to determine absorption rate of soils for liquid waste. If soils are rocky, frozen, or a high water table exists, then personnel must plan to burn wastes instead of bury.

Water sources

Selection of a water source is one of the most important elements of the site selection process. Water source selection is completed by a team that includes civil engineering (CE) (water production and environmental), security police, and preventive medicine personnel. CE is the point of contact (POC). Water may be obtained from a variety of sources in the field such as rivers, streams, ponds, lakes, wells, existing water distribution systems, and bottled water.

When choosing a water source, the following factors must be considered:

- Quantity—Will the source provide an adequate supply of water for all personnel for the expected duration of operations?
- Quality—Is the water free of contamination such as sewage, toxic chemicals, and/or NBC agents?
- Accessibility—Is the sourced accessible to water purification and transport equipment?
- Vulnerability—Can the source be made secure against contamination by sabotage or enemy attack?

In field conditions, personnel must have enough safe water for drinking and for personal hygiene. The quantity of water required for personnel varies with the season of the year, the geographical area, and the tactical situation. The table below provides water use planning factors for determining potable and nonpotable water consumption needs.

Air Force Pamphlet (AFPAM) 10–219, Volume 5, *Bare Base Conceptual Planning* gives water standard while using the base expeditionary airfield resources (BEAR) system and fixed water treatment plant. At the time of writing, the BEAR 550 system the standard system for the setup of bare base systems. BEAR is replacing the previously used Harvest Falcon/Harvest Eagle systems. Air Force Handbook (AFH) 10–222, Volume 2, Guide to Bare Base Assets contains detailed equipment and usage. The following table is from (AFPAM 10–219, Volume 5), *Water Use Planning Factors***.**

Functions	**Water Usage Factor (gal/person/day)**	
Potable Water	**Using BEAR Assets**	**Using Fixed Water Treatment Plant**
Drinking	4.0	4.0
Personal Hygiene	3.0	3.0
Shower	5.0	15.0
Food Preparation	4.0	5.0
Hospital	1.0	2.0
Heat Treatment	1.0	1.0
Nonpotable Water	**Using BEARAssets**	**Using Fixed Water Treatment Plant**
Laundry	2.0	14.0
Construction	2.0	2.0
Graves Registration	0.5	0.2
Vehicle Operations	0.5	1.8
Aircraft Operations	2.0	3.0
Firefighting	2.0	4.0
10% Loss Factor	3.0	5.0
Total	**30.0**	**60.0**

Vectors

Be aware of swamps, drainage ditches, old tire dumps, and other artificial containers that may be an ideal breeding ground for hazardous vectors. Choose a site away from vectors, especially if your medical intelligence reveals vectorborne disease in your AOR.

Site setup

The way facilities are set up can significantly impact the effects DI has on the deployed personnel. To avoid vector or mechanical transmission of disease, you must separate the waste areas from eating and living areas. Commanders often want an exact distance for locating the latrines from food operations to prevent the spread of diseases; however, there are no magic numbers to prevent cross contamination. Good sanitation and hygiene must be continually reinforced to become a learned attitude. Numbers cannot make command decisions, only commanders can. In most deployment situations, you will be giving your recommendations through the medical commander to the base commander so he or she can make sound command decisions. Your recommendations may or may not be followed, but it's your job to communicate risk effectively to prevent DI from impacting the mission.

Facility placement

The following table is not all-inclusive. Common sense must be used to ensure areas that may be ideal breeding areas for flies, rodents, or mosquitoes are located away from areas where personnel eat, work, rest, and play.

Reference	What and How Far?	Why?
Field Manual (FM) 21–10, *Field Hygiene and Sanitation* FM 4–25.12, *Unit Field Sanitation Team* Navy Medicine (NAVMED) P5010, *Manual of Naval Preventive Medicine, Preventive Medicine for Ground Forces*	Food facilities must have a grease separator between food facility and soakage pit: 100 yards (yd) uphill, upwind, upstream from latrines, and 30 yd from garbage and soakage pits	To prevent contamination of water supply used for cleaning, to prevent the attraction of rodents and insects, and to avoid the smell from other facilities to reach food serving and eating areas.
	Latrines: 100 yd downhill, downwind, and downstream from food facilities and 100 feet (ft) from nearest water source, and at least 50 feet from sleeping quarters.	To avoid contamination of water and food sources. Also, far enough from sleeping quarters to prevent odors to travel to living areas, yet close enough to prevent troops from using areas around their living quarters to urinate or defecate.
	Garbage and soakage pits: 30 yd from food facilities, a minimum of 50 feet from latrines, and away from the flightline.	To eliminate rodents and insects from being attracted to food facilities and to prevent odors from traveling to food facilities.
	Water points: Upstream from all waste sites. Storage tanks must be located at least 50 ft from sewage disposal system.	To prevent cross contamination.
	Hospital: Away from tactical targets.	To be able to provide care during wartime.
	Patient decontamination site: 250 ft downhill, downwind, and downstream from the hospital. At an accessible location to intercept patient flow.	To provide a smooth transfer of contaminated patients without contaminating the MTF.

Reference	What and How Far?	Why?
	Contaminated materials dump: 75 ft downhill, downwind, and downstream from the decon site.	To avoid cross contamination or recontamination from removed materials.

Preventing disease transmission in the field

As a Public Health technician you are responsible for helping prevent the spread of disease during contingency operations. You must identify areas that pose a threat to personnel and ensure deployed personnel are provided education to prevent disease transmission.

Proper waste disposal

Under field conditions, large quantities of all types of waste—liquid and solid—are generated at approximately 100 pounds (lb) per person, per day. These materials must be removed and disposed of promptly; otherwise, the camp will quickly become an ideal breeding area for flies, rats, and other vermin. Filth-borne diseases such as dysentery, typhoid, and plague could become prevalent. Try to imagine a camp with no waste disposal facilities. Besides the health threat, the flies, the smell of human waste, and the sight of garbage piling up, would certainly decrease a unit's morale. You will learn ways to dispose of waste in a field situation so that it does not present a problem later. Public health personnel are responsible for inspecting waste disposal facilities and operations, as well as, recommending changes that are necessary to protect the health and welfare of personnel.

Safe food and water

Safe food and water in sufficient quantities is essential to any unit's existence. Even the most appetizing food can cause illness if it becomes contaminated with pathogens. Outbreaks of food poisoning have resulted from improper handling of foods. You must ensure food is safely prepared, served, and stored if you are to prevent foodborne disease outbreaks. You must educate personnel to consume food and water from approved sources only. On deployments, the two most commonly used and easily approved food sources are meals-ready-to-eat (MRE) and dining facilities which may use tray pack rations (T-rats). Personnel may get bored eating at the same food establishment every day, and those tantalizing foods offered by street vendors outside the gate begin to look tempting. You must make sure our troops are educated on the risks of consuming food from unapproved sources; however, sometimes we may find ourselves away from approved sources and forced to eat food and water off the economy. Some simple rules to prevent foodborne disease outbreaks are as follows:

- Eat only foods served to you piping hot.
- Avoid dairy products; many countries do not pasteurize their dairy products.
- Eat only fruits and vegetables that can be peeled, by peeling you can remove any contamination.
- Do not eat food from streetside vendors.
- Drink only bottled water or carbonated beverages from approved sources. Do not drink local water or consume ice.

If you cannot determine where these vendors have purchased the food or how they have prepared or handled it, your chances of acquiring a foodborne disease are increased.

Disease surveillance

Once you have set up your site and provided safe food, water, and waste disposal, disease surveillance should be the next step in preventing disease. Disease surveillance is necessary to determine if you have any "broken field sanitation and hygiene links" at the deployment location that could cause disease. For example, troops going into the local community and purchasing food from a questionable street vendor causes an increase in the number of cases of diarrhea. An epidemiological investigation would need to be initiated to determine source of high numbers and countermeasures. A countermeasure for this type of behavior would be reeducation of the troops.

Disease case numbers are gathered from your MTF or squadron medical elements. Diseases should be recorded daily and sent through the preventive medicine chain of command at the unified command level. Not only does this let you know what is occurring in your deployed population, it is also gathering disease surveillance for the overall "big picture" of the deployment. The medical commander should also be briefed on disease surveillance results by public health weekly. If your surveillance data indicates a problem or outbreak, the medical commander should be updated more frequently.

Vectorborne disease prevention

"Integrated disease management" is the combination of immunizations, chemoprophylaxis, personal protection, and avoidance to further protect oneself from arthropods and arthropod-borne disease. Individuals can practice countermeasures to reduce their chances of getting vectorborne diseases while living in field conditions. Preventing vectorborne diseases can be easy if personnel adhere to the preventive medicine countermeasures listed below.

Immunizations

Immunizations for yellow fever, plague, and Japanese encephalitis are among the first line of defense for our troops to remain protected from vectorborne disease.

Chemoprophylaxis

Medications like malarone, doxycycline, primaquine, and chloraquine are frequently prescribed to prevent Air Force personnel from becoming a victim to malaria. Medications are ingested before exposure to vectorborne disease. They circulate in the body killing disease pathogens. Some pathogens are resistant to chemoprophylactic treatments and may require alternative solutions to prevent disease. Chemoprophylaxis doesn't change the immune system, so sometimes it is required before, during, and after a deployment to ensure its effectiveness.

Personal protection

Personal protection is a must during contingency operations. Personal protection is the key factor used to protect personnel during contingency operations. Personal protection includes such things as the Airman battle uniform (ABU) and insect repellants.

Personal Protection Against Vectorborne Disease	
What	**How**
Personal protective equipment (PPE) is that equipment which our forces use to limit their exposure to vectors and other animals they may encounter during contingency operations. Of the many types of PPE that you can suggest to our personnel, examples include the head net, the ABU with sleeves rolled down and pants properly bloused.	Hot weather parka, headnet, bednet, and ABU with sleeves rolled down and top buttoned.

Personal Protection Against Vectorborne Disease	
What	**How**
Repellents are chemicals that repel insects and other pests when applied to the skin, clothing, or around living quarters. Examples include DEET, permethrin, and individual dynamic absorption (IDA) kit.	DEET, which can be applied to the exposed skin, comes in three different packages—a liquid in a 2- ounce (oz) plastic bottle, a cream in a 2 oz plastic tube, or a DEET/sunscreen combination in a plastic tube. Permethrin (.05%) can be applied to uniforms at a rate of 1 can per uniform, and lasts up to 5 hot washings. Permethrin can be sprayed around tents or bednets by a certified pesticide applicator, using 40% permethrin. The IDA kit which contains 40% permethrin mixed with a half canteen cup of water can be effective for up to 50 washings or 6 months on ABUs.
Barriers	Bednets treated with permethrin, headnets, screens, other solid barriers and ABU's.
Avoidance	Avoid breeding areas (e.g., swamps or marshes) and certain terrain features (e.g., holes in trees, vegetation along camp or trails), and dwelling places for vectors (e.g., mud and thatch huts).

Training

You provide field sanitation training to all deployed organizations (e.g., security police, CE, dining facilities, maintenance organizations, and the medical facility). The public health OIC/NCOIC is responsible for ensuring that all 4E0X1 personnel are trained in field sanitation. Another training program you are sometimes involved in is medical unit readiness training (MURT). You also conduct continual training during deployments. There are many sources of information available that will supplement your training program. Remember, if you find a gold mine of information; do not just hold onto it for yourself, let others know about it. Three important publications are as follows:

1. FM 4–25.12, *Unit Field Sanitation Team*.
2. FM 21–10, *Field Hygiene and Sanitation*.
3. NAVMED P–5010, *Manual of Naval Preventive Medicine, Preventive Medicine for Ground Forces*.

As you have noticed throughout this volume, we are responsible for giving a lot of guidance and education to other people. Without it, the medical unit would probably see a much larger number of patients. You must strive to increase our knowledge so you can train others more effectively.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

112. Public health threats under field conditions

1. What are the four types of diseases that occur in contingency operations?

2. In the field, what are the countermeasures to prevent respiratory diseases?

3. What is the number one cause of skin disease in the field?

4. Before we can make recommendations on how to avoid hazardous flora and fauna, what is our primary consideration?

5. One of the most important countermeasures in the field is personal hygiene. How is good personal hygiene maintained?

113. Public Health responsibilities during contingency operations

1. What are public health responsibilities in the field?

2. What are some simple rules to follow to prevent foodborne disease outbreaks under field conditions?

3. Which organizations receive field sanitation training from public health?

4. Who is responsible for ensuring all 4E0X1 personnel are trained in field sanitation?

2–2. Safe Food and Water

Food and water must come from approved sources. This is especially important on deployments. Local street vendors will offer a variety of nonapproved food and water sources to our personnel. At times, the only variety of food is operational rations for all three meals. If you are lucky, you may be be able to eat at a field kitchen. We educate services personnel to take extra care in ensuring the field kitchen is kept clean and the foods are protected to prevent foodborne disease outbreaks. Some believe that food code requirements can be reduced in field conditions; however, just the opposite is true. On deployments, extra care must be taken to ensure our food and water supplies are not contaminated by dusty environments or by an enemy saboteur. If food or water is contaminated, the entire unit is vulnerable to disease or illness. It is your job to help prevent that from happening. You must work with services personnel and other medical personnel to ensure our troops are safe from disease. In this section you will study food handling and water in a field environment.

114. Transporting and storing foods

It can be challenging to feed personnel deployed in field conditions. As a rule, when deployed overseas, you should assume food from local vendors is suspect; therefore, foods from approved sources must be transported to us and stored safely. Foods may be transported many miles or stored for long periods of time. You must keep the stressors of time and temperature in mind as you inspect foods in the field.

Transportation

Vehicles used to transport foods must be clean and covered to protect foods from the sun, dirt, insects, rodents, and other sources of contamination. They should not be used for transporting garbage, trash, petroleum products, or other materials that could contaminate the food. In a deployment situation, vehicles are often used for hauling garbage, munitions, supplies, and food. You must ensure the vehicles are thoroughly cleaned prior to transporting food. To prevent contaminating the food, you should recommend that the food facility supervisors and vehicle drivers use clean tarpaulins, bags, or other clean containers. If bulk quantities of meat and dairy products are transported a considerable distance, refrigerated vehicles must be used. Cold and hot foods should be transported as quickly as possible in containers that will maintain their proper temperatures. The deployed public health (PH) tech should be working with the Contracting Office to make sure there are food safety requirements written into the food vendor's contract.

Storage

Upon receipt of food products in the food service facility, the unit food service officer or another responsible individual must inspect it. Any food suspected of being unfit for human consumption is referred to the unit public health officer, medical unit commander, or authorized representative for his or her evaluation and recommendation.

Just as foods must be transported in clean vehicles at proper temperatures, they must also be stored in a similar manner. Remember, in a field situation storage facilities will have to be made from the resources available. Keep the following general food storage principles in mind:

- Store foods in clean, covered containers once they have been removed from their original wrappers or containers.
- Store containers of food at least 6 inches above the floor/ground to reduce contamination and facilitate cleaning.
- Do not use galvanized containers to store meat, fruits, salads, tea, coffee, lemonade, fruit juices, or other foods containing acids to prevent toxins.
- Foods should be stored out of direct sunlight and in a dry, cool place.
- Storage facilities should be insect and rodent proofed to prevent infestations and food loss.
- When storing food products in tents, bury the tent flaps to prevent rodent access. Ensure screens are in good repair to exclude flies.

Potentially hazardous food

Although specialized equipment may be limited during field conditions, food safety becomes a more paramount concern. Under field conditions, potentially hazardous foods require the same care as they would in a permanent facility. To ensure the safety of potentially hazardous foods, they should be stored in accordance with (IWA) the food code.

Perishables

The important thing to remember is refrigeration capabilities will vary from unit to unit and mission to mission. If refrigeration units are available, they will most likely run off generators, which are subject to failure. Therefore, close monitoring of temperatures is essential; and an excellent method for services personnel to use is tracking charts. When a refrigeration outage occurs, have a plan to work with services personnel. Try to salvage as much food as possible because it may be days or even weeks before you get more food. In a more primitive setting, ice chests may be all you have to keep foods cold. Ice used in ice chests and ice that comes into contact with food or food contact surfaces must be potable. Remember, the more primitive the refrigeration facilities, the closer you will have to watch the foods because they will deteriorate more rapidly.

Semiperishable

Semiperishable foods, such as dry goods and canned items, should be stored in clean, sealable containers and protected from excessive heat and moisture. You should check these items frequently for deterioration and rodent or insect problems.

115. Preparing, handling, and serving foods

Food must be prepared, handled, and served correctly to ensure it remains safe during contingency operations. Often conditions will be less than optimal in field situations and warrant personnel exercising extra precaution to help food remain safe.

Facilities

Facilities for preparing and serving food will vary depending upon the unit, its location, number of personnel, and the mission. Although facilities vary, they should all be kept clean and in good repair. The following facility guidelines should be followed:

- They should be as insect and rodent proofed as possible.
- Screening, if available, should be used over open windows. Holes or cracks in the facility should be repaired quickly and tent bottom flaps buried or sandbagged.
- Utensils and food preparation equipment should be stored in protected areas to minimize contamination (like airborne dust from vehicles driving by on a dusty road).
- Sanitizing food contact surfaces cannot be overemphasized. In a dusty, dirty environment, sanitize both before and after food preparation/handling.
- Food and other kitchen wastes need to be disposed of quickly in an acceptable manner to reduce insect and rodent feeding and breeding places.
- If insecticides or rodenticides are used, they should be applied following label directions by certified pest management personnel. Great care should be taken not to contaminate foods and food contact surfaces.

Food employees

During Desert Shield/Storm, one of the major problems in preventing foodborne disease outbreaks was trying to educate contracted food employees from many different nations that spoke different languages. Language barriers may require you to educate food employees through a translator and may require you to perform more frequent inspections for contract compliance. A food employee not following proper food handling practices, or with a communicable disease, could cause a foodborne disease outbreak among your deployed forces, rendering them unable to perform their mission. This is why it is important for all food employees to stay healthy and remain knowledgeable about food storage, preparation, and serving procedures. Train all assigned food employees in the principles and practices of controlling foodborne disease outbreaks IAW the food code.

The person in charge of the food facility inspects food employees daily for signs of illness or evidence of infection. Personnel with skin infections, boils, diarrhea, or other signs of illness should *not* be allowed to work until they are examined by a medical officer.

Cleaning and sanitizing utensils and equipment

When facilities and conditions permit, utensils and equipment should be cleaned and sanitized IAW the food code. Under most field conditions, personnel will not have the luxury of having piped-in hot water or automatic dishwashers. Many times, adequate washing and sanitizing equipment will have to be improvised from supplies on hand.

Cleaning procedures

Utensils, equipment, and mess kits must be cleaned and disinfected after each use by using a mess kit laundry. Immersion heaters are used to heat the water in three 36-gallon (gal) cans. When the immersion heaters are put in the 36-gal cans, it will result in only 20 gal of water, so remember to dose chlorine accordingly. The cans in the laundry setup are used for the following:

1. Scraps—food waste.
2. Wash water—contains warm soapy water and a stiff bristle brush.

3. Rinse water—contains boiling water.
4. Sanitizing—contains boiling water or sanitizing solution.

Sanitizing procedures

Utensils and equipment can be sanitized by immersing them in boiling water for 30 seconds or in a chlorine solution for at least one minute. When hot water is not available, a food service disinfectant may be used for sanitizing; however, a 100-ppm chlorine solution is most commonly used. If using chlorine, the solution can be made by adding one-third canteen cup of five percent chlorine bleach to each 10 gal of water, or one mess kit spoonful of calcium hypochlorite to 10 gal of water. A fresh chlorine solution should be made for rinsing and disinfecting utensils for each 100 people. Other sanitizing solutions may also be used as defined in the food code.

Once washing and sanitizing are complete, items must be air-dried in a clean, dust-free place. Educate personnel to rinse their mess kits again just prior to use. Usually services personnel will place a 36 gal can with boiling water just in front of the mess kit trailer so personnel have one last chance to sanitize their kits before food is served to them. Other food contact surfaces may be sanitized by swabbing them with a chlorine solution at least twice as strong as that described above. Remember to keep items protected from contamination.

Serving food

You have already learned basic food preparation and serving techniques, cooking and holding temperatures, and which foods are potentially hazardous. You are going to use these basic principles and adapt them to the different field situations. Hot foods should ideally be served hot (more than 135 degree Fahrenheit [°F]) and cold foods (less than 41°F) served cold. If optimum temperatures cannot be achieved, you should evaluate the situation based on what the food is, how hazardous it is, what temperature is being maintained, and the length of time held at that temperature. Minimize the time between the preparation and serving of food. Thorough cooking and immediate serving will reduce the chances of food becoming contaminated. Also, meals should be planned to reduce the amount of leftovers. Items held at improper temperatures should not be retained as leftovers for reuse. Food code guidelines should be followed as much as possible.

Inspecting food service facilities

Common sense must also be used when inspecting food service facilities. Facilities may range from a tent to an initial deployment kitchen (IDK), or to an actual hardened building. Adjustments may be made based on the facilities available. The purposes of inspecting these facilities are to do the following:

- Ensure basic standards are maintained.
- Identify potential problems that could result in a foodborne disease outbreak.
- Recommend ways to correct problems.
- Provide an opportunity to educate food service personnel in effective food sanitation procedures.

It is very important that you work closely with food service personnel to help prevent foodborne disease outbreaks. Remember, the health and safety of our troops depends on you.

116. Field water

Water is one of our most vital resources and is necessary for our survival. Without it, the human body will only survive two to five days. Insufficient quantity and quality of drinking water are not only debilitating to the individual, but could have a significant impact on operational readiness. Preventive medicine personnel assist in selection of field water sources and insure the water is safe to drink by performing inspections and periodic water tests. This lesson provides information and guidance on selection and surveillance of field water.

Sources of water

Water may be obtained from a variety of sources in the field. Below are the most commonly used sources of field water. All water sources should be considered unsafe until treated, tested, and approved for use by the preventive medicine personnel.

Existing public water supply

Existing public water systems are the easiest and, in most cases, the safest sources because this water has been treated to some extent. However, this does not preclude the requirement to test the quality of the water. Many municipal water supplies do not conform to high levels of water safety. Water from any source must be tested and meet military standards prior to use.

Surface water

Surface waters such as streams, ponds, rivers, and lakes are generally the most accessible, and are commonly selected for use in the field. They are usually more polluted than other water sources; but in the field, quantity and accessibility requirements are given priority over quality requirements. Surface water is also the easiest target for sabotage. Ensure proper treatment prior to use.

Ground water

Ground water from wells and springs may be selected for use when a surface source is not readily available. Ground water is usually less contaminated than surface water and requires less treatment; however, it is difficult to determine the quantity available. It is also difficult, costly, and time-consuming to drill wells. Because of these disadvantages, the use of ground water in the field is limited unless existing wells are available. Ground water sources must be at least 100 yards from potential sources of contamination such as latrines, and industrial run-off.

Bottle water

Bottled water is sealed in bottles or other containers by a commercial or military source for human consumption. Water that is produced and packaged by the military will conform to established standards. Preventive medicine personnel will inspect military purification and packaging operations prior to the start of operations. Commercially purchased bottled water must come from approved military sources. A list of military approved sources can be found through the US Army Public Health Command (USAPHC). USAPHC or Defense Logistics Agency (DLA) quality assurance personnel inspect commercial bottling facilities to ensure compliance with acceptable sanitation standards.

Water purification

Water that is not properly treated and disinfected can spread diseases such as cholera, shigellosis, typhoid, and paratyphoid fever. Untreated water can also transmit viral hepatitis, gastroenteritis, and parasitic diseases such as amoebic dysentery, giardiasis, cryptosporidosis, and schistosomiasis. Although isolated cases of each of these may not be a big problem, imagine what would happen if 80 percent of the personnel in a unit were sick. A contaminated water supply can quickly disable an entire unit, making it impossible for personnel to carry out their mission.

Potable water is free from disease-producing levels of organisms, poisonous substances, chemical or biological agents, and radioactive contaminants. However, potable water may not be palatable. Palatable water is pleasing in appearance and taste. It is free from color, turbidity, taste, and odor.

NOTE: Palatable water may not be potable.

Reverse osmosis water purification unit

The reverse osmosis water purification unit (ROWPU) is the Air Force’s preferred method for purifying water because it reliably provides high-quality potable water, even from low-quality, contaminated sources. This versatile machine will produce potable water from contaminated sources including fresh, brackish, or saltwater. The intake line of the ROWPU shall be affixed with a strainer. When the source is a body of water (lake, pond, river, stream, etc.), a float or anchor should hold the intake line at least four inches from the surface or bottom. The effluent line should be positioned so effluent is discharged at least 25 yards downstream from the intake line in the case of flowing surface sources. The ROWPU trailer/pallets must be level and grounded. The filter backwash tank must be filled with brine, and there will be a separate storage tank for raw water, if raw water storage is used. Generator(s) should be grounded and ventilated to prevent carbon monoxide intoxication. A fire extinguisher should be in the immediate area and operators should wear ear protection within 50 feet of operating equipment. Where diseases such as schistosomiasis and leptospirosis are prevalent or chemical warfare agents are likely, operators must wear rubber hip boots and long rubber gloves. CE personnel use gauge readings to ensure the unit's components are operating properly. Preventive medicine personnel should familiarize themselves with normal readings for the type of unit in use.

Water disinfection

While the ROWPU water for physical and chemical contaminants, it does not remove or destroy harmful microbiological organisms. Accordingly, potable water must be disinfected to remove disease-producing organisms.

Chlorine is the disinfectant agent specified for military use throughout the tactical water distribution system (TWDS). It is the only widely accepted agent that destroys organisms in water and leaves an easily detectable residual (free-available chlorine) that serves as a tracer element. Disappearance of chlorine in potable water signals potential contamination in the system. Sodium hypochlorite (liquid bleach) and calcium hypochlorite powder are the two chemicals used by the military to chlorinate water. CE personnel are responsible for disinfecting all field water supplies; however, preventive medicine personnel may be asked to provide guidance on the proper disinfecting procedures.

Disinfection of water distribution system

The TWDS consists of water production (600 gallons per hour (gph) and 3,000 gph ROWPU), storage (800K gal, 300K gal, and 40K gal bladders), and bulk transport (3K gal and 5K gal semitrailer-mounted fabric tanks) systems. Free-available chlorine (FAC) will be maintained at 2 ppm throughout the TWDS. The correct contact time prior to testing is 30 minutes at all points throughout the system.

Disinfection of water treated by other means

Water purified by means other than ROWPU will be disinfected by adding chlorine, at the production site, to maintain a 5 mg/L (5 ppm) FAC through the TWDS.

Disinfection at the unit level

FAC will be maintained at 1 ppm in unit-level containers (400 gal trailers, Lyster bags collapsible pillow tanks, and 55 gal and 250 gal drums).

Disinfection at the individual level

FAC will be maintained at 0.2 ppm at the individual service member level (canteen). Each service member is instructed how to personally disinfect his or her individual water supply.

Emergency disinfection

When away from supply lines and treated water is not available, individual service members must select the clearest, cleanest water with the least odor and treat the water using individual water purification means. Preventive medicine personnel will brief troops on the following emergency disinfection procedures:

Emergency Water Disinfection	
Name	**Procedure**
Iodine	When treated water is not available, individuals must disinfect their own water using iodine tablets. Usable and effective iodine tablets should be blue-green in color. Two iodine purification tablets added to a canteen (1 quart) of water releases 16 ppm of iodine as a disinfecting agent. To use these tablets, place the tablets into the canteen. After five minutes shake the canteen, loosen the canteen cap, and allow the iodine-treated water to seep around the neck of the canteen to kill any organisms harbored there. A minimum contact time of 60 minutes is required for water disinfection using the iodine purification tablets. At the present time, there is no field method used to determine the iodine residual.
Chlor-Floc	One of the shortcomings of the iodine water treatment is that it doesn't remove suspended solids, and it doesn't kill some disease-causing organisms. The newest method for the emergency treatment of individual water supply in the field is the Chlor-Floc water treatment kit. It is intended for the clarification and disinfection of the individual's canteen water supply. Chlor-Floc tablets contain a combination of flocculation (chemical suspending particles) and coagulating (forming into a thickened mass) agents and chlorine that promote rapid formation of sediment in the treated water. Pollutants and microscopic particles adhere to the sediment and settles out by gravity. The clarified water is strained through the provided canteen flannelette filter, removing even more solids. After clarification of the water by separating the sediment from the treated water, the chlorine released by the tablet is free to kill giardia lamblia cysts, bacteria, viruses, and other pathogens. Each kit comes with 30 Chlor-Floc tablets, one treatment bag, one canteen flannelette, and easy-to-follow instructions.
Boiling	Boiling is not the best field-water disinfection method since there is no residual protection against recontamination. Use boiling water when other disinfecting compounds are not available. Boiling water at a rolling boil for five to 10 minutes kills most organisms that are known to cause intestinal diseases. You must be careful to use clean containers for boiling the water. After boiling, the water must be stored in a clean, closed container to prevent recontamination

117. Water storage inspections

Preventive medicine personnel will perform periodic inspections of the TWDS to ensure potability of the water and sanitary conditions. Inspection results must be documented. A copy of the inspection report should be left with the inspected unit. Below are the inspections that fall into the preventive medicine area of responsibility.

General site conditions

No pollution sources shall exist nearer than two miles upstream or upgradient from the water source (e.g., river or lake). Drainage must be adequate to prevent ponding at distribution points. Dust control measures will be employed to prevent dust-borne bacteria from contaminating water and equipment. Rodent and insect breeding areas must be controlled to prevent the spread of disease. Garbage and trash must be properly stored and disposed to prevent contamination of the water source or system.

400 gal water trailer (water buffalo)

Manhole covers will seal effectively to prevent contamination. Rubber gaskets will be intact and not have cracks, missing pieces, excessive dry rot, or improper fit. The manhole cover locking mechanism will be functional. The manhole cover and tank interior will not be rusted. Spigots will be functional. Locking devices for spigot covers will be functional. Drain plugs should be hand-tight and easy to remove. Stains caused by natural water impurities, such as iron and manganese, are permitted. However, stains resulting from rust, storage of unauthorized liquids, or improper painting are not permitted. Chips or cracks in the interior surface are ideal areas for biological growth and contamination. Trailers where more than 10 percent of the interior is chipped or cracked or where the fiberglass subsurface is exposed will be put out of service and repaired. Flaking of the interior surface paint may result from use of unauthorized paint or improper surface preparation. Trailers with excessive flaking of interior surfaces should be put out of service and repaired.

When the water trailer arrives in the unit area from a filling point, always check the chlorine residual. This completes and verifies the following two things:

1. The driver went to an approved water point.
2. The water point is maintaining the correct chlorine residual in the water.

The chlorine residual should be at 1 ppm FAC or the level established for the area of operation. If the residual meets the required standard, the water is safe to drink; if not, the water must be rechlorinated to the required level. After rechlorination the water must be checked periodically to maintain the minimum required level. Heat and sunlight will cause chlorine to dissipate more rapidly; therefore, periodic rechlorination may be required. To rechlorinate a full water buffalo follow these steps:

1. Use one mess kit spoonful of calcium hypochlorite, or mix three MRE spoonfuls of calcium hypochlorite, or 27 ampules of calcium hypochlorite dissolved in one-half canteen cup of water.
2. Flush the four water spigots for several seconds.
3. Wait 30 minutes, then flush the spigots again and check the chlorine residual. If the residual is at least 1 ppm FAC or greater, release the water for consumption.
4. If the residual is below 1 ppm (FAC) additional chlorine must be added to the water. Mix a slurry as before; however, the amount of chlorine required may be less than three MRE spoonfuls, estimate the amount needed.
5. After adding the new batch, the 10-minute waiting time, flushing, and testing procedures as above must be repeated.

Lyster bag

The 36 gal Lyster bag (fig. 2–1) is issued to units on the basis of one per 100 persons. If the fabric material has been repaired, patches or temporary plugs in the Lyster bag must be secure. The check-valve adapter must be undamaged and open easily. Dust caps must be attached to couplers when not in use. The Lyster bag must be cleaned before it is used. Also, it must be hung away from areas that could cause potential contamination, such as a tree.

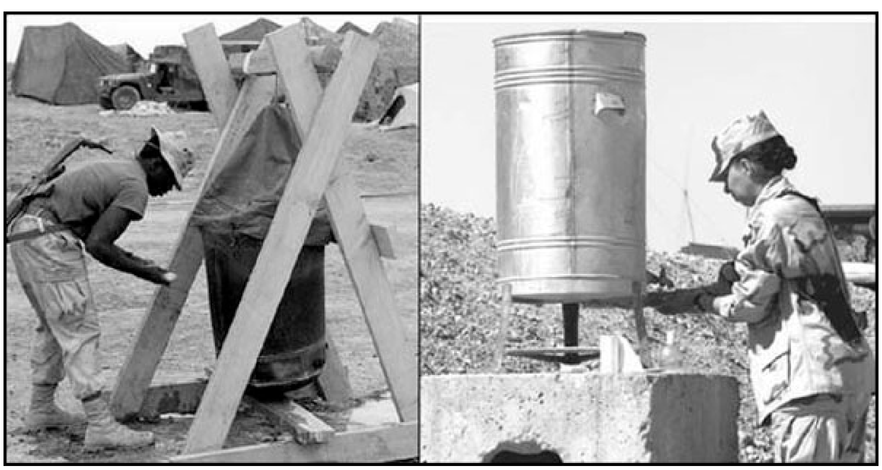

Figure 2–1. Lyster bag.

Before it is filled with water, clean the bag with a solution made with one ampule of calcium hypochlorite dissolved in one gal of water. Fill the cleaned bag only to within four inches from the top. Then, flush the faucets with a small quantity of water. After 10 minutes flush the faucets again, and determine the chlorine residual.

The calcium hypochlorite ampules are issued for convenience. Each ampule contains 0.5 gram of calcium hypochlorite and gives a chlorine dosage of approximately 2 ppm FAC when added to the water in the Lyster bag. Use as many ampules as necessary to provide the required 1 ppm (FAC) chlorine residual after a 30 minute contact period.

Water trailers/trucks

Inspection criteria for manhole covers are the same as for 400 gal buffalos. Dispensing valves should operate freely and close tightly. Threads on hose couplings should be intact and undamaged. Dust caps must be attached to dispensing valves except when valves are in use. The mesh screen inside the filling port and the tank interior should be free of rust. Metal interiors will not be painted. The required chlorine residual at a water trailer is 2 ppm FAC.

Water monitoring

During peacetime, bioenvironmental engineering personnel are responsible for testing potable water sources. However, with the development of new preventive medicine UTCs, public health personnel are required to perform field water source selection and testing more and more.

Chlorine and pH testing

CE water production/distribution personnel will check the water from purification equipment for chlorine residual pH (symbol for hydrogen) every 30 minutes of the operating day. Also, they will check bulk storage and distribution points every hour and check water trailers daily. Preventive medicine personnel must test host nation water, and/or potable water from military purification equipment, storage tanks, distribution points, field kitchens, and latrines for FAC and pH on a weekly basis. The bulk containers should also be tested after each refill.

There are two primary chlorine residual testing kits available in the Air Force inventory. They are the Hach N, N-Diethyl-P-Phenylenediamine Sulfate (DPD) kit and the orthotoludine water test kit. Both kits come with a color comparator and instructions to determine the chlorine residual and pH of the water.

Bacteriological testing of water

The bacteriological test is primarily for testing the quality of treated water, bottled water, and swimming pool water. Preventive medicine personnel must test host nation water, and/or potable water from military purification equipment, storage tanks, distribution points, field kitchens, and latrines for bacteria on a weekly basis.

The indicator organisms you use to determine if water is contaminated are *coliforms*. Coliform determination has been used as a measure of water contamination for over 70 years. It is valuable not because coliforms are pathogenic, but because they are always present in the normal intestinal track of humans and warm-blooded animals. They are found in great numbers throughout fecal wastes. Since they have these characteristics and die off after pathogenic bacteria, they are used as “indicator organisms” to indicate the presence of fecal contamination of drinking water.

The presence of coliforms may not indicate the water is hazardous but their absence provides reasonable evidence of water safety. Protozoa, bacteria, viruses, fungi, and parasitic worms are the result of animal and human defecation and hence the presence of coliforms may indicate their presence as well. The acceptable level of coliforms per 100 ml (milliliter) for drinking water is one coliform forming unit (CFU). Any counts greater than this requires retesting and two successive negative results to be approved. Ensure proper levels of chlorination are maintained. The two primary kits used by the DOD for testing drinking water are Colilert (presence/absence) and Millipore (membrane filter). These kits are not complicated to use; however, they require hands-on training. Therefore, we suggest you either learn them from your local BE office, or attend the Contingency Preventive Medicine (CPM) course at the USAF School of Aerospace Medicine (USAFSAM).

Superchlorination

The superchlorination process is used to disinfect water containers and distribution systems initially (before they are used) or when they have become contaminated. Superchlorination is completed by chlorinating the water in a container or distribution system to at least 100 ppm FAC residual and holding it in the container for four hours. During that time the FAC must not drop below 50 ppm; otherwise, the process must be repeated. The words “Poison Do Not Drink” must be displayed clearly on all sides of the container or at all water outlets during the process. Superchlorination can be completed through the following steps:

1. Fill the water container or line with water containing at least 100 ppm. A higher concentration may be desirable, depending on the extent of the contamination in the container, to ensure the residual does not drop below 50 ppm after the four-hour contact time. Refer to the *Chlorine Dosage Calculator* (see table below) for the amount of calcium hypochlorite granules or sodium hypochlorite bleach to use for the volume of the container or water pipes to be disinfected.
2. Determine the resulting FAC using a chlorine test strip.
3. Measure the FAC residual again after a four-hour contact time. The FAC must be at least 50 ppm at this time. If the FAC is below 50 ppm, the superchlorination procedure must be repeated.

After superchlorination has been completed, drain the container or pipes, rinse them thoroughly, and fill them with potable water from an approved source.

Sodium Hypochlorite Dosage Calculator									
Desired Parts Per Million		**1**	**1**	**1**	**1**	**5**	**5**	**5**	**5**
Strength of Chlorine Solution		**5%**	**10%**	**15%**	**16%**	**5%**	**10%**	**15%**	**16%**
Gallons of Water to be Chlorinated	**50000**	1.0 gal 3785 cc	2.0 qt 1892 cc	42.7 oz 1262 cc	40.0 oz 1183 cc	5.0 gal 18925 cc	10.0 qt 9463 cc	213.3 oz 6308 cc	200.0 oz 946 cc
	25000	2.0 qt 1892 cc	1.00 qt 946 cc	21.33 oz 631 cc	20.00 oz 591 cc	10.0 qt 9463 cc	5.0 qt 4731 cc	106.7 oz 3154 cc	100.0 oz 2957 cc
	10000	25.6 oz 757.0 cc	12.80 oz 378.5 cc	8.53 oz 252.3 cc	8.00 oz 236.6 cc	128.0 oz 3785 cc	2.0 qt 1892 cc	42.67 oz 1262 cc	40.0 oz 1183 cc
	5000	12.8 oz 378.5 cc	6.40 oz 189.2 cc	4.27 oz 126.2 cc	4.00 oz 118.3 cc	2.0 qt 1892 cc	1.0 qt 946.0 cc	21.33 oz 630.8 cc	20.0 oz 591.4 cc
	2000	5.1 oz 151.4 cc	2.56 oz 75.7 cc	1.71 oz 50.5 cc	1.60 oz 47.3 cc	25.6 oz 757.0 cc	12.8 oz 378.5 cc	8.53 oz 252.3 cc	8.0 oz 236.6 cc
	1000	2.56 oz 75.70 cc	1.28 oz 37.85 cc	0.85 oz 25.23 cc	0.80 oz 23.66 cc	12.80 oz 378.5 cc	6.40 oz 189.2 cc	4.27 oz 126.2 cc	4.00 oz 118.3 cc
	500	1.28 oz 37.85 cc	0.64 oz 18.92 cc	0.43 oz 12.62 cc	0.40 oz 11.83 cc	6.40 oz 189.2 cc	3.20 oz 94.62 cc	2.13 oz 63.08 cc	2.00 oz 59.14 cc
	200	0.51 oz 15.14 cc	0.26 oz 7.57 cc	0.17 oz 5.05 cc	0.16 oz 4.73 cc	2.56 oz 75.70 cc	1.28 oz 37.85 cc	0.85 oz 25.23 cc	0.80 oz 23.66 cc
	100	0.26 oz 7.57 cc	0.13 oz 3.78 cc	0.09 oz 2.52 cc	0.08 oz 2.37 cc	1.28 oz 37.85 cc	0.64 oz 18.92 cc	0.43 oz 12.62 cc	0.40 oz 11.83 cc
	50	0.13 oz 3.78 cc	0.06 oz 1.89 cc	0.04 oz 1.26 cc	0.04 oz 1.18 cc	0.64 oz 18.92 cc	0.32 oz 9.46 cc	0.21 oz 6.31 cc	0.20 oz 5.91 cc
	25	0.06 oz 1.89 cc	0.03 oz 0.95 cc	0.02 oz 0.63 cc	0.02 oz 0.59 cc	0.32 oz 9.46 cc	0.16 oz 4.73 cc	0.11 oz 3.15 cc	0.10 oz 2.96 cc
	10	0.03 oz 0.76 cc	0.01 oz 0.38 cc	0.01 oz 0.25 cc	0.01 oz 0.24 cc	0.13 oz 3.78 cc	0.06 oz 1.89 cc	0.04 oz 1.26 cc	0.04 oz 1.18 cc

$$\textbf{Ounces of Sodium Hypochlorite for 1 ppm solution} = \frac{1}{1{,}000{,}000} \times \frac{\text{gallons of water to be chlorinated}}{\text{Strength of chlorine solution}} \times \frac{128 \text{ fluid ounces}}{\text{gallon}}$$

Conversion Factors:

1 gallon (gal) = 4 quarts (qt)
1 gallon = 8 pints (pt)
1 gallon = 128 Fluid Ounces (oz)
1 gallon = 3785.41 Cubic Centimeters (cc)
1 quart = 946.35 Cubic Centimeters
1 pint = 473.18 Cubic Centimeters
1 Fluid Ounce = 29.57 Cubic Centimeters

Calcium Hypochlorite Dosage Calculator

Desired Parts Per Million		1	1	1	1	5	5	5	5
Strength of Chlorine Solution		55%	60%	65%	70%	55%	60%	65%	70%
Gallons of Water to be Chlorinated	50000	12 oz 344 grams	11.12 oz 315 grams	10.26 oz 291 grams	9.53 oz 270 grams	60.7 oz 1720 grams	55.60 oz 1576 grams	51.32 oz 1455 grams	47.66 oz 1351 grams
	25000	6.07 oz 172 grams	5.56 oz 158 grams	5.13 oz 146 grams	4.77 oz 135 grams	30.3 oz 860 grams	27.80 oz 788 grams	25.66 oz 728 grams	23.83 oz 676 grams
	10000	2.43 oz 69 grams	2.22 oz 63 grams	2.05 oz 58 grams	1.91 oz 54 grams	12.1 oz 344 grams	11.12 oz 315 grams	10.26 oz 291 grams	9.53 oz 270 grams
	5000	1.21 oz 34 grams	1.11 oz 32 grams	1.03 oz 29 grams	0.95 oz 27 grams	6.07 oz 172 grams	5.56 oz 158 grams	5.13 oz 146 grams	4.77 oz 135 grams
	2000	0.49 oz 13.8 grams	0.44 oz 12.61 grams	0.41 oz 11.64 grams	0.38 oz 10.81 grams	2.43 oz 68.8 grams	2.22 oz 63.05 grams	2.05 oz 58.20 grams	1.91 oz 54.04 grams
	1000	0.24 oz 6.88 grams	0.22 oz 6.31 grams	0.21 oz 5.82 grams	0.19 oz 5.40 grams	1.21 oz 34.4 grams	1.11 oz 31.53 grams	1.03 oz 29.10 grams	0.95 oz 27.02 grams
	500	0.12 oz 3.44 grams	0.11 oz 3.15 grams	0.10 oz 2.91 grams	0.10 oz 2.70 grams	0.61 oz 17.2 grams	0.56 oz 15.76 grams	0.51 oz 14.55 grams	0.48 oz 13.51 grams
	200	0.05 oz 1.38 grams	0.04 oz 1.26 grams	0.04 oz 1.16 grams	0.04 oz 1.08 grams	0.24 oz 6.88 grams	0.22 oz 6.31 grams	0.21 oz 5.82 grams	0.19 oz 5.40 grams
	100	0.02 oz 0.69 grams	0.02 oz 0.63 grams	0.02 oz 0.58 grams	0.02 oz 0.54 grams	0.12 oz 3.44 grams	0.11 oz 3.15 grams	0.10 oz 2.91 grams	0.10 oz 2.70 grams
	50	0.01 oz 0.34 grams	0.01 oz 0.32 grams	0.010 oz 0.29 grams	0.010 oz 0.27 grams	0.06 oz 1.72 grams	0.06 oz 1.58 grams	0.05 oz 1.46 grams	0.05 oz 1.35 grams
	25	0.01 oz 0.17 grams	0.006 oz 0.16 grams	0.005 oz 0.15 grams	0.005 oz 0.14 grams	0.03 oz 0.86 grams	0.03 oz 0.79 grams	0.026 oz 0.73 grams	0.024 oz 0.68 grams
	10	0.00 oz 0.07 grams	0.002 oz 0.06 grams	0.002 oz 0.06 grams	0.002 oz 0.05 grams	0.01 oz 0.34 grams	0.01 oz 0.32 grams	0.010 oz 0.29 grams	0.010 oz 0.27 grams

Notes: Figures expressed in ounces are in dry ounces not fluid ounces. Where two figures are shown, use one or the other, not both.

$$\text{Ounces of Calcium Hypochlorite for 1 ppm solution} = \frac{1}{1{,}000{,}000} \times \frac{\text{gallons of water to be chlorinated}}{\text{Strength of chlorine solution}} \times \frac{\text{16 ounces}}{\text{pound}} \times \frac{\text{8.34 pounds}}{\text{gallon}}$$

Conversion Factors

1 ounce (oz) = 28.35 grams
1 pound (lb) = 453.59 grams
1 pound = 16 ounces
1 gallon of water weighs 8.34 pounds

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

114. Transporting and storing foods

1. Why should vehicles used to transport food be clean and covered?

2. List the principles for storing food in field situations.

3. How should potentially hazardous foods be stored?

4. What is the requirement for ice used in ice chests and ice that comes in contact with food or food contact surfaces?

5. How should semiperishable foods be stored?

115. Preparing, handling, and serving foods

1. To minimize contamination where should utensils and equipment be stored?

2. Why do food and other kitchen wastes need to be disposed of quickly and in an acceptable manner?

3. What should be used to train permanently assigned food employees?

4. Why should the food facility supervisor inspect food employees daily?

5. Which food employees should *not* be allowed to work until they are examined by a medical officer?

6. When are utensils and equipment cleaned and disinfected?

7. How can utensils and equipment be disinfected?

8. Why are food service facilities inspected in field conditions?

116. Field water

1. List possible sources of water for a deployed unit.

2. Which water source is most commonly selected for use in the field? Why?

3. What two chemical agents are most commonly used for chlorinating water in the field by the military?

4. After adding two iodine purification tablets to a canteen of water and shaking for five minutes, how much contact time is required before the water is considered safe to consume?

5. List three different methods of disinfecting water.

6. What is the biggest disadvantage of boiling to disinfect drinking water?

117. Water storage inspections

1. A large trailer of water has been chemically treated with chlorine. What is the minimum chlorine residual necessary for drinking water to be considered safe?

2. In a deployed environment, how often should CE water production/distribution personnel check the water from purification equipment for chlorine residual and pH?

2–3. Waste Disposal

The proper disposal of all wastes is essential in preventing the spread of disease. Liquid and solid wastes produced under field conditions may amount to 100 lb per person, per day. A camp without proper waste disposal methods soon becomes an ideal breeding area for flies, rats, and other vermin and may result in diseases such as dysentery, typhoid, paratyphoid, and cholera among personnel. In this section, you'll study disposal methods of human waste, garbage, and medical waste. The methods selected for use will depend upon the location of the unit and the military situation. Generally, wastes are buried if the environment, especially soil conditions, and local regulations permit.

118. Human waste disposal in field conditions

Human waste disposal becomes a problem for both the individual and the unit in the field. Latrines are constructed to prevent the contamination of food, water, and the environment. The basic sanitary requirements for latrines are as follows:

1. They must be located at least 100 yards downwind from food service facilities and at least 100 feet downstream from any unit ground water source.
2. Latrines must not be dug to the ground water level or in places where pit contents may drain into the water source.
3. They must be built at least 30 yards from the border of a unit area but within reasonable distance for easy access.
4. A drainage ditch should be dug around the edges of the latrine enclosure to keep out rainwater and other surface water.

At a minimum, handwashing devices are installed at each latrine enclosure and in front of dining facilities. These devices should be easy to operate and provided with ample soap and water. Each person must wash his or her hands after using the latrine and prior to eating. As a guideline, enough latrines to service four percent of the male population and six percent of the female population within the command should be provided.

Closing latrines

When a latrine is filled to within 1 foot (ft) of the ground surface or when it is to be abandoned, it is closed in the following manner.

1. The pit is filled to the ground surface in 3-inch layers of dirt, each layer being compacted and sprayed with a residual insecticide. This is to prevent fly pupae from hatching and gaining access to the open air.
2. Dirt is then compacted over the pit to form a mound at least 1 ft high. This will provide a 24-inch dirt cover over the waste before closing.
3. A sign is posted with the date and the words "closed latrine," if the tactical situation permits.

Types of latrines

Under field conditions, numerous types of latrines are used—cat-hole, straddle trench, deep pit, burn-out, mound, pail, and chemical. The field unit's length of stay usually determines the type of latrine that is used.

Field Condition Latrines	
Length of Stay	**Type of Latrine**
Short stays (i.e., one day or less), when troops are on a march.	A *cat-hole* latrine dug approximately 1 ft deep and completely covered and packed down with dirt after use.
Temporary stays (i.e., 1 to 3 days).	*Straddle trench* latrine unless more permanent facilities are provided for the unit.
Temporary camp (i.e., two weeks or less).	*Deep pit* latrine and urine soakage pits.

Cat-hole latrine

The cat-hole latrine (fig. 2–2) is used and dug by each person for his or her individual use. It is most frequently used by Armed Forces personnel on the go.

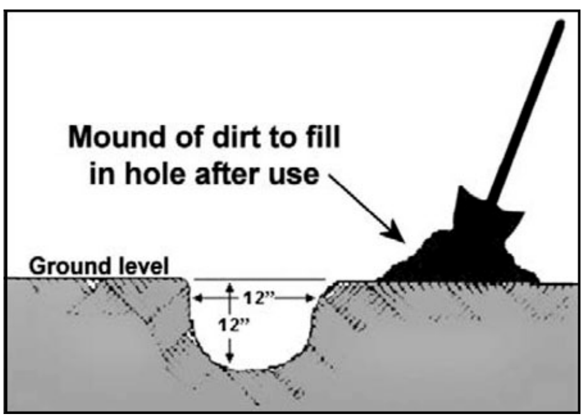

Figure 2–2. Cat-hole latrine.

Straddle trench latrine

For a straddle trench latrine (fig. 2–3), a trench is dug 1 ft wide, $2^1/_2$ ft deep, and 4 ft long. Two feet of length are allowed per person. The trenches are constructed parallel to one another, at least 2 feet apart. As a general rule, remember to construct enough straddle trenches for four percent of the male population and six percent of the female population. Since there are no seats on this type of latrine, boards may be placed along both sides of the trench to provide sure footing. As the earth is removed, it is piled at one end of the trench. A shovel or paddle is provided so each person can promptly cover his or her excreta. Toilet paper is placed on suitable holders and protected from bad weather by a tin can or other covering.

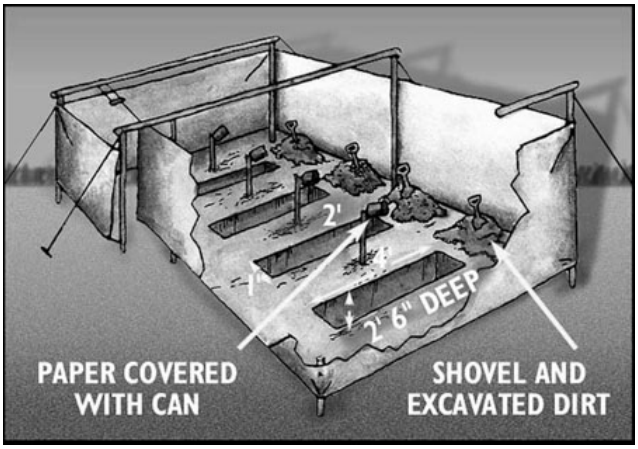

Figure 2–3. Straddle trench latrine.

Deep pit latrine

This type latrine (fig. 2–4) is a deep pit with the standard latrine box placed over it, and is used for longer periods of time. The two-seat box is 4 ft long, $2^1/_2$ ft wide at the base, and 18 inches high. A four-seat box is 8 ft long, $2^1/_2$ ft wide at the base, and 18 inches high. The pit is dug 2 ft wide and either $3^1/_2$ or $7^1/_2$ ft long, depending upon the size of the latrine box. This allows 3 inches of earth on each side of the pit to support the latrine box. The depth of the pit depends on the estimated length of time the latrine is going to be used. As a guide, a depth of 1 foot is allowed for each week of estimated use, plus 1 foot of depth for dirt cover. Generally, it is not desirable to dig the pit more than 6 feet deep because of the danger of the walls caving in.

Rocks or high ground water levels may also limit the depth of the pit. In some soils, planking supports or other material may be necessary to prevent the walls from caving in. To prevent fly breeding and to reduce odors, the latrine box must be kept clean, the lids closed, and all cracks sealed. If a fly problem exists, they may be controlled by the application of a residual pesticide. Controls should be based on fly surveys, and pesticides applied in accordance with label directions. Pit contents should not be sprayed routinely because flies can develop resistance to pesticides repeatedly used. The latrine boxes and seats are scrubbed daily with soap and water.

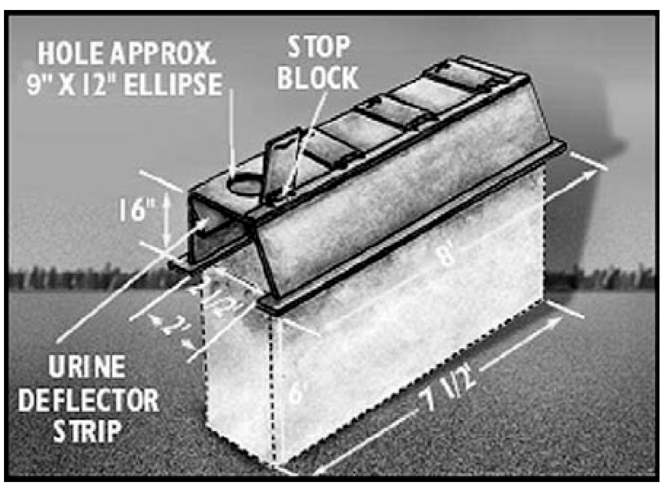

Figure 2–4. Deep pit latrine.

Burn-out latrine

The burn-out latrine (fig. 2–5) may be provided when it is difficult to dig a deep pit latrine (e.g., the soil is hard, rocky, or frozen). It is particularly suitable in areas with high water tables because digging a deep pit is impossible. The burn-out latrine is not used when regulations prohibit open fires or air pollution. Personnel should urinate in a urine disposal facility rather than the burn-out latrine because more fuel is required to burn out the liquid. To construct a burn-out latrine, an oil drum is cut in half, and handles are welded to the sides of the half drum for easy carrying. A wooden seat with a fly-proof, self-closing lid is placed on top of the drum. The latrine is burned out daily by adding sufficient fuel to incinerate the fecal matter. Highly volatile fuel, such as JP4, should not be used because of its explosive nature. A mixture of 1 quart (qt) of gasoline to 4 qt of diesel oil is effective, but must be used with caution. It is convenient to have two sets of drums; one set for use while the other set is being burned clean. If the contents are not rendered dry and odorless by one burning, they should be burned again. Any remaining ash should be buried.

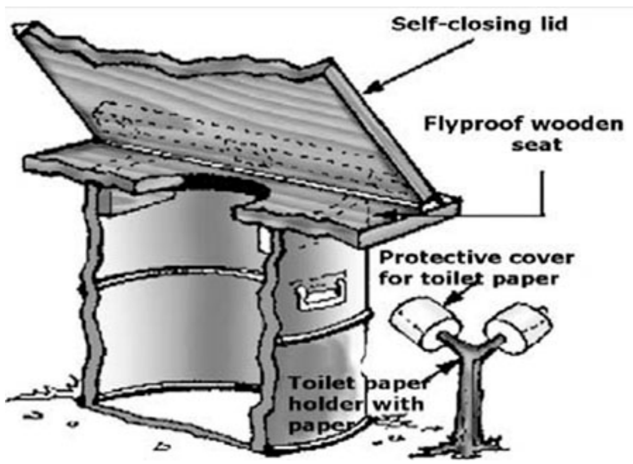

Figure 2–5. Burn-out latrine.

Mound latrine

This latrine may be used when high ground water level or a rock formation near the ground surface prevents digging a deep pit. A dirt mound makes it possible to build a deep pit and still not extend it into the ground water or rock. A mound of earth with a top at least 6 ft wide and 12 ft long is formed so that a four-seat latrine box may be placed on top of it. It is made high enough to meet the pit's requirement for depth, allowing 1 foot from the base of the pit to the level of the ground water or rock level. The mound is formed in approximately 1-foot layers. The surface of each layer is compacted before adding the next layer. When the desired height is reached, the pit is then dug in the mound. Wood or other bracing may be needed to prevent the pit walls from caving in.

An alternate method is to construct a latrine pit on top of the ground using lumber, logs, corrugated sheet metal, or whatever other material is available. Next, pile dirt around the pit and up to the brim, thus creating the mound around the latrine pit. The exact size of the mound base depends upon the type of soil. The mound base should be made large enough to avoid a steep slope. It may be necessary to provide steps up the slope.

Pail latrine

A pail latrine (fig. 2–6) may be built when surrounding conditions (e.g., populated areas, rocky soil, marshes) do not allow other types of latrines to be constructed. A four-seat latrine box may be converted for use as a pail latrine by placing a hinged door on the rear of the box, adding a floor, and placing a pail under each seat. If the box is located in a building, it should, if possible, be fitted into an opening made in the outer wall so that the rear door of the box can be opened from outside the building. The seats and rear door should be self-closing, and the entire box should be made fly-proof. The floor of the box should be made of an impervious material (preferably concrete) and should slope enough toward the rear to facilitate rapid water drainage used in cleaning the box. The waste in the pails may be disposed of by burning or burying. Emptying and hauling containers of waste must be done carefully to prevent careless spillage. The use of plastic bag liners for pails reduces the risk of accidental spillage. The filled bags are tied at the top; then are disposed of by burning or burial.

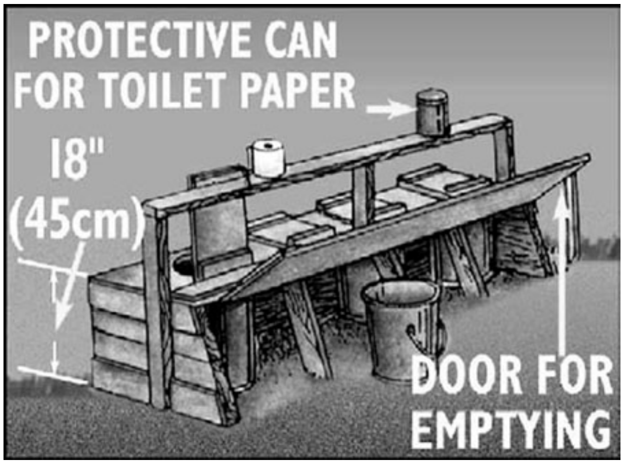

Figure 2–6. Pail latrine.

Chemical latrines

Chemical latrines are used in the field when federal, state, or local laws prohibit the use of other field latrines. These toilets are self-contained because they have a holding tank with chemical additives to aid in decomposition of the waste and to control odor. The medical authority in the area of operation establishes how many of these facilities are required in that area. The facility must be cleaned daily and the contents pumped out for disposal in a conventional sanitary waste-water system. The frequency of emptying is determined by the demand for use of the device.

Urine disposal

Urine disposal facilities should be provided for males, and they should be collocated with the latrine. These facilities prevent soiling of toilet seats and discourage males from urinating in burn-out latrines. (It becomes very difficult to burn urine in burn-out latrines.)

Urine should be drained from the urinals either into a soakage pit, a deep pit latrine, or a chemical latrine. The urine may be drained into a pit latrine through a pipe, hose, or trough. If a soakage pit is used, it should be dug 4 ft square and 4 ft deep and filled with rocks, flattened tin cans, bricks, broken bottles, or similar nonporous rubble. The types of urinals that can be used in the field are urinal pipe, urinal trough, and urinoil.

Urinal pipes

Urinal pipes (fig. 2–7) should be at least 1 inch in diameter and approximately 36 inches long. They should be placed at each corner of a soakage pit and, if needed, on the sides halfway between the corners. The pipes are inserted at least 8 inches below the surface of the pit with the remaining 28 inches slanted outward above the surface. A funnel of tarpaper, sheet metal, or similar material is placed in the top of each pipe and covered with a screen.

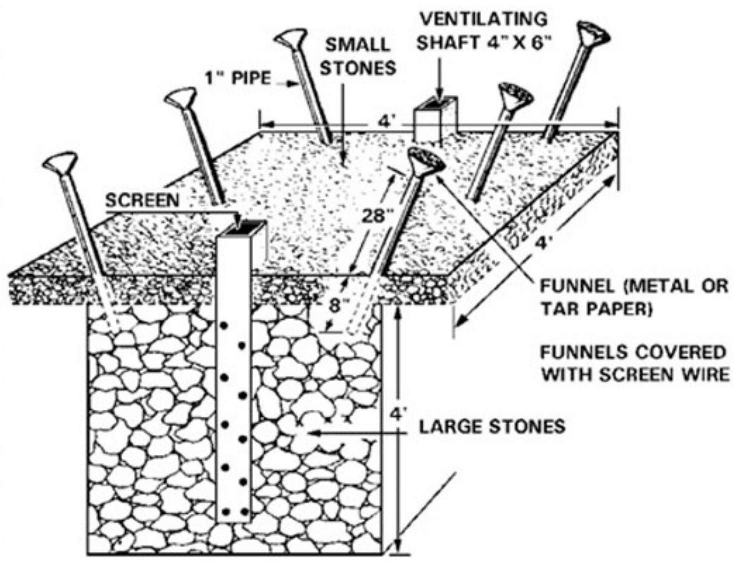

Figure 2–7. Urinal pipes.

Urinal trough

A urinal trough (fig. 2–8) is provided when material for its construction is more readily available than pipes. The trough, which is about 10 feet long, is made of sheet metal or wood with either V- or U-shaped ends. If the trough is made of wood, it is lined with a nonabsorbent material (e.g., tar paper or metal). The legs supporting the trough are cut slightly shorter on the end where a pipe carries the urine into a soakage pit or latrine pit.

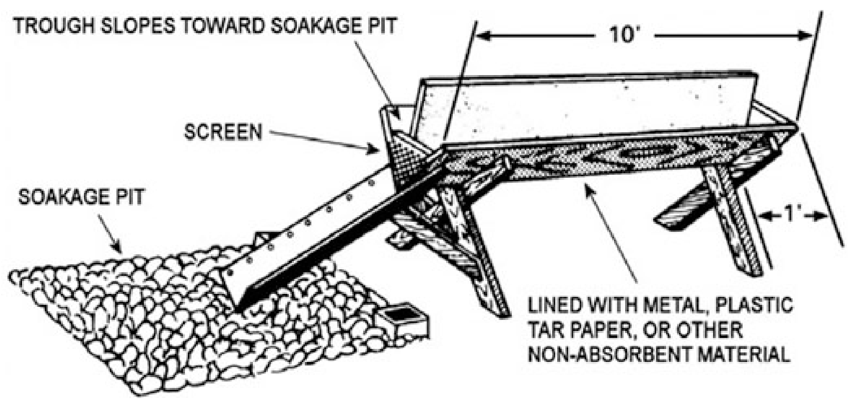

Figure 2–8. Urinal trough.

Urinoil

In areas where the ground water level is more than 3 feet below the surface, the urinoil is an acceptable substitute for other types of urine disposal facilities. The urinoil is a 55 gal drum designed to receive and trap urine and then dispose of it into a soakage pit. Urine voided through the screen onto the surface of the oil immediately sinks through the oil to the bottom of the drum. As urine is added, the level rises within the 3-inch diameter pipe and overflows into the 1$^{1}/_{2}$-in diameter pipe through the notches cut in the top of this pipe. The oil acts as an effective seal against odors and fly entrance. The screen on top of the oil is lifted by supporting hooks and cleaned of debris as necessary.

For urine soakage pits to function properly, personnel must not urinate on the surface of the pit. The funnels or trough must be cleaned daily with soap and water and the funnels replaced as necessary. Oil and grease must never be poured into the pit because both substances will clog it. When a urine soakage pit is to be abandoned or it becomes clogged, it is sprayed with a residual insecticide and mounded over with a 2-feet covering of compacted earth.

119. Garbage and medical waste disposal in field conditions

Garbage (food wastes) and rubbish (nonfood trash) is disposed of by burial or incineration; tactical requirements must be considered in either case. The excavated soil must be concealed; however, smoke and flame may not be tolerated in a tactical situation. In a training situation, environmental protection may rule out burning or burying; therefore, garbage will have to be collected and hauled away to a landfill. We will discuss two methods of garbage disposal—burial and incineration.

Burial

Garbage must not be buried within 100 feet of any natural source of water (e.g., a stream or well) used for cooking or drinking. The garbage burial area should be at least 30 yards (yd) from dining facilities to minimize problems with flies, odor, and appearance. In camps of less than one-week duration, the kitchen wastes are disposed of by burial in pits or trenches. Pits are preferred for overnight halts. They are usually dug 4 ft square and 4 ft deep. The pit is filled to not more than 1 ft from the top; then it is covered, compacted, and mounded with 1 ft of earth.

The continuous trench is more adaptable to stays of two days or more. This method is started by digging a trench about 2 ft wide, 4 ft deep, and long enough to accommodate the garbage. As in the pit method, the trench is filled to not more than 1 ft from the top. The trench is extended as required, and the excavated dirt is used to cover and mound the first deposit. This procedure is repeated daily or as often as garbage is dumped. It is a very efficient field expedient method for disposing of garbage.

Incineration

In temporary camps of one week or more, the garbage is often burned in open incinerators. Excellent types of open incinerators may be constructed from materials that are readily available in any camp area. Since incinerators will not handle wet garbage, it is necessary to separate the solid from the liquid portions of the garbage. This is done by straining the garbage with a coarse strainer such as an old bucket, salvage can, or oil drum with holes punched in the bottom. The solids remaining in the strainer are incinerated, and the liquids are poured through a grease trap into a soakage pit. Since field incinerators create an odor nuisance, they should be located at least 50 yards downwind from the camp.

Cross trench and stack incinerator

The cross trench and stack incinerator will effectively take care of the waste produced by a medium-size unit. This is an excellent dry-trash incinerator, but wet material tends to disrupt the draft, which makes burning difficult. Two trenches, each 10 feet long, are constructed so that they cross at right angles. The trenches slope from the surface of the ground at the ends to a depth of 18 inches at the intersection. A grate is made from pieces of scrap iron laid over the intersection of the trenches. A stack is made from an oil drum with both ends cut out, or with one end cut out and the other end liberally punched with holes to admit draft air. A fire is built on top of the grates and the waste is added, one shovelfull at a time, on top of the fire.

Inclined plane incinerator

The inclined plane incinerator will dispose of the garbage of larger units. Its effectiveness, and the fact that it is not affected by rain or wind, makes it an excellent improvised device. Time and skill, however, are required in building it. A sheet metal plane is inserted through telescoped oil drums from which the ends have been removed. A loading or stoking platform is built; then one end of the plane-drum device is fastened to it, creating an inclined plane. A grate is positioned at the lower end of the plane, and a wood or fuel oil fire is built under the grate. After the incinerator becomes hot, drained garbage is placed on the stoking platform. As the garbage dries, it is pushed down the incline in small amounts to burn. Final combustion takes place on the grate.

Liquid waste disposal

Liquid waste includes wash and bath water and liquid kitchen wastes. It is usually disposed of in the soil by soakage pits or trenches. Grease, soap, and other solid particles inhibit the soil's absorption of the liquids and must be removed. For this reason, a grease trap is made as a part of each soakage pit or trench used for wash and kitchen waste disposal. Evaporation beds may be used where soil conditions prevent the use of soakage pits or trenches. Liquid kitchen wastes accumulate at the rate of 1 to 5 gallons per person, per day. It is imperative they are disposed of properly. Let's study some methods of getting rid of these wastes.

Soakage pits

Liquid wastes are disposed of in the soil by soakage pits at or near the place where they are produced. A soakage pit for the disposal of kitchen wastes is constructed in the same manner as the soakage pit for urine disposal, except it is equipped with a grease trap. Two pits are needed for a medium size unit so that each one can have a rest period every other day. In porous soil, a soakage pit 4 ft square and 4 ft deep will take care of 200 gal of liquid per day. In camps of long duration, each soakage pit should be given a rest period of one week every month. Even though precautionary measures are taken, a pit may become clogged with organic material.

Soakage trenches

If the ground water table is high or a rock stratum is encountered near the surface, soakage trenches (fig. 2–9) may be substituted for soakage pits. These trenches are extended outward from each corner of a central pit dug 2 ft square and 1 ft deep. The trenches are dug 1 ft wide and 6 or more feet long. The depth is increased from 1 foot at the end joining the pit to 18 inches at the outer end. The pit and the trenches are filled with rock, flattened cans, broken bottles, or other coarse contact material. Two such units should be built for every 200 persons fed, and each unit should be used on alternate days. A grease trap is used with this device.

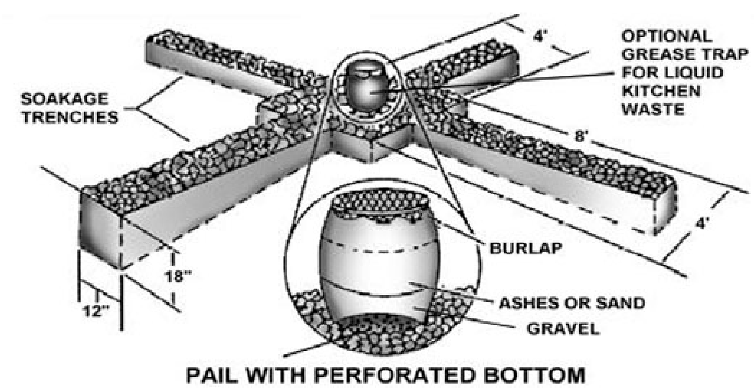

Figure 2–9. Soakage trench.

Evaporation beds

In a hot, dry climate where heavy clay soil prevents the use of standard soakage pits, evaporation beds (fig. 2–10) may be required. These beds actually involve the processes of evaporation, percolation, and oxidation. Sufficient beds, 8 × 10 ft, are constructed to allow 3 square feet per person, per day for kitchen waste and 2 square feet per person, per day for bath waste. The beds are spaced so that the wastes can be distributed to any one of the beds. The beds are constructed by scraping off the topsoil and constructing small dikes around the 8 × 10 ft spaces. These spaces are then spaded to a depth of 10–15 inches, and the surfaces are raked into a series of ridges and depressions, with the ridges approximately 6 inches above the depressions. These rows may be built either lengthwise or crosswise for the best distribution of water. In operation, beds are flooded at different intervals. On a certain day, one bed is flooded to the top of the ridges with liquid waste. This condition is equivalent to an average depth over the bed of 3 inches, and liquid waste is allowed to evaporate and percolate. After about four days this bed is usually sufficiently dry for respading and reforming. The other beds are flooded on successive days, and the same sequence of events is followed. Careful attention must be given to proper rotation, maintenance, and dosage. It is also essential that the kitchen waste run through an efficient grease trap before it is allowed to enter the evaporation beds. If these beds are used properly, they create no insect hazard and only a slight odor.

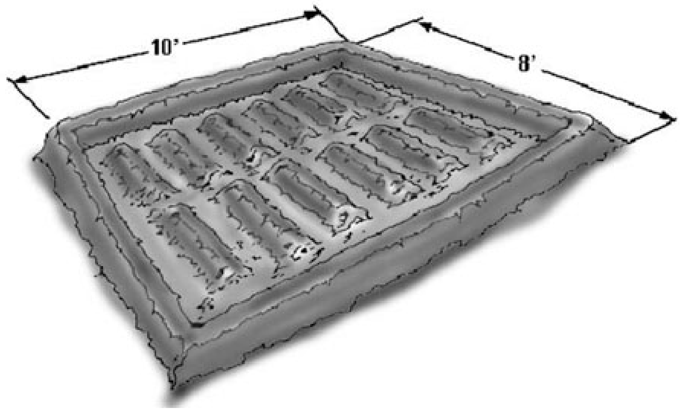

Figure 2–10. Evaporation bed.

Grease traps

The grease trap is a necessary addition to the kitchen soakage pit and trenches. All kitchen liquids are passed through a grease trap to remove food particles and as much grease as possible. If traps were not used, the soakage pits become clogged and useless. There are two types of grease traps—the filter and the baffle.

Filter grease trap

The filter grease trap (fig. 2–11) is built using an oil drum. The drum, with the top removed and the bottom perforated, is filled two-thirds full with crushed rock or large gravel at the bottom. This is followed by smaller size gravel and then a 6-inch layer of sand, ashes, charcoal, or straw. The top of the drum is covered with burlap or other fabric to strain out the larger pieces of debris. The barrel is usually placed in the center of the soakage pit with the bottom of the barrel about 2 inches below the pit surface. The burlap or other fabric is removed daily, burned or buried, and replaced with a clean piece of fabric. The 6-inch layer of filtering material is removed, buried, and replaced once or twice weekly.

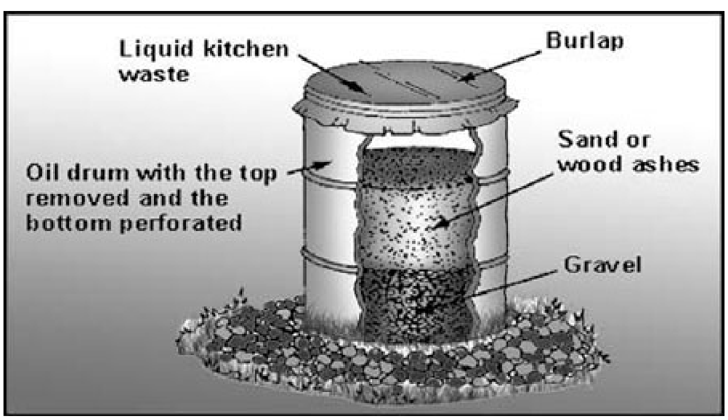

Figure 2–11. Filter grease trap.

Baffle grease trap

The baffle grease trap is the most effective way of removing grease. It is a watertight container divided into entrance and exit chambers by a baffle. The entrance chamber has about twice the capacity as the exit chamber. The lower edge of the baffle hangs within 1 in of the bottom. The outlet, a 2-inch pipe, is placed from 3 to 6 inches below the upper edge of the exit chamber. The baffle grease trap is usually placed on the ground at the side of the soakage pit with the outlet pipe extending 1 foot beneath the surface at the center of the pit. The liquid waste is strained of solids and debris before it goes into the entrance chamber of the trap. The strainer is filled two-thirds full with loose straw, hay, or grass. Before the grease trap is used, the chambers are filled with cool water. When the warm liquid strikes the cool water in the entrance chamber, the grease rises to the surface and is prevented by the baffle from reaching the outlet to the soakage pit. If the water is warm, proper separation of the grease will not occur. (This often happens in hot climates.) The grease retained in the entrance chamber is skimmed from the surface of the water daily, or more frequently as required, and buried. The trap should be emptied and thoroughly scrubbed with hot, soapy water as often as necessary. The efficiency of this grease trap can be increased by constructing it with multiple baffles. You may also use a series of baffle grease traps.

Medical waste

Under field conditions, medical waste should be given the same precautions as medical waste generated during peacetime. The major difference between peacetime and wartime is that a unit's access to services for the removal of medical waste may be limited or nonexistent. If units have resources available for the removal of medical waste (i.e., contractors specifically hired to handle medical waste), these resources are the preferred method of removal to ensure proper handling and disposal. Units without contractor support should dispose of medical waste either by burial or incineration. In either case, the medical waste should remain in Sharps containers while handling to prevent exposure to blood-borne pathogens.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

118. Human waste disposal in field conditions

1. What are the basic sanitary requirements for latrines?

2. How many latrines are required for males and females?

3. What is a "cat-hole?"

4. What are the different types of latrines?

5. Where should urinal pipes and urinal troughs drain?

119. Garbage and medical waste disposal in field conditions

1. What are the methods for garbage disposal?

2. What are three ways to dispose of liquid waste?

3. What is the purpose of a grease trap?

Answers to Self-Test Questions

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1. Diarrheal, respiratory, skin, and vectorborne.
2. Immunizations, living areas with adequate space and ventilation, head-to-foot sleeping arrangements, and frequent handwashing to reduce droplet and aerosol spread of respiratory diseases.
3. Breakdown in personal hygiene and sanitation.
4. Research and be able to recognize the hazardous species indigenous to the area of operations.
5. Proper handwashing, practicing good oral hygiene, showering, and foot care.

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1. Site selection, overall site set-up, disease surveillance and disease prevention, and training for deployed personnel.
2. Eat only foods served to you piping hot, (2) avoid dairy products; some countries do not pasteurize their dairy products, (3) eat only fruits and vegetables that can be peeled, by peeling you can remove any contamination, (4) do not eat food from streetside vendors, (5) drink only bottled water or carbonated beverages from approved sources, (6) do not drink local water or consume ice..
3. Security police, civil engineering, dining hall, maintenance organizations, and medical teams.
4. Public health OIC or NCOIC.

114

1. To protect the foods from the sun, dirt, insects, rodents, and other sources of contamination.
2. (1) Store foods in clean, covered containers.
   (2) Store containers at least 6 in from the floor/ground.
   (3) Do not use galvanized containers for acidified foods.
   (4) Store foods out of direct sunlight.
   (5) Facilities should be insect and rodent proof.
3. In accordance with the food code.
4. The ice should be potable.
5. In clean, sealable containers and protected from excessive heat and moisture.

115

1. In protected areas.
2. To reduce insect and rodent feeding and breeding places.
3. The food code.
4. To detect signs of illness or evidence of infection.
5. Personnel with skin infections, boils, diarrhea, or any evidence of infection or illness.
6. After each use.

7. Immersing in boiling water for 30 seconds, or immersing in a chlorine water solution for at least one minute.
8. (1) To ensure basic standards are maintained.
   (2) To identify potential problems that could result in a foodborne illness outbreak.
   (3) To recommend ways to correct problems.
   (4) To provide an opportunity to educate food service personnel in effective food sanitation procedures.

116

1. Existing public water supply, surface water, ground water, and bottle water.
2. Surface water, because it is generally the most accessible.
3. Sodium hypochlorite (liquid bleach) and calcium hypochlorite powder.
4. 60 minutes.
5. Iodine tablets (canteens for personal use), Chlor-Floc water treatment kit, and boiling.
6. There is no residual protection against recontamination.

117

1. Parts per million FAC or other level established for the area of operation.
2. Every 30 minutes of the operating day.

118

1. (1) Built at least 100 yards from food facilities and unit ground water sources; (2) Not dug to ground water level; (3) Built at least 30 yards from the border of unit area, but within reasonable distance for easy access; and (4) Have a drainage ditch dug around the edges of it.
2. Enough to service 4 percent of the male and 6 percent of the female population.
3. A latrine that is a hole, approximately 1 foot deep, covered and packed down with dirt after use, which is used for short stays for an individual's use.
4. Cat-hole, straddle trench, deep pit, burn-out, mound, pail, and chemical latrines.
5. Into a soakage pit, deep pit latrine, or a chemical latrine.

119

1. Burial or incineration.
2. Soakage pit, soakage trench, and evaporation beds.
3. To remove grease and other food particles from liquid wastes.

Do the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter.

Do not return your answer sheet to AFCDA.

22. (112) The four types of diseases *most* commonly occurring in contingency operations are diarrheal, respiratory, skin, and
    a. tickborne.
    b. foodborne.
    c. vectorborne.
    d. sexually transmitted.

23. (112) The number one cause of skin disease in the field is
    a. improper base sanitation.
    b. improper hand washing technique.
    c. breakdowns in basic personal hygiene and sanitation.
    d. breakdowns in personal hygiene and proper food storage.

24. (113) Who is responsible for ensuring all 4E0X1 personnel are trained in field sanitation?
    a. Career field manager.
    b. Superintendent of public health.
    c. Medical treatment facility (MTF) commander.
    d. Officer in charge (OIC) or noncommissioned officer in charge (NCOIC) of public health.

25. (114) Who makes evaluations and recommendations regarding any food suspected of being unfit for human consumption?
    a. Food facility employees.
    b. Food facility supervisors.
    c. Public Health officer.
    d. Vendor.

26. (115) How often are food service personnel in the field inspected for signs of illness?
    a. Daily.
    b. Weekly.
    c. Every other shift.
    d. When an outbreak occurs.

27. (115) Who is responsible for applying insecticides or rodenticides following label directions?
    a. Public Health.
    b. Facility supervisor.
    c. Certified Pest Management Personnel.
    d. Bioenvironmental Engineering.

28. (116) Ground water sources must be how far from potential sources of contamination?
    a. 50 feet.
    b. 100 feet.
    c. 50 yards.
    d. 100 yards.

29. (117) Which office is responsible for performing residual chlorine/pH water testing every 30 minutes?
    a. Bioenvironmental engineering.
    b. Preventive medicine.
    c. Civil engineering.
    d. Public health.

30. (117) What must be put into place to prevent dust borne bacteria from contaminating water and equipment?
    a. Dust control measures.
    b. Dust prevention team.
    c. Bacteria prevention team.
    d. Bacteria control measures.

31. (118) When “closing” latrines, how many inches deep should the covering of dirt be?
    a. 24.
    b. 18.
    c. 12.
    d. 6.

32. (118) How many straddle trench latrines should be constructed for each 100 men?
    a. 4.
    b. 6.
    c. 10.
    d. 15.

33. (119) What are soakage pits equipped with to drain kitchen wastes?
    a. A chlorine solution.
    b. Heat treatment.
    c. Insecticides.
    d. Grease trap.

34. (119) How should units without contractor support dispose of medical waste?
    a. Burial or incineration.
    b. Empty into a soakage pit.
    c. Empty into a chemical latrine.
    d. Ship back to United States of America.

Please read the unit menu for unit 3 and continue ➔

Unit 3. Medical Entomology

IN THIS UNIT you will read about arthropods and animals, known as vectors, that transmit disease to humans; and you will read about vector control. You will also review vectorborne diseases that affect the Air Force population and learn about your responsibilities, as well as responsibilities of other agencies, in this area.

3–1. Air Force Medical Entomology

Medical entomology is the study of insects that cause illness and injury. However, due to similar characteristics, other arthropods, such as the arachnids (e.g., spiders, ticks and mites), centipedes and millipedes are typically included in this study. The Air Force Medical Service further expands “medical entomology” to include all animals that may harm Air Force personnel; therefore, Air Force medical entomology often includes rats, snails, birds, and feral animals.

As the organisms that threaten our personnel are numerous and diverse, the Air Force medical entomology program relies heavily upon different agencies and individuals to prevent illness and injury. The keys to prevention are education, personal protection, and integrated pest management.

In many parts of the world, vectorborne diseases, especially malaria and dengue, can and will stop wars. Because the Air Force mission is global, arthropods and other organisms threaten Airmen and the mission at hand. This section details surveillance and control of vectors and the diseases they spread, venomous organisms, and pests of food.

120. Functions and responsibilities

Public Health (PH) is concerned with pest/vector biology and surveillance. The Pest Management section works to control pests and vectors and the bioenvironmental engineers assure safe use, storage, and handling of pesticides. Entomology consultants assist with technical issues, and when needed, they use aerial application of pesticides to prevent severe outbreaks of disease.

A clear understanding of the functions and responsibilities of medical entomology is of vital importance. The goals of the medical entomology program are preventing and controlling vectorborne diseases by reducing disease vectors and reservoirs (e.g., places where a disease survives, which can be live organisms, soil or water), blocking transmission of pathogens to susceptible hosts, and protecting the base population.

Installation commander

The installation commander has the ultimate responsibility for taking proper actions to protect personnel within the command from vector-borne diseases and pests of medical importance.

Chief, Aerospace Medicine

The Chief of Aerospace Medicine oversees the medical entomology activities of both PH and BE. AFI 48–102, *Medical Entomology Program*, outlines the Air Force's medical entomology program.

Civil Engineering

The base Pest Management section falls under Civil Engineering. This section is responsible for planning, carrying out, and coordinating vector and pest management activities in accordance with AFI 32–1053, *Integrated Pest Management Program*. Pest management coordinates with PH prior to applying pesticides in food preparation, medical facilities and child development centers to ensure pest management operations are based on appropriate surveillance data.

Public Health

In the medical entomology program, you will survey disease vectors by using approved methods at frequencies set by the Aerospace Medicine Council. Surveying involves collecting and identifying specimens. Surveillance data is compared with historical baselines and disease incidence in the area to determine if there is potential for an outbreak. You must maintain a close liaison with federal, state and local health agencies, including foreign and civilian public health agencies, to determine disease incidence. If surveillance data indicate that vectors or medical pests pose a health threat, interfere with duty performance or cause a significant morale problem, you must recommend that CE implement control measures.

Adviser

PH personnel advise healthcare providers on preventive measures and control requirements for the vectorborne diseases in the area. Healthcare providers may not recognize vectorborne diseases, because the symptoms are sometimes similar to those of many other diseases. PH also must advise healthcare providers of the threats of vectorborne disease.

Educator

A large portion of your job in medical entomology is to educate personnel who deploy to areas considered at risk for vector-borne disease. Deployers must be educated on personal protective measures, such as using N-Diethyl-meta-toluamide (DEET), permethrin, and bed nets to prevent vectorborne disease. PH also assists in contingency site selection to minimize vectorborne disease potential.

Department of Defense Pre-Clearance Program

The DOD pre-clearance program is a cooperative effort between United States Transportation Command (USTRANSCOM), United States Central Command (USCENTCOM), Department of Homeland Security's Customs and Border Protection, and the US Department of Agriculture's (USDA) Animal and Plant Health Inspection Services (APHIS). The USDA is responsible for the consultation, advice, and education to military organizations.

In the Air Force, Logistic Readiness and Aerial Port personnel conduct inspections. CE provides control when needed and PH provides specific consultation on specimen identification and lab submission when requested.

If required, you may act as a consultant for quarantine inspections of aircraft arriving or departing when there is potential for pests or diseases of concern to enter the United States. As a consultant, you will make recommendations concerning removal of insects from or disinfection of the aircraft, as necessary.

Aerial application of pesticides

Public Health is closely involved in the aerial application of pesticides to control vectors or medically important pests. Typical PH tasks during aerial spray missions include educating the public, and pre- and post-treatment vector surveys to determine if the aerial spraying was effective. PH may perform vector surveillance before or after a spraying operation.

Reviewer

PH is responsible to review the Installation Pest Management Plan maintained by the Pest Management section. Pest Management updates the Pest Management Plan annually and completely revises and formally staffs the plan every five years. PH (and other agencies) reviews and signs this plan before the plan goes to the installation commander. AFI 32–1053, *Integrated Pest Management Program* outlines guidance for the Installation Pest Management Plan.

Bioenvironmental engineering

The BE section provides technical information concerning the safe storage and use of pesticides. The BE monitors the acquisition, storage, and environmental impact of pesticides for the Pest Management section, the commissary, and the Base Exchange facilities. BE also reviews the installation Integrated Pest Management Plan before it is sent to the applicable MAJCOM CE for approval.

Entomology consultants

The medical entomologist with the USAFSAM Public Health Consultation Section (PHR) provides vector identification and medical entomology consultation and interprets vector surveillance data for bases in the continental United States (CONUS). Additional medical entomologists also serve Pacific Air Forces (PACAF) and United States Air Forces in Europe (USAFE).

The 910th Airlift Wing (AW), Youngstown Air Reserve Station, Ohio commonly provides aerial pesticide spraying for bases that have been validated for aerial spraying to control vectors and common pests where vectors or pest populations have exceeded predetermined thresholds. Aerial spray operations have also been conducted in off-base humanitarian campaigns.

121. Taxonomy

Taxonomy is the science of classification. You need to have a general knowledge of classifying insects to identify pests and vectors. It is also important to understand formal taxonomy to communicate with others about pests and vectors.

Classification of organisms

All living organisms are grouped into kingdoms: bacteria (Monera), protozoa and algae (Protista), fungi, plant, and animal kingdoms. Groupings or subclassifications within the kingdoms, in descending order, are phylum, class, order, family, genus, and species.

Phylum

A phylum is a major taxonomic unit comprised of organisms sharing a fundamental pattern or organization and a common descent. The phylum Chordata, for example, contains all the animals with a backbone, including humans and other mammals, birds, reptiles, and fish. The phylum Arthropoda contains about 86 percent of all described animal species. Members of this phylum have segmented bodies, jointed appendages, and an exoskeleton. A subdivision of phylum is a class.

Class

A single phylum contains one or more classes. To carry the example of Arthropoda (phylum) further, the classes include Hexapoda (insects and other six-legged arthropods); Arachnida (ticks, mites, spiders, and scorpions); Crustacea (crabs, shrimp, and copepods); Chilopoda (centipedes); and Diplopoda (millipedes).

Orders

There are orders within each class. An example is the order Diptera (true flies).

Family

Within each order, there may be multiple groups that have basic similar characteristics, which place an organism into a particular family. An example is the family Culicidae (mosquitoes) in the order Diptera (true flies).

Genus

At this point, identification is almost complete. Familiarization with this division is essential to identify a specific organism. An example is *Culex*, a genus of mosquito in the family Culicidae (mosquitoes) in the order Diptera (true flies). Note that the plural of “genus” is “genera.”

Species

In most cases, species is the last major division in the classification system. This final identification is the most important, since habits and habitats of various species of the same genus may vary greatly, thus affecting the type of surveillance and control measures used. A species is a distinct group of animals with well-defined common characteristics that produce offspring with the same characteristics.

Scientific names versus common names

It is important to use precise names for organisms. Scientific names typically use an organism’s genus and species as a label for the organism. A common name of the Oriental cockroach, *Blatta orientalis*, is “water bug.” Others use the term “water bug” to refer to the American cockroach, *Periplaneta americana*. This issue is further complicated when we are overseas where “water bug” may be entirely meaningless. However, *Blatta orientalis* refers to the same organism worldwide.

Structure of arthropods

One of the main differences between humans and arthropods is in the skeleton. In insects, for example, the skin has become hardened, almost like a suit of armor, into a stiff outer skeleton known as an exoskeleton. This exoskeleton protects the internal organs from injury and serves as a framework for the attachment of muscles. By contrast, human skeletons are inside the skin; we refer to this as an endoskeleton.

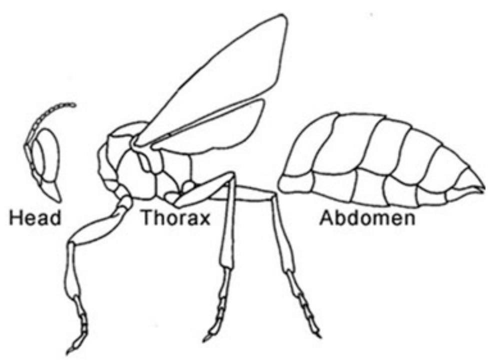

Figure 3–1. Parts of an insect.

The body of an insect is divided into the three main regions: head, thorax, and abdomen (fig. 3–1).

Arachnida

In the class Arachnida, usually called the arachnids, the body is composed of the two regions of the cephalothorax and the abdomen. The arachnids include scorpions, spiders, mites, and ticks.

Arthropods

In most arthropods, the outer parts of the body wall are hardened or sclerotized into plates called *sclerites*, which are not flexible. These sclerites are joined by flexible portions of the body wall called *membranes*, which allow considerable movement of the exoskeleton. For example, the abdomen of a mosquito enlarges greatly during feeding. The sclerites may be covered with many small structures, such as hairs, scales, protuberances, and spines; many of which are useful in insect identification.

Arthropod physiology

Insect physiology deals with the functions of the various organs and systems that support the life of the insect. Many pathogens develop or survive inside insects. Generally, an insect vector's digestive system is involved since the insect vectors of major importance are largely bloodsucking arthropods. They suck up disease organisms along with the host's blood and, in subsequent feedings, transfer the pathogens to other hosts. Thus, an elementary knowledge of the internal structure and physiology of arthropods is of much interest and use to public health workers.

Arthropod development

The life cycle begins with the egg and completes at the adult stage. The term "life span" refers to the entire length of life of the insect. Some insects, such as tropical termite queens, may live for 15 to 20 years, and the periodical cicada lives for 14 to 17 years. Mayflies may live only a few days as adults, after spending 2 to 3 years in the developing, immature stages. The changing of structure and habits in animals during normal growth, usually after the egg stage, is *metamorphosis*. This development is through either complete metamorphosis, gradual metamorphosis, or no metamorphosis (no changes from young to adult stage). All arachnids go through gradual metamorphosis.

Complete metamorphosis

Insects with complete metamorphosis have the four stages of egg, larva, pupa, and adult (fig. 3–2). Insects with this life history are greatly different in the immature and adult stages. Typical larvae are the wigglers of mosquitoes, the maggots of flies or the caterpillars of butterflies and moths. The pupal stage is an important evolutionary development when the simple larva undergoes many external and internal changes to become the complete adult.

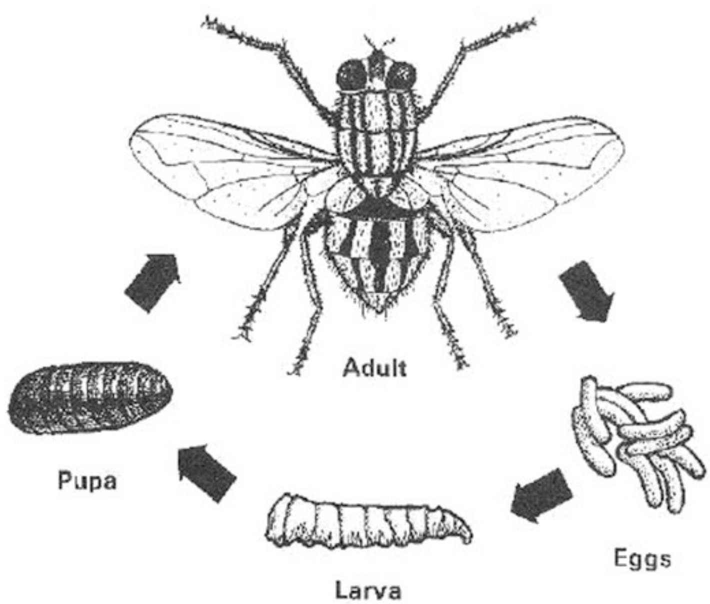

Figure 3–2. Complete metamorphosis–fly life cycle.

Winged and wingless

Most of the insects with complete metamorphosis have wings as adults, but some species, such as the flea, are wingless. Normally, the wing buds first appear in the pupal stage. However, not all insects with complete metamorphosis have pupal shells. For example, the beetle and ant do not have pupal shells even though they go through complete metamorphosis.

Orders of insects

There are many orders of insects having complete metamorphosis. Five of these orders are very important to public health workers; they are as follows:

1. Diptera—flies, mosquitoes, midges, and punkies.
2. Siphonaptera—fleas.
3. Lepidoptera—moths, butterflies, and skippers.
4. Hymenoptera—ants, bees, and wasps.
5. Coleoptera—beetles.

Gradual metamorphosis

Insects with gradual metamorphosis pass through three developmental stages: egg, nymph, and adult (fig. 3–3). Insects in this group gradually go through a succession of changes to become adults. The young resemble the adult insect except for their smaller size and the absence of wings in wing-bearing species. The young, or nymphs, are not sexually mature and may bear wing pads in the latter stages of their development.

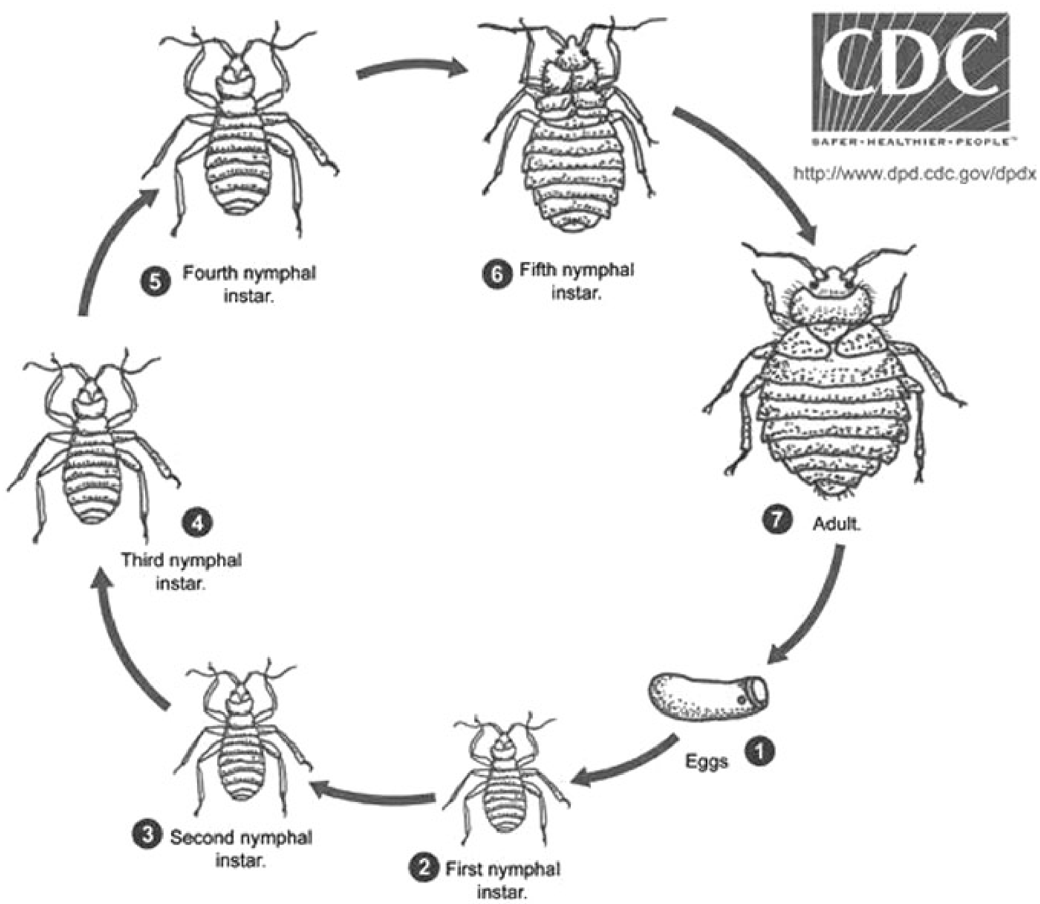

Figure 3–3. Gradual metamorphosis – bed bug life cycle.

Some important orders with gradual metamorphosis include the following:

- Blattaria—cockroaches.
- Anoplura—sucking lice, including crab and body lice.
- Hemiptera—true bugs, including the bed bug and kissing bug

No metamorphosis

Insects with no metamorphosis usually are wingless as adults, and size is the primary difference between nymph and adult. For example, Collembola (springtails) are found in gardens, greenhouses, and mushroom cellars; Thysanura (silverfish) are found as household pests feeding on starchy material.

Identification of insects

To identify an insect to order, family, genus, or species; examine the structure of the antennae, wings, legs and mouthparts. Frequently, very small details such as specific body hairs or scales are important. Therefore, you must keep the collected specimens in good condition for proper identification. You can identify most large insects using a hand lens or low-power dissecting microscope. However, very small insects may require the use of a compound microscope.

Even though laboratories are available for pest identification, it may be necessary for you to identify a pest. The best way to identify insects is with a key. Two types of keys are pictorial and word.

Pictorial key

This is a diagram-based key. The pictorial key for stinging caterpillars can be seen in the diagram on the next page (fig. 3–4).

The key is usually read from the top down, and the pictures are connected by lines like an organizational functional chart or chain-of-command diagram. At each line, you decide between two major identifying features. As you find each major identifying feature, you trace the line in the direction indicated by arrows to the next differentiating feature.

Written key

This is a brief description of anatomical features used to identify insects. The key is arranged in a couplet (two-statement) format. Each statement includes a specific description of a body part, followed by either a name or a number. The name shows the phylum, class, order, family, genus or species of the specimen; the number refers you to another couplet to help you complete the identification process. You must always make a choice between the couplet statements at each step.

Keys for various arthropods and rodents are available from the Centers for Disease Control and Prevention. Entomology textbooks as well as a variety of other sources also offer keys.

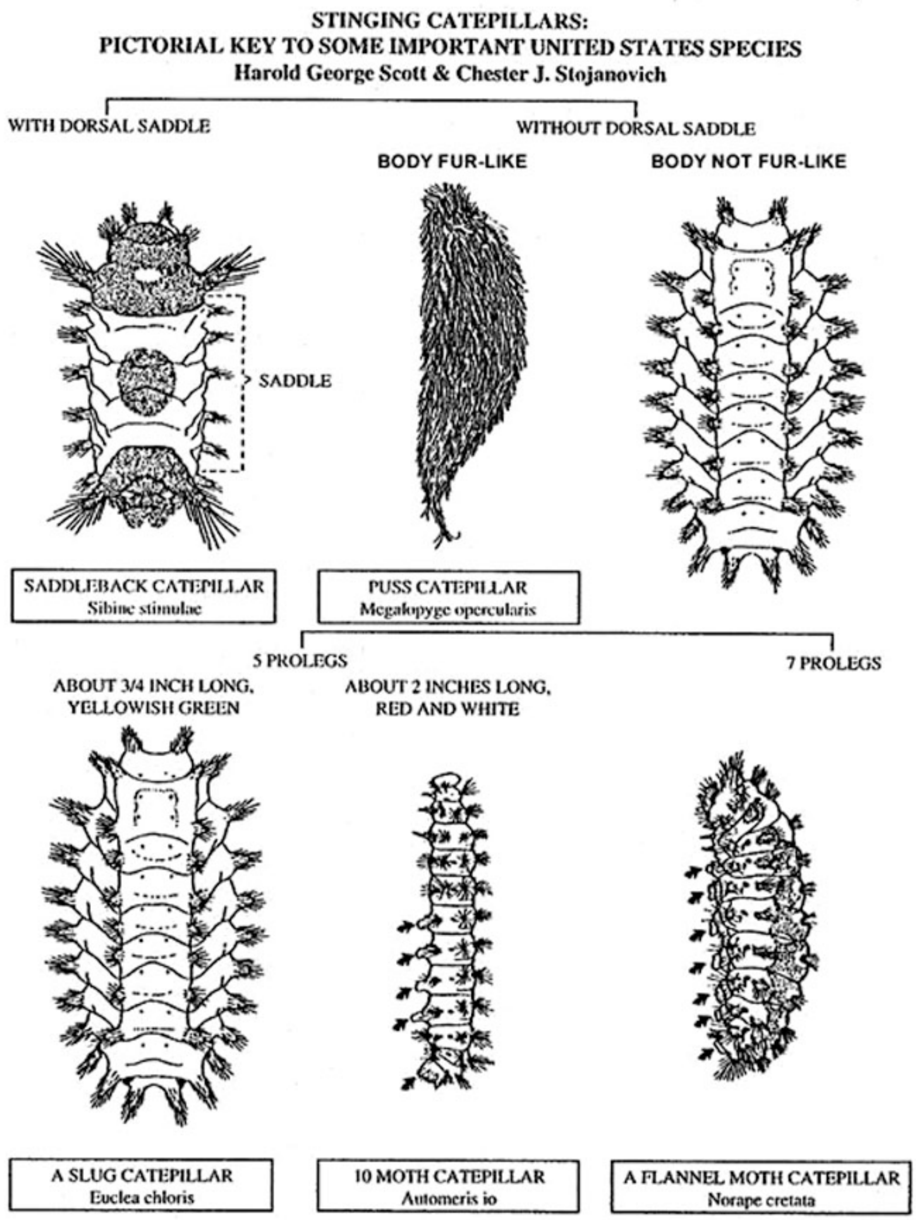

Figure 3–4. Pictorial key for stinging caterpillars.

122. Air Force Pest Management Program

Public health technicians need to know about the different control programs for pest management in the Air Force because they will be recommending many controls for the installation. In this lesson, you will learn about the Air Force Pest Management Program and the Air Force quarantine programs so that you will know who is responsible for the various aspects of pest control.

A pest is any organism that is in the wrong place at the wrong time. Pests can be arthropods, weeds, rodents, birds, wild animals, snakes, nematode worms, snails and so forth. Many of these have no medical significance; however, the core mission of Pest Management is to prevent and control pests. This mission must be carried out using integrated pest management (IPM).

Responsibilities

The Pest Management section provides or monitors all pest control activities for the entire installation. In general, Pest Management surveys for all pests, except disease vectors and medical pests, and controls all pests, particularly if pesticides are needed. Pest Management will typically fall under the Operations Flight within the Civil Engineer Squadron (or Group). It is usually a mix of military and civilian personnel. Depending on the installation, contractors may augment, or in some cases provide all of the pest management services.

PH surveys for disease vectors and medical pests, cooperates with Pest Management in the non-pesticidal aspects of pest management, and interfaces in several areas.

Four major directives define the Air Force Pest Management Program are as follows:

1. DOD Instruction (DODI) 4150.7, *DOD Pest Management Program*.
2. AFI 32–1053, *Integrated Pest Management Program*.
3. AFI 32–1074, *Aerial Application of Pesticides*.
4. AFI 48–102, *Medical Entomology Program*.

Air Force policy

Because of the temporary nature of chemical control, and its potential threat to human health and the living environment, DOD and Air Force policies state that IPM will be used to the maximum extent possible to control all pests. AFI 32–1053 defines IPM as, “a planned program, incorporating continuous monitoring, education, record keeping, and communication, to prevent pests and disease vectors from causing unacceptable damage to operations, people, property, materiel, or the environment.”

IPM uses targets, sustainable (effective, economical, environmentally sound) methods (including education, habitat modification, biological control, genetic control, cultural control, mechanical control, physical control, regulatory control, and where necessary, the judicious application of least-hazardous pesticides). Simply stated, IPM is a combination of control techniques to prevent and control pests. The most common techniques used in IPM include cultural control, mechanical control, biological control, and chemical control.

Cultural control

Cultural control consists of changing the environment so that the pests can no longer live there. Cultural controls are generally long-term or permanent, avoid pesticide and are often inexpensive and simple, such as cleaning kitchens to suppress cockroaches. The disadvantages to cultural control include feasibility (draining and filling a wetland for mosquito control) and financial considerations.

Mechanical control

Mechanical control consists of using methods to kill or separate arthropods from their food source. The most common types of mechanical control include trapping and exclusion (e.g., snap traps or window screens). The advantages of mechanical control are low costs and low chemical threats to the environment. However, mechanical controls are sometimes expensive, time-consuming, and/or impractical.

Biological control

Biological control consists of using predators, pathogens or genetic engineering to control arthropods. An example of biological control is the use of minnows or dragonfly larvae to control mosquito larvae. Advantages of biological control include reducing chemical use and low environmental impact. Disadvantages include high costs, frequent reapplication of the control agent, and low efficacy. For example, genetically engineered biological controls require specially trained people, sophisticated rearing and storage areas, and delivery systems.

Chemical control

Chemical control is the use of pesticides to kill or break the life cycles of pests. Pesticides are typically immediate and inexpensive in the short term. However, many are hazardous to human health, other organisms and the environment if not used properly. Chemical control is not permanent, and reapplication is usually necessary, sometimes at frequent intervals. Over time, chemical control may result in pesticide resistance.

Pesticides are chemicals that are deliberately applied to kill pests, and we classify the following pesticides by the type of pest that they kill:

- Insecticides kill insects.
- Rodenticides kill rodents.
- Herbicides kill weeds.
- Acaricides kill ticks and mites (acarines).
- Molluscicides kill mollusks (snails and slugs).

Insecticides can also be classified by the stage of the life cycle they attack (adulticides, larvicides, or ovicides), the way they are applied (space, residual, or fumigation), their chemical structure (organophosphates, carbamates, pyrethroids, organochlorines, and others), and their origin.

Governing laws

Pesticides are governed by federal laws, with the major governing legislation in the Federal Insecticide, Fungicide and Rodenticide Act of 1942. In 1972, Public Law 92–516 passed the Federal Environmental Pesticide Control Act, which resulted in restrictions on pesticide use and added requirements for applicator training. Some major provisions of the law are as follows:

- Pesticides must be used according to the *label directions only*. The “label” in this provision refers to the paper directions for use that are attached on (or with) the original pesticide container.
- Pesticides are classified as “General Use” or “Restricted Use.” Restricted Use classification is given to a pesticide when the EPA determines through testing that it may cause adverse effects on the environment. If the EPA determines that the pesticide is benign to the environment when it is applied according to the label, the pesticide is considered to have a General Use classification.
- The use of Restricted Use or General Use pesticides on military installations requires a certified and competent Applicator, or someone who is under the direct supervision of a Certified Applicator.
- The EPA has established severe penalties for violations of pesticide misapplication.

Pesticide labels

The pesticide label contains the most important information concerning the product. The label contains information that classifies the pesticide as a restricted use or general use pesticide. The label also contains the hazard warnings to the user and the statement, “Keep out of reach of children.” Other label parts found include trade name, common name, ingredient statement, net contents, name and address of manufacturer, registration and establishment number, directions for use, misuse statement, reentry statement, storage and disposal directions, type of formulation, precautionary statement, environmental hazards, physical and chemical hazards, and statement of practical treatment.

Insecticides, the most common pesticides, are designed to kill insects, but are usually toxic to other arthropods, such as mites, ticks, and spiders. Insecticides are grouped according to the following table.

Insecticides	
Group	**Definition**
Inorganic	Made from naturally occurring minerals. Developed during the 1940s, and one of the first types of insecticide to be used in a large-scale control program. They are no longer stocked or used by the military, except for boric acid.
Organochlorines	• Primarily affect the central nervous system. They are used against a wide range of insects. Due to their long-term persistent problems in the environment, they have decreased in use within the CONUS. Examples are DDT, chlordane, and lindane.
Organophosphates	• This type of insecticide has replaced the chlorinated hydrocarbons for pest control. They kill by inhibiting the cholinesterase enzyme that affects nerve function. Examples are malathion, chlorpyrifos (dursban), and diazinon (dursban and diazinon no longer approved for use in DOD).
Carbamates	• The carbamates also inhibit the enzyme cholinesterase. An example is carbaryl (Sevin®).
Pyrethroids	• Synthetic pesticides that act on the central nervous system of the insect. Pyrethroids tend to have low mammalian toxicity and are widely replacing the other types of insecticides. Examples are permethrin, cypermethrin, d-phenothrin, and allethrin.
Growth regulators	• Cause the pest to develop improperly, which inhibits reproduction. This type of insecticide is generally nontoxic and affects only the target pest. These products are widely used in the pest control field. Examples are gencor and precor.

Other integrated pest management considerations

It is important for you to recommend control measures on surveillance—find out if the pest is there, and if so, where, when, and why. Do not try to control pests that are not present, and do not use control methods that are ineffective. This is particularly important for chemical control methods. Study the pest, its life cycle and its environment carefully, and then use as many types of control in the IPM program as practical. Place minimum emphasis on chemical control and maximum emphasis on the other control techniques.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

120. Functions and responsibilities

1. What are the goals of the medical entomology program?

2. What instruction outlines the pest management program for the base civil engineer?

3. What instruction outlines the Air Force’s Medical Entomology Program?

4. Who establishes the surveillance frequencies for disease vectors?

5. What are primary PH tasks during an aerial spray mission?

6. What are the BE responsibilities in the medical entomology program?

121. Taxonomy

1. What is taxonomy?

2. What is the next lower subdivision of a phylum?

3. What subdivision comes after order?

4. What subdivision is before genus?

5. In most cases, what is the last major division in the classification system?

6. What is the stiff outer skeleton in arthropods called?

7. What are the three regions of an insect’s body?

8. What are the four stages of complete metamorphosis?

9. What is a written insect key?

122. Air Force Pest Management Program

1. Which organisms does the Air Force consider "pests?"

2. What is "integrated pest management?"

3. What form of pest control relies on changing the environment?

4. What is "mechanical" pest control?

5. Who may use "restricted use" pesticides?

6. Which type of pesticides has a low toxicity for mammals and is widely replacing all other types of pesticides?

3–2. Mosquitoes

Mosquitoes transmit diseases to millions of people worldwide each year. This is very significant since the military deploys to most parts of the world. Mosquito-borne diseases continue to infect Americans throughout the USA. For example, West Nile virus caused encephalitis in most states.

123. Biology

The mosquito belongs to the most abundant group of invertebrate animals, the insects. They are in the class Insecta, order Diptera, family Culicidae. There are a variety of genera within the Culicidae, such as *Aedes, Anopheles, Coquillettidia, Culex, Culiseta, Deinocerites, Haemaogogus, Mansonia, Orthopodomyia, Psorophora, Uranotaenia* and *Wyeomyia*. There are many species within each genus.

Bionomics

To understand mosquitoes, you need to know the mosquito life cycle (fig. 3–5) and their adult habits. Mosquitoes have a complete metamorphosis which means that they go through four life stages: egg, larvae, pupae, and adult. In complete metamorphosis, the immature stages look completely different from the adult stage. The first three stages occur in the water and when adult mosquitos emerge they live in habitats such as vegetation, hollow trees, caves, underneath rock ledges and overhanging banks along streams. Both male and females adults feed on nectar, but only the females feed on blood which is required for her eggs to develop.

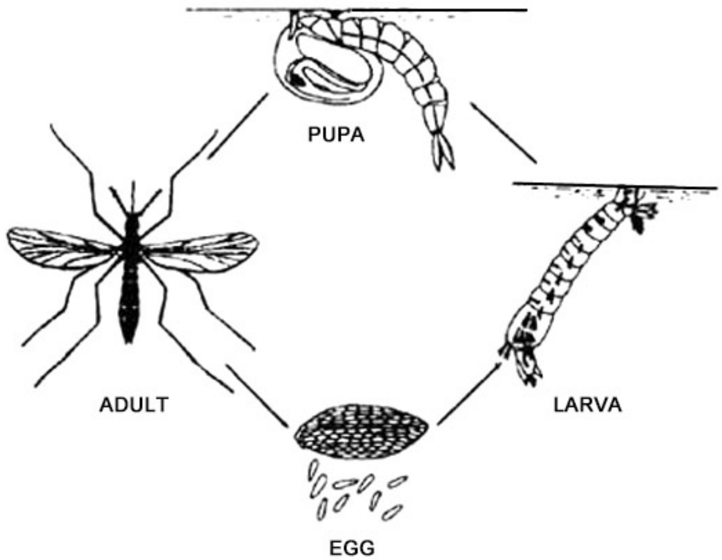

Figure 3–5. Mosquito life cycle.

Egg stage

Eggs are deposited in or near water because juvenile mosquitoes are aquatic. Mosquitoes of the genus *Culex* deposit their eggs attached together in the form of rafts that float on the water. The *Anopheles* deposit single eggs that have floats on the sides. *Aedes* mosquitoes deposit single eggs without any floats attached.

The mosquito eggs can develop in almost any standing body of water. Eggs of some species of mosquitoes can develop in farm ponds, while others can develop in salt marshes, tree holes, tires, tin cans, sewage catch basins or ditches. To maintain control over mosquitoes, it is important that you know the breeding biology of a particular vector species, because even closely related mosquitoes may have very different larval habitats.

Larval stage

The second stage of the mosquito life cycle is the larval stage (larva is singular; larvae [pronounced LAR-VEE] is plural). Larvae can develop only in water, and they feed on algae and organic debris. The larvae breathe air much like a dolphin or whale. However, larval mosquitoes obtain oxygen through a breathing tube at the posterior end of the body (except *Anopheles*, which breathes through a pair of holes at the posterior end of the body). The genera *Mansonia* and *Coquillettidia* obtain air by piercing the underwater portions of aquatic plants.

The position of the larvae in the water is important to identifying their genus. *Anopheles* larvae lie parallel to the water surface, while *Culex* and *Aedes* lie at an angle to the water surface. Mosquito larvae swim by undulations of their bodies. The average length of time in the larval stage is 4 to 10 days, depending on the species, water temperature and food availability.

Pupal stage

This third stage is the transition stage from larva to adult. The pupae stay in the water and remain active. They do not feed during this stage, and they breathe through the trumpet-like structures on the thorax.

Adult stage

Adult mosquito populations are generally 50 percent (half) male and 50 percent (half) female. The males usually emerge first and remain in the area until the females emerge. You can use behavior, as well as, some physical structures (fig. 3–6), to differentiate between male and female mosquitoes. Take a few minutes to study the following information:

- Male mosquitoes—male antennae are bushy and palps are at least as long as their proboscis (sucking mouthpart).
- Female mosquitoes—anopheline female palps are as long as their proboscis. Culicine female palps are shorter than their proboscis. Regardless of the length of the palps, all females have few hairs on the palps and the antennae.

NOTE: Only the female mosquitoes feed on blood. Both adult females and males feed on nectar.

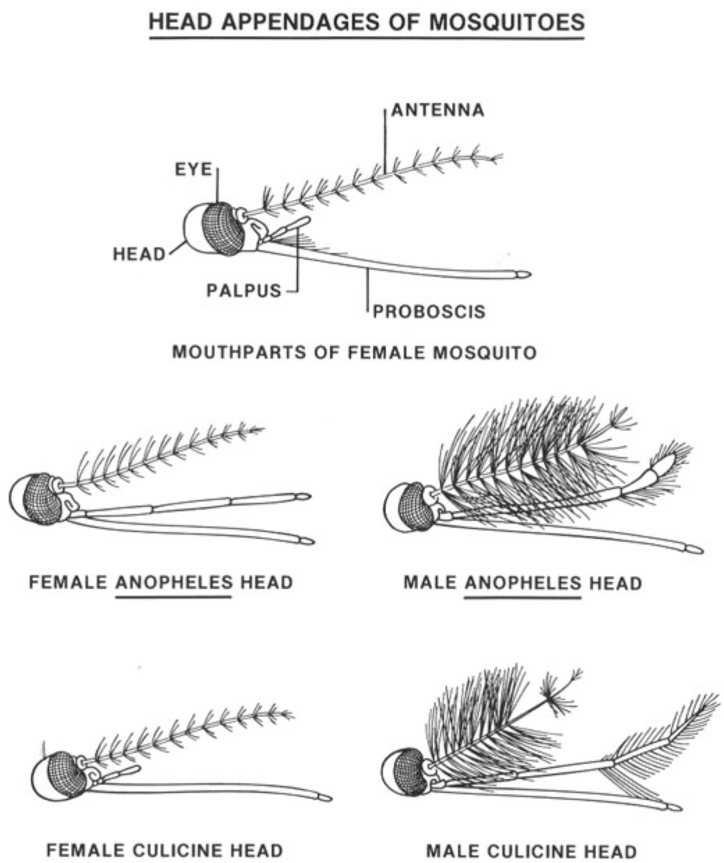

Figure 3–6. Comparison of male and female mosquito.

Flight range

Females tend to fly farther and live longer than males. The flight range varies among the different species from less than 100 meters to several kilometers. Some species increase their flight activities during a full moon. Most species are inactive during daylight hours when they rest in cool, dark, and humid places that are protected from the wind. Some species feed only during daylight hours. Some species can survive through the winter months as adults and deposit eggs in the spring.

Identify the species

Identification of mosquito species is important. You should be able to tell the difference between common mosquito genera (i.e., *Aedes*, *Culex*, etc.) at your location. All collected specimens should be sent to the nearest entomology consultant for proper identification to the species level.

124. Mosquito-borne diseases

Encephalitides (inflammatory infections of the brain) are the most significant mosquito-borne diseases in the Unites States. Other important mosquito-borne diseases include dengue fever, yellow fever, and malaria.

Encephalitis

Encephalitis is the inflammation of the brain. “Encephalitides” is the plural form of the word “encephalitis” and includes more than one type of encephalitic disease. Encephalitides are complex diseases that have several vectors and several reservoirs, and they can range from mild to fatal.

The mosquito-borne encephalitides are viral infections of the brain and/or spinal cord. They are often named after either the geographic location where they were first identified or the animal from which they were isolated. In CONUS, the primary vectors of encephalitis are infected *Culex* and *Aedes* mosquitoes.

Encephalitides are the most important mosquito-borne diseases in the US. Several species of viruses cause encephalitis; they are as follows:

- West Nile virus (WNV) encephalitis is one of the most common mosquito-borne diseases in CONUS. The virus ranges across North and South America, Australia, parts of Asia, Europe and Africa.
- Saint Louis encephalitis (SLE) occurs in eastern and central states but cases range from Canada to Argentina.
- Eastern equine encephalitis (EEE) occurs along the East Coast from New England to the southern tip of Texas with the virus and disease ranging into South America.
- Venezuelan equine encephalitis (VEE) is one of the severe mosquito-borne diseases in the Americas.
- Western equine encephalitis (WEE) is found in the western two-thirds of CONUS and ranges down to South America.
- California encephalitis (CE) group includes California, Snowshoe Hare, LaCrosse, Trivittatus, Keystone, Jerry Slough, San Angelo and Jamestown Canyon viruses, which are distributed throughout the CONUS, Canada, Alaska, and the Americas.
- Japanese encephalitis is the leading cause of vaccine-preventable encephalitis in Asia and the western Pacific.

The reservoirs of the encephalitides are varied; however, wild birds are the most common reservoirs of WNV, EEE, and WEE. Reservoirs for VEE include rodents and horses. Although humans become ill, they cannot transmit these viruses to an uninfected mosquito or from human-to-human. Certain adult female mosquitoes can transmit SLE and LaCrosse virus directly to their eggs (transovarial [across ovary] transmission). The offspring of these mosquitoes are then infective.

Encephalitis is a serious condition. Viral encephalitides range from asymptomatic, through generalized flu-like illness, to severe central nervous system (CNS) disease that causes permanent damage or death. Specific symptoms may include fever, headaches and drowsiness, occasional vomiting, stiff neck, tremors, confusion, and convulsions. The incubation period from infective bite to sickness for most viral encephalitides ranges from 2–20 days. Severity varies by species of virus; for example, EEE is extremely rare but likely to cause death or long-lasting CNS damage. Japanese encephalitis can have a case fatality proportion of about 25percent.

Encephalitides are diagnosed is through laboratory testing. Treatment is supportive.

All people without previous exposure or vaccination to a given virus are susceptible to infection, but children and the elderly are generally at greater risk for severe disease.

Dengue fever

Dengue fever, dengue shock syndrome, and dengue hemorrhagic fever are viral diseases spread by mosquitoes found primarily in tropical areas; however, temperate areas such as Florida, Texas, and Japan also experience outbreaks. Another name for this disease is “break bone fever” because the pain is likened to the pain of broken bones.

The most common symptoms are fever, head, joint, and body aches, as well as pain behind the eyes. Up to half of the cases may exhibit a body rash. Typical dengue infections are rarely fatal. However, dengue hemorrhagic fever and dengue shock syndrome have significant fatality proportions, except in areas that have good hospital care and fluid therapy.

Dengue vectors are *Aedes albopictus* and *Aedes aegypti*. The incubation period is about three to 14 days, commonly five to seven days. This disease is controlled through sanitation, public education, vector avoidance and control, and environmental cleanup.

Yellow fever

Yellow fever is a viral disease that occurs primarily in Africa, Central, and South America. The virus is transmitted by *Aedes aegypti* and other mosquitoes with a mosquito-human-mosquito cycle. In jungles, primates can serve yellow fever reservoirs, but the virus can survive in mosquitoes where primates are not present. Symptoms of yellow fever are fever, headache, backache, jaundice, and internal bleeding. The disease incubates in about three to six days. Preventive measures include the administration of a highly effective vaccine and the use of individual protective measures against mosquitoes. As with dengue, yellow fever can be controlled through sanitation, public education, vector avoidance and control, and environmental cleanup.

Chikungunya

Chikungunya is a viral threat to both CONUS bases and operations in Europe, Africa, the Pacific, and Asia. This mosquito-borne disease causes large outbreaks. Symptoms include fever, joint pain, and a rash. It is similar to dengue; therefore, patients should be tested for both diseases. Chikungunya virus vectors are *Aedes albopictus* and *Aedes aegypti*. There is no vaccine for chikungunya but patients have protection after recovering from a past infection. As with dengue, chikungunya can be controlled through sanitation, public education, vector avoidance and control, and environmental cleanup.

Malaria

Malaria is a public health problem today in more than 90 countries that are inhabited by half of the world’s population. Worldwide prevalence of the disease is estimated to be in the order of 200 to 250 million clinical cases each year. More than 90 percent of all malaria cases are in sub-Saharan Africa. Mortality due to malaria is estimated to be over six hundred thousand deaths each year. The vast majority of these deaths occur among young children in Africa, especially in remote rural areas that have poor access to health services.

Malaria is a disease caused by any of five parasitic protozoan organisms belonging to the genus *Plasmodium*. These five *Plasmodium* species of cause different types of malaria: *P. falciparum*, *P. vivax*, *P. malariae*, *P. ovale*, and *P. knowlesi*. All forms of this disease are transmitted by certain *Anopheles* mosquitoes. The disease has three stages: cold stage (chills and shaking), hot stage with a high fever, and a profuse sweating stage (over the entire body). The disease attacks the patient’s red blood cells, causing anemia and an enlargement of the spleen and liver because of the pigment released from the bursting red blood cells. The capillary vessels in the brain may rupture or become blocked by parasitized red blood cells or clotted blood causing neurological complications and even death. This is where most of the complications develop and most fatalities occur.

Falciparum

Falciparum malaria is found in tropical regions worldwide. It is often fatal, particularly when untreated. It takes about 10 to days to incubate; and it remains infective in patients for seven to eight months, provided they survive the acute phase of the disease. The disease runs its course for about one month, and relapses do not occur. If untreated, complications affecting the brain capillaries (cerebral malaria), liver (bilious remittent fever), body temperature (reduction—called Algid malaria), and urine (turning dark red or black due to hemorrhaging called black water fever) can cause rapid death. Black water fever is extremely rare and occurs only in patients who have taken quinine as a preventive measure.

Vivax

This form of malaria is found in the tropics, subtropics, and temperate regions of the world. It can cause relapses for up to five years after the initial infection, and it is an important military threat. Although fatalities and complications are rare, it is incapacitating due to relapses.

Malariae

This disease is relatively rare and is found in the temperate regions of the world. The disease can become chronic (relapse), lasting up to 50 years after the initial attack.

Ovale

This form of malaria is rare and is found mostly in West Africa. The relapses of ovale are much milder and of shorter duration than relapses of the other forms of malaria.

Knowlesi

This is the fifth major cause of malaria in humans. Knowlesi is most common in Southeast Asia and is zoonotic with primate reservoirs. Human cases are relatively rare.

Chemoprophylaxis

Drugs are available to inhibit parasite development. The most used drugs are chloroquine, doxycycline, Malarone® (atovaquone and proguanil hydrochloride), and primaquine. Malaria in many parts of the world is resistant to chloroquine and other drugs; therefore, Malarone and doxycycline are currently the drugs of choice for flight crew. Contact the National Center for Medical Intelligence for current information on malaria incidence. Refer to the CDC's Traveler's Health page and the American Public Health Association's *Control of Communicable Diseases Manual* for recommended treatment and prevention.

125. Surveillance methods

Mosquito populations and factors affecting those populations, vary from one base to another. A surveillance program on one base may not be adequate for another. Species diversity, habitat variations, climatic conditions, geographic variability, effectiveness of various survey techniques, and local control measures must be considered when developing a surveillance program.

NOTE: It may be difficult for people to identify mosquito traps for what they are. It is possible that mosquito traps can be mistaken for malicious equipment, for example bombs; therefore, it is important to label traps as "Mosquito Trap," the name of the office setting them, as well as a contact telephone number to reach individuals who set any traps. It may also help to notify Security Forces or the local police department.

Installation survey

Before establishing or revitalizing your surveillance program, conduct a baseline entomology survey of the entire installation. A base map will help you identify areas of standing or running water. You may need to survey the base and mark the poor drainage areas and wind patterns on the map. This will help you locate potential and actual breeding sites for placing mosquito traps. After you have identified breeding sources and placed your traps, indicate the site locations on your installation map as part of the permanent record of your surveillance program.

Adult mosquito traps

There should be at least three traps operating at each installation, and they should be placed between the populated areas (such as housing units and flight lines) and the mosquito breeding sources, or located in the populated areas themselves. The traps should be located away from competing light sources, and they should be protected from wind. In general, traps should be placed so the light is about6 feet above the ground to attract the most mosquitoes and operated at least once a week, from dusk to dawn, during the mosquito season.

Keep in mind not all mosquitoes are attracted to light, which may affect your surveillance data. You may be incorrect to assume that a specific mosquito vector is not present at your base if you have used only light baited traps. Other ways to attract mosquitoes include using a carbon dioxide (CO_2) source, such as dry ice. This assumption that all types of mosquitoes will be attracted to light baited traps could lead to disease outbreaks if appropriate surveillance practices and vector control measures are not maintained.

While there are several different types of traps that you can use to collect adult mosquitoes, the solid-state Army miniature trap is the most common.

Solid-state Army miniature traps

The key features of the solid-state Army miniature (SSAM) (fig. 3–7) trap are portability, rechargeable battery, photoelectric switch, and the option of using D-cell flashlight batteries. Live specimens are collected in a net connected to the trap. The SSAM traps primary attractant is light; however, it can also be baited with CO_2.

Figure 3–7. Solid-state Army miniature trap.

CO_2-baited light traps

A standard SSAM trap can be baited with CO_2. Traps baited with CO_2 have the following advantages over traditional light-baited traps:

1. The CO_2, which is usually in the form of dry ice, mimics the CO_2 you breathe out as you exhale.
2. Traps baited with CO_2 usually attract more species and larger numbers of mosquitoes.
3. The traps baited with CO_2 attract primarily female mosquitoes.

The CO_2-baited traps can be operated on the same schedule as the light-baited traps. However, you can also operate the CO_2 traps during the daytime to catch species that are active in the late morning and early evening. A combination of light and CO_2 in the same trap will supplement your surveillance program and ensure that more species are attracted. Try to be consistent with the source and amount of CO_2 in the traps.

Resting site collection boxes

Many mosquitoes are active only at night, and rest in dark, quiet places during the day. Resting places include animal burrows, privies, drainpipes, old tires, empty flowerpots, tree holes, culverts, and sheltered areas under bridges. You can construct artificial resting sites from a 12-inch wooden box.

Paint the box red on the inside, and place it near bushes, forests, swamps, or similar areas to collect adult mosquitoes. Since most resting areas are dark, use a flashlight and battery-powered aspirator when you are collecting the mosquitoes. Resting boxes are best used to collect mosquitoes that have previously fed on blood.

Larval collection traps

You can collect mosquito larvae from sites, such as tree holes, artificial containers, catch basins, temporary pools, roadside ditches, ponds, swamps, and marshes. Although most larval collecting is done in ditches and ponds with a white dipper, you can use a large bulb pipette, such as a turkey baster, to sample water containers, such as tree holes, that have small openings.

After you identify the breeding sites, mark them on the base map. Generally, you would sample these areas at least weekly. However, the frequency of taking samples depends on the base location and the area environment.

The larval survey shows the exact breeding areas and areas where control is needed. However, you should analyze both the adult survey and the larval survey to determine if the adults are breeding on base or are flying in from off base.

Ovitraps

The ovitrap was developed primarily to collect the eggs of two species of mosquitoes—*Aedes aegypti* and *Aedes albopictus*. These species can potentially transmit chikungunya, dengue fever, and yellow fever. Light traps most likely will not attract either of these species, because the female *Aedes aegypti* mosquito prefers to lay her eggs inside small dark containers. This led the US Public Health Service to develop the ovitrap as a surveillance tool.

To make an ovitrap, take a 1-pint wide mouthed jar painted black on the outside (or a black plastic jar) and fill it about halfway with water (fig. 3–8). Wrap the lower half of a tongue depressor with a paper towel and secure the towel with rubber bands. Use a paper clip to fasten the wrapped tongue depressor to the side of the jar. Make sure the tongue depressor is down in the water, because the mosquitoes lay their eggs on the paper towel right at the water line.

To survey your base, place ovitraps at ground level in sheltered, dark areas near houses or in tire and equipment storage yards. Horse stable areas also are good locations (due to lots of blood sources), as are locations near mosquito breeding sites. You may want to use about 10 traps and rotate them in different areas for one to two weeks at a time. Whatever you decide to do, be sure to document the location of the ovitraps on your base map and check them at least weekly. If traps are left longer than a week, they will become mosquito breeding habitats.

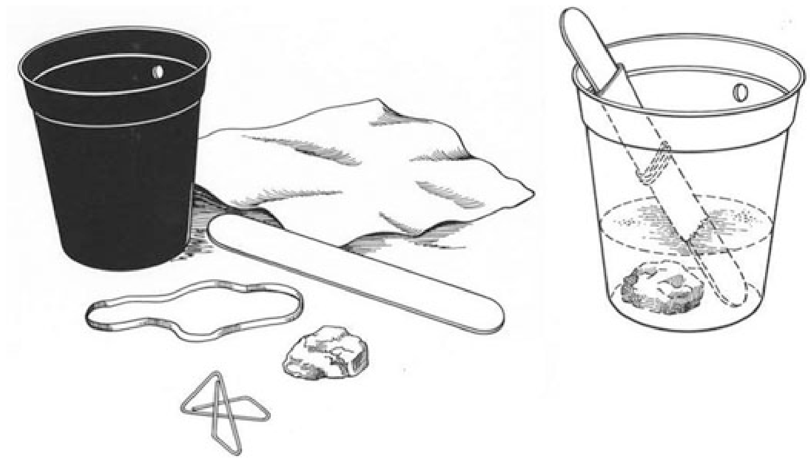

Figure 3–8. Ovitrap.

When checking ovitraps, remove the paddles and examine them for eggs. Also, check the water for early larvae. You will need to ensure that it is legal for you to ship ova or larvae to USAFSAM from your location.

To have USAFSAM assist in identifying the species from your ovitraps, dry the tongue depressors, put them in labelled sealable bags, put them in a box and send them to the USAFSAM for identification. Jars can be reused after being washed and having new tongue depressors wrapped in paper towel attached.

A “positive” ovitrap should stimulate a search to find and eliminate the source of the detected mosquitoes. Your search can be limited to within a few blocks of the ovitrap since *Aedes albopictus* and *Aedes aegypti* are weak fliers and rarely fly more than 100 yards from their breeding site.

Packing and shipping specimens

It is very important that you properly pack specimens before shipping them to USAFSAM/PHR. Pack and ship all specimens in accordance with the instructions below (fig. 3–9).

Improper packaging and shipping could hinder fast, accurate identifications. Some specific problems encountered include the following:

1. Damaged specimens caused by crowding or improper packaging—specimens should not touch each other.
2. Stale, wet, moldy, or old specimens.
3. Unnecessary insects included with the female mosquito specimens.
4. Incomplete collection information on container labels.
5. Incorrect address on shipping container.

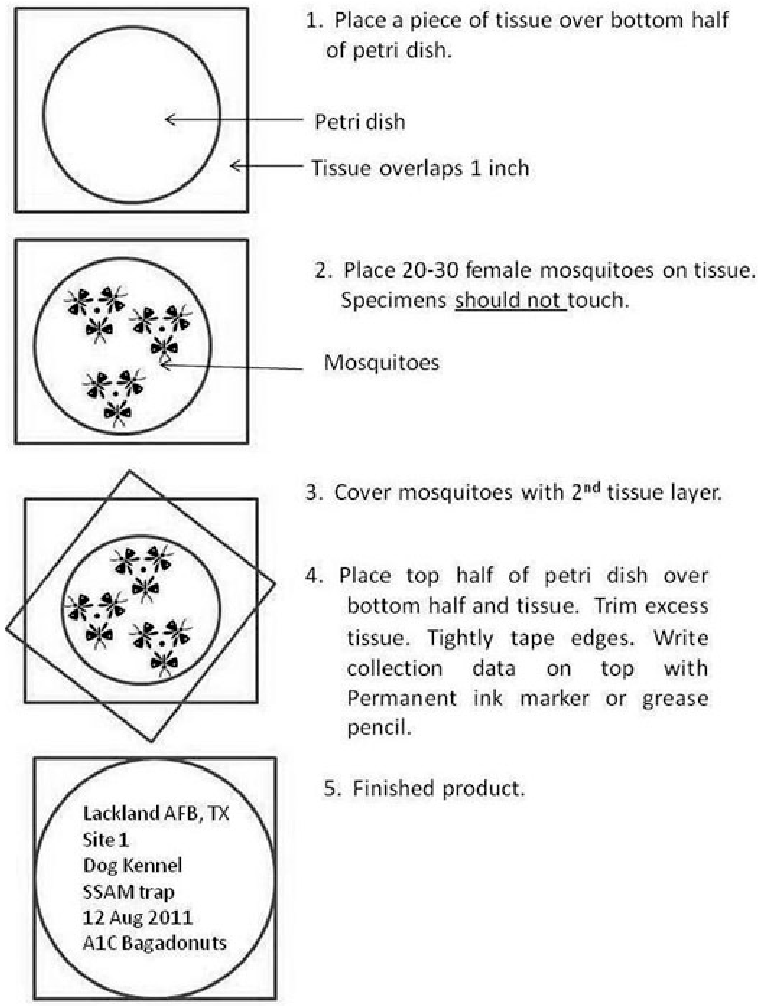

Figure 3–9. Procedures for packing and shipping specimens.

Using surveillance data

The primary goals of your mosquito surveillance program are to detect and monitor pest and vector species in the populated areas of the base, and to help CE Pest Management personnel manage mosquito control programs. Surveillance data generated from trapping can help you to predict peak periods of mosquito abundance and evaluate control measures. Also, it is very important that you inform CE of the numbers found and give them the identification information as soon as it is available.

Trap index

The trap index (TI) helps you to organize trap data and compare different periods or locations. The TI is simply the average number of females caught per trap night.

NOTE: One trap night equals one trap operated for one night. Do not include data from malfunctioning traps in your calculations.

The formula for computing a TI for a given time interval:

$$\mathrm{TI} = \frac{\text{Total number of females trapped}}{\text{Total number of trap nights}}$$

Assume that an Air Force installation operated four light traps for three nights during the first week in August to collect female mosquitoes. The table below indicates which traps were used and how many female mosquitoes were collected in each trap each night.

Date	Trap number	Number of female mosquitoes
2 Aug	1	8
	2	24
	3[a]	0
	4	13
4 Aug	1	6
	2	30
	3[b]	9
	4	0
5 Aug	1	11
	2[c]	5[c]
	3	5
	4	11

NOTES:

[a] Although it did not collect any female mosquitoes, the trap was operating and should be included in the trap-night count.

[b] The trap was inoperative and should be subtracted from the trap-night count.

[c] The trap malfunctioned; female trap-night specimens collected before the malfunction should not to be included in the total number collected. However, specimens should be submitted for identification.

Calculate the weekly TI as follows:

$$\text{TI} = \frac{8+24+0+13+6+30+0+11+5+11}{(4\text{ traps}\times 3\text{ nights}) - 2\ \text{ bad traps}} = \frac{108}{10} = 10.8$$

Specific trap index

To show the average population of a single species or particular group of mosquitoes, you would use another type of trap index called the specific trap index (STI). This type of index is particularly useful to plot fluctuations in local pest species or disease vectors. Do not include data from malfunctioning traps in your calculations. For example, you need to know the average number of female *Aedes vexans* trapped in one week. The species index for *Aedes vexans*, which is primarily a pest species, would be calculated as follows:

$$\text{STI} = \frac{\text{Number of female } \textit{Ae. vexans} \text{ trapped in 1 week}}{\text{Total trap nights for that week}}$$

Graphs

As you calculate the weekly TIs, plot them on a graph for a visual picture of population fluctuations. From these weekly graphs, you can prepare annual graphs to identify and predict peak periods of mosquito activity. In addition, TI graphs are valuable when planning mosquito control. One note of caution: be sure to document on the graphs any reasons for fluctuations in TIs, such as abnormal weather, aerial spraying or lack of CO_2 for the week.

126. Mosquito control measures

There are four common types of mosquito control: cultural (or environmental), mechanical, chemical, and biological.

Cultural control

Generally, the preferred method is cultural control, eliminating water so the mosquitoes have no place to breed. Cultural or controls for mosquito control are often quite expensive, initially. However, since these methods are usually less expensive in the long run, recommend them whenever and wherever possible. Of course, you must keep in mind that the Air Force operates on a strict year-to-year budget, and you sometimes must abandon plans for cultural control methods in favor of less expensive controls.

Fill the holes

One of the best methods of cultural control is to fill low-lying areas that contain water with gravel and dirt to eliminate breeding sites when possible. This usually requires heavy equipment, and is the responsibility of CE.

Control drainage

Properly controlling water drainage also prevents mosquito breeding; however, this requires more maintenance than filling alone and should be considered only when filling is unfeasible. Draining and ditching are often used with filling, especially in irrigated areas where water flow can cause temporary ponds in low-lying areas. Draining and ditching are also frequently used in salt-marsh areas. Ditches are designed to take advantage of tides to periodically flood and drain breeding areas. Underground drains might be necessary in marshes and swamps. This is appropriate where the soil is impervious and does not allow water to pass to lower areas.

Other controls

There is a wide variety of other cultural controls that include filling tree holes; removing cans, bottles, tires, and other receptacles that hold water; using floodgates across small streams; and screening windows and doors with fine mesh screen.

Mechanical control

Mechanical controls will provide exclusion and aid in disease prevention. Mechanical controls separate the pest from the environment. The most common type of mechanical mosquito control is exclusion through screening and nets. The standard issue 16-mesh-to-the-inch screening meets the requirements for mosquito exclusion; however, 24-mesh screen is necessary to exclude some of the smaller insect species such as sand flies. Complaints that mosquitoes are coming in through the screen are usually the result of holes in the screens or improperly installed doors and windows, rather than the size of the screening itself. A close inspection of the openings usually reveals the need to change doors, patch screens, or replace weather stripping.

Chemical control

Chemical control measures are usually fast acting, temporary in nature, and aimed at killing only the adult or larval mosquitoes. This type of control requires applications at intervals during the breeding season. You should recommend chemical control methods be used only in conjunction with cultural controls directed at adult and larvae populations.

Control mosquito larvae

The best form of overall mosquito control is killing the mosquito larvae or removing their breeding areas. Chemicals used to control mosquito larvae are called “larvicides.” They work primarily by poisoning, or by a combination of poisoning and suffocating the larvae. Larvicides do not greatly affect eggs, unless they become coated with oil; nor do larvicides affect pupae, unless the air supply is eliminated.

Other larvicides including granular larvicides and dunks have come into widespread use. Methoprene dunks such as Altosid act to disrupt the growth of larval mosquitoes. Larvicides such as *Bti* briquettes and granules are relatively safe for the environment and very effective.

Control adult mosquitoes

Chemical control may be necessary in situations that warrant an immediate mosquito knockdown or to prevent further spread of certain mosquito-borne diseases. There are two methods for chemical control of adult mosquitoes: (1) application of insecticide to surfaces where mosquitoes rest, which is referred to as a “residual treatment” or (2) direct application of very fine insecticide droplets into the airspace where mosquitoes fly, which is referred to as a “fogging.”

Residual treatment

Interior walls and exterior surfaces of buildings can be treated with residual pesticides to control adult mosquitoes. This method is more common in less-developed countries and poisons the mosquito as it rests on vertical surfaces of the dwelling. If residual sprays are applied in the form of oil solutions or water emulsions, the insecticide will remain in crystalline form after the liquid evaporates.

Fogging

Outdoor spraying requires the use of fogging or ultra-low-volume (ULV) machines. Although fogging kills adult mosquitoes quickly, there is no residual effect. ULV uses low amounts of pesticide to kill adult mosquitoes without adversely affecting other insect populations. ULV application kills by body contact of the mosquito with the pesticide droplets. Ground applied ULV is the most common method.

Aerial ULV adulticide should be used when all other methods fail to control mosquitoes or when there is an imminent threat of mosquito-borne disease. When the adult mosquito population is very large, spraying from aircraft can give rapid control over a large area in a short time. Aerial spraying uses space-spraying techniques and requires specialized aircraft not usually available on all bases. Proposed aerial spray projects must be validated and approved in advance in accordance with DOD guidance.

Repeated surveys and spraying

You should survey for mosquito populations after spraying. If significant populations of mosquitoes persist, then the mosquitoes can be sprayed again. However, pesticides will be used after resistance testing is completed for target mosquitoes.

Biological control

Biological control methods are not as well developed as chemical or environmental methods; however, future control practices will probably lean more and more toward the biological methods. Biological control methods reduce the mosquito population through predators, parasites, anddisease. Before any biological control program is attempted, you should consult your CE and PH entomologists. Most biological control programs have severe legal and regulatory restrictions.

Predators

There are many natural predators, such as larvae of various insects (such as dragonflies) that feed on mosquito larvae. However, one of the most widely used predators is not an insect, but a small top-feeding minnow known as *Gambusia affinis*. This fresh water minnow will feed on larvae along the shallow edges of streams; however, use of these fish is severely restricted in many states and countries and should be coordinated prior to consideration. *Fundulus* species serve the same purpose in saltwater. Another predator is *Tilapia mossambica*, as well as, other *Tilapia* species. Stocking waters with non-native fish requires approval of federal and local wildlife and fishery agencies.

Mosquito IPM overview

Integrated Pest Management programs manage mosquitoes by combining biological, cultural, physical, and chemical tools. IPM programs use information on the biology of mosquitoes and their interactions with the environment. Mosquito IPM program controls are based on identifying mosquitoes through surveillance and source reduction of habitats. Mosquito surveillance identifies locations where mosquitoes are at peak abundance. Surveillance helps to determine the mosquito species in a given area, and allows you to recognize species that can carry disease. Source reduction is the process of removing or modifying mosquito larval habitats to make them unsuitable for larval development. Control is carried out by applying pesticides such as adulticides for adult mosquitoes and larvicides for larvae. Biological controls are also an option such as dragonflies, and the *Gambusia* or mosquito fish that eat larvae. The general public should be informed of personal protective measures to prevent mosquito bites. This includes using physical barriers (ex. window screens) and using appropriate personal protection when outdoors. To be successful, surveillance of vectors and pest must be done and compared to determine if the current control measures are working. Control procedures used in a sound IPM program for mosquitoes should include the following procedures:

1. The first step in any IPM program is surveillance of your pests and vectors.
2. Source reduction to reduce or eliminate mosquito breeding using cultural control.
3. Protective devices, such as repellents, bed nets, and screens, to decrease contact with biting mosquitoes (mechanical control).
4. Bio control agents could be considered.
5. Larvicide at known breeding areas with a DOD-approved insecticide when necessary.
6. ULV adulticide with a DOD-approved insecticide when necessary.
7. Conduct surveillance of your pests and vectors to determine if control is working.

Along with direct vector control, the susceptible personnel must be protected from attack by parasites and infective mosquitoes. In many cases, personal protection is your best defense against vector-borne disease. This is usually done by use of proper wear of permethrin treated uniforms, prophylactic drugs, personal protective devices, and repellents.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

123. Biology

1. What genus of mosquito deposits its eggs attached together to form rafts that float on water?

2. Where do mosquito larvae develop?

3. What percentage of adult mosquitoes are typically male?

4. What sex of mosquito has bushy antennae?

124. Mosquito-borne diseases

1. What mosquito genera are the two primary vectors of encephalitis in CONUS?
2. What is the most common mosquito-borne disease in CONUS?
3. Which encephalitis group includes Snowshoe Hare, LaCrosse, and Jamestown Canyon viruses?
4. What are thought to be the most common reservoirs of WNV, SLE, EEE, and WEE?
5. What is another name for dengue fever?
6. What genus of mosquito transmits dengue fever?
7. What are the three control measures for dengue fever?
8. What are the symptoms of yellow fever?
9. What are the five species of malaria?
10. What are the three stages of malaria?
11. What is the incubation period for falciparum malaria?
12. What form of malaria can cause rapid death if left untreated?
13. What forms of malaria have relapses?
14. What chemoprophylaxis for malaria is typically prescribed for flight crew?

125. Surveillance methods

1. What should you complete prior to establishing or revitalizing your surveillance program?

2. What are the important things to remember when locating the adult mosquito traps on base?

3. What device is used to collect live specimens in adult mosquito traps?

4. What does the SSAM trap use to attract mosquitoes?

5. What are the advantages of a CO_2-baited trap over a light-baited SSAM trap?

6. Why would you operate a CO_2-baited trap during daylight hours?

7. Generally, when should you sample larval mosquito collection sites?

8. What two mosquito species are collected primarily with an ovitrap?

9. What is a TI?

10. What is an STI?

126. Mosquito control measures

1. What are the four types of mosquito control?

2. What is one of the best mosquito cultural control methods?

3. What are the two methods of chemical control used on adult mosquitoes?

4. What predator is most widely used for feeding on mosquito larvae?

5. In many cases, what is your best defense against vectorborne disease?

3–3. Other Arthropods

In addition to mosquitoes, many other arthropods transmit disease. Some of the primary ones are lice, flies, fleas, ticks, and mites. Outside of transmitting viruses, bacteria or parasites, other arthropods can cause illness in humans.

127. Lice

All human lice are small, flat, and wingless. They all have gradual metamorphosis: egg to nymph (young louse) to adult stage. Body lice and head lice are anatomically similar (fig. 3–10).

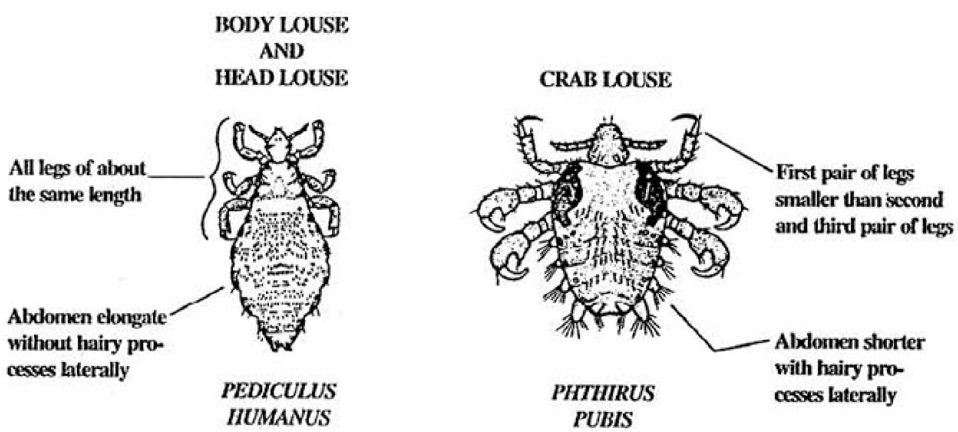

Figure 3–10. Human lice.

There are three distinct varieties of lice that infect humans: *Pediculosis humanus capitis* (head lice), *P. humanus humanus* (body lice) and *Phthirus pubis* (crab or pubic lice). Head lice and crab lice attach themselves to the hair shafts of humans to remain close to their blood supply; body lice are found in the host’s clothing except while feeding.

Habitats of human lice

Human lice are found all over the world. They thrive during famines, wars, and among people suffering economic hardships. Louse infestations can spread when large groups of people are deprived of homes, laundry, and bathing facilities.

Body lice are particularly associated with cold weather. Although lice are present in the higher altitudes of the tropics, they are found more commonly in temperate and subarctic areas where people wear heavy clothing in several layers.

Diseases transmitted by human lice

Louse-borne diseases have been a threat to the fighting forces. Wars have been lost because of casualties caused by louse-borne diseases. There is little evidence that head and pubic lice are disease vectors, although they can be severe pests. The body louse is considered the most medically important because of its ability to transmit multiple bacterial pathogens.

The louse-borne diseases are epidemic typhus, relapsing fever, and trench fever.

- Epidemic typhus occurs most commonly among people living in overcrowded conditions with poor sanitation. The disease is spread when an infected body louse defecates or is crushed into a wound (bite). Cases can be found in Central Africa, Asia, and the Americas.
- Louse-borne relapsing fever is a serious disease that can be mistaken for hemorrhagic fever. Untreated case fatality rates can exceed 40 percent. Currently more than 95 percent of cases worldwide are restricted to Africa.
- Trench fever (or five day fever) is far less severe than the preceding two diseases. It is endemic to homeless people worldwide including those in many major US, European, and Asian cities.

These diseases, which are spread from human-to-human by body lice, may occur in epidemics. They are a particular threat to military personnel in refugee camps or prison camps.

Neither epidemic typhus nor trench fever is transmitted by the actual bite of a louse. The bacteria contained in the louse are passed out with the fecal droppings of the louse when it feeds. When people scratch itchy louse bites, the skin can be broken and the bacteria can gain entry to the body. Crushing the lice can also rub the bacteria into wounds. Pathogens are also transmitted when contaminated fingers contact mucous membranes or the conjunctiva.

Relapsing fever bacteria are transmitted from crushed lice. When the lice bite, scratching crushes them, and the fingers then rub the crushed pieces into the wound or into mucous membranes or conjunctiva. These bacteria are not found in the feces of the lice. Relapsing fever bacteria are transmitted by crushed lice. Transmission occurs when the louse is crushed and the infected body cavity within the lice is released onto the human skin. The specific bacteria causing relapsing fever, Borrelia recurrentis, is able to penetrate intact mucosa and skin. The transmission causes the death of the louse which is why an individual louse can only infect one person. Therefore, louse-borne relapsing fever outbreaks have a higher incidence when there are high louse densities in human populations.

Integrated pest management for lice

With all forms of louse control, education of the people is the most effective method of prevention. It is equally important to educate people on what is not effective. You can use cultural control, chemical control, and mechanical control measures against lice; however, the methods of control differ based on the habits of the individual species.

Cultural control

Head lice can be averted by avoiding contact with other people’s headgear, combs, brushes, and hair. Visual inspection of the head may show nits or live lice. Nits should be combed out of the hair with a fine comb. Treatment with pediculicide may be employed. Laundering clothing and environmental cleaning can reduce the chance of re-infestation. Retreatment may be necessary. In addition, individuals should shampoo often. Also, permethrin treated clothing has been shown to protect against louse infestations after 20 wash cycles. The best method available to control louse-borne disease in dense populations would be to bathe and clean clothes with detergents lethal to adult lice and their eggs; therefore, the best control for body lice is to maintain personal cleanliness.

As long as people take frequent baths and change clothes regularly, lice can be kept under control. People should avoid contact with other people who are infested with lice and infected people’s clothing and bedding. Infested clothing and bedding should be washed in hot, soapy water and the water should be at least 140˚F. If clothing cannot be washed, dry cleaning is also effective.

Pubic lice can be controlled by avoiding sexual and other body contact with infected people and their clothing. Wash clothing and bedding in hot water.

Chemical control

Head lice and pubic lice can be treated with insecticidal shampoos. Follow the label and do not apply more than the labeled dose. Pesticide resistance is known in head lice. Area insecticidal control is useless for head lice, because the lice do not live off their human host.

Body lice control includes hot water laundering and machine drying of clothing, bedding, and towels. If absolutely necessary, body lice control can be enhanced through disposing of infested bedding or clothing. Pesticides are no longer available for dusting, spraying, or treating people. Refer patients to their primary care manager. Area insecticidal control is useless for body lice.

Mechanical control

Louse eggs are called nits. For head lice, remove nits and lice with a nit comb, or by hand. Manual control of body lice is highly effective if clothes or bedding can be washed with soapy water or put in a dryer. Wear silk or plastic clothes while handling infested fabrics to avoid infesting yourself. Manual removal of body lice from clothing and bedding is not effective. Manual removal of pubic lice and louse nits from affected areas is effective.

128. Flies

Flies are pests both indoors and out. They have complete metamorphosis with four stages in their life cycle: egg, larva (called maggots in some species), pupa, and adult. Although there are many fly species that cause concern for public health officials, only a few are introduced here.

Categories of flies

One is the biting fly. Biting flies spread disease agents through their bites (biological transmission) into animal blood sources. Some of the flies in the category of biting flies are stable flies, sand flies, black flies, biting midges, and deerflies. The other category is the Filth fly. Filth flies get their name because they breed in excrement and filth from which they carry (mechanical transmission) disease-causing organisms to food, drinking water, or the human body. In the filth fly category, there are dump flies, fruit flies, flesh flies, bottle flies, and house flies. Filth flies are one of the most common pests encountered during deployments.

Diseases spread by flies

Throughout the world, flies are mechanical and biological vectors of organisms that cause some of the most common and important diseases, such as diarrhea, dysentery, onchocerciasis, leishmania, loa loa, sleeping sickness, tularemia, anthrax, and others. Many types of flies, particularly the housefly and other domestic flies, have filthy habits that make them efficient vectors of disease. In the tropics, various skin and eye diseases are spread by flies. Biting flies can transmit onchocerciasis, leishmaniasis, and trypanosomiasis. Flies spread pathogens in the following five ways:

1. On their mouthparts (through blood feeding).
2. Through their vomitus (used to dissolve solid foods).
3. On their body hairs.
4. On the sticky pads of their feet.
5. Through their feces.

Myiasis is the condition in which a living tissue is infested with maggots. Myiasis is irritating and possibly even a fatality depending on the species, number of maggots, and human body part involved. Certain flies, like the screwworm (*Cochliomyia hominivorax*), may cause significant damage; others, such as the human bot fly of South America, may simply cause painful boil-like infestations. Injured and incapacitated personnel must be particularly protected from fly exposure, as they may have open wounds and be unable to prevent fly contact.

Integrated pest management for flies

Proper sanitation around facilities is the number one prevention against filth flies. In addition, screening of living quarters and use of chemicals to kill both adults and larvae are effective in controlling the fly population.

Cultural control

To maintain control of filth flies remove all garbage, manure, carrion, and other materials where flies spend their larval stage and feed in their adult stage. The filth fly problem should go away. If it does not, you must reassess the location of breeding sites. Cultural control for biting flies largely depends on the species involved. Common controls may include damming flowing streams to prevent black flies, or draining and ditching water sites to reduce horse and deer fly populations.

Chemical control

Spot fly baits may be used indoors for filth flies. Use residual insecticides on surfaces where flies land and space sprays where flies are flying. Bait that has been formulated to attract flies is particularly effective. Chemical control for biting flies may include *Bti* briquettes to kill aquatic larvae and outdoor fogging.

Mechanical control

Use screens, nets, and other exclusion devices. Traps can also be used to provide some control against flies. Filth fly traps include hanging bag traps and sticky tape. The Manitoba trap is used for surveillance of biting flies, but the Manitoba trap can also act as a control. “Air curtains” are another example of mechanical control.

129. Fleas

Fleas are small wingless insects of the order Siphonaptera (fig. 3–11). There are several medically important fleas including oriental rat flea, human flea, northern rat flea, dog and cat fleas, and the stick tight flea. Both male and female fleas feed on blood. The female must have a blood meal to produce eggs.

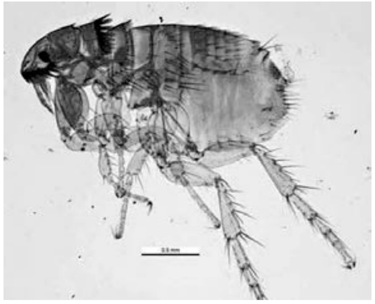

Figure 3–11. Flea.

Diseases spread by fleas

Fleas are responsible vectors of plague (*Yersinia pestis*) and murine typhus (endemic typhus). Various rodents, principally rats and ground squirrels, are reservoirs of infection from which fleas pick up the bacteria and transmit bacteria to humans. When the normal rodent hosts are unavailable, rodent fleas will bite humans. The Chigoe flea (or jigger) does not transmit disease but causes direct damage when it attaches inside the skin on bare feet or exposed skin. This can lead to extreme painful swelling and inflammation and possibly gangrene infections.

Transmission of disease

Most fleas do not transmit diseases. Certain rodent fleas become infected with plague bacteria when they feed on an infected host. Plague is then transmitted to humans through the bite of the infected flea. Humans also can become infected with plague when they breathe in plague bacteria coughed from the lungs of a person or animal with pneumonic plague, or through blood-to-blood contact with an infected animal. Murine typhus is transmitted by flea bite or when flea or rodent louse feces are scratched into an open wound or inhaled.

Integrated pest management for fleas

The three forms of control that can be used against fleas are cultural, chemical, and mechanical. Flea control programs vary extremely depending on the nature of the problem. Indoor infestations of cat or dog fleas are primarily pests but ground dwelling rodent fleas are entirely different problems.

Control measures indoors

Indoor flea infestations are primarily cat or dog fleas. You can use both cultural and chemical controls for indoor flea infestations. The following list explains cultural and chemical controls:

1. Cultural—vacuum all rugs and floors several times each week. Also, vacuum the heating and air-conditioning ducts periodically. Wash pet bedding in hot water with detergent.
2. Chemical—treat pets or working animals with a veterinarian-approved insecticide. Then follow up with a continuous treatment, such as the flea pills or flea collars, as prescribed by the veterinarian. In severe infestations, treat rooms with residual or space insecticide or insect growth regulator (IGR) sprays.

Control measures outdoors

Outdoors you can use cultural, chemical and mechanical control measures. Outdoor flea infestations are far more likely to be the source of diseases, and thus control is medically relevant. The following list explains outdoor controls:

1. Cultural—rodent nesting sites can be destroyed; however, this poses a threat to personnel and must be done in accordance with both public health, engineering, and environmental regulations. Discourage rodents from establishing nests in or near buildings.
2. Chemical—flea control is difficult and should only be attempted if there is a flea-borne disease outbreak. Treat rodent burrows with insecticidal dusts or set up dusting stations. If rodent control is part of the plague control program, kill the fleas first.
3. Mechanical—fence yards and other small areas to be protected to keep out domestic and wild animals that could shed fleas in the area.

130. Ticks

Ticks are found throughout the world, but they are less common in the arctic and subarctic zones. Ticks typically live in burrows, dens, or nests of their host. Ticks belong to the class Arachnida and order Acari which is divided into ticks and mites. Ticks are divided in soft ticks and hard ticks; hard ticks are most commonly found more than soft ticks. Immature ticks have six legs and mature ticks have eight legs. Ticks typically quest for their hosts, which is a passive behavior of resting on the end piece of vegetation with front legs extended and they latch onto a suitable host when detecting a carbon dioxide source. Ticks prefer to quest near transitional areas which is when the vegetation meets a clear pathway.

Tick groups

The two types of tick that you will have to be familiar with are hard ticks and soft ticks (fig. 3–12).

1. Hard tick—a hard tick has a hard shield on its back, and its mouthparts can be seen from above. The hard tick species includes lone star ticks, blacklegged ticks, American dog ticks, and Rocky Mountain wood ticks.
2. Soft tick—a soft tick does not have a hard shield on its back, and its mouthparts cannot be seen from above. A soft tick often has a leather-like appearance essentially resembling a raisin with legs. A few species of soft ticks are known to spread relapsing fever and therefore are called “relapsing fever ticks.”

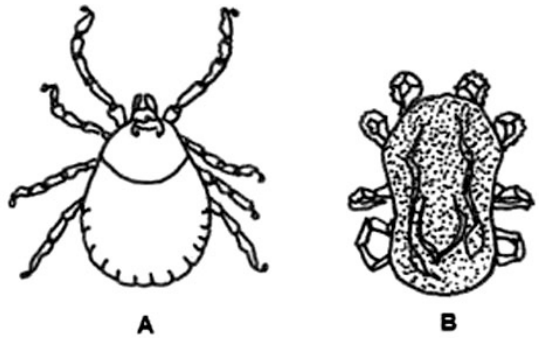

Figure 3–12. (A) Hard ticks and (B) soft ticks.

Diseases spread by ticks

Ticks spread the following four groups of deadly diseases to humans:

1. Rickettsial diseases, such as spotted fevers and Q fever. Rickettsiae are bacteria that must live inside cells. (**NOTE**: Rickettsiae are not related to rickets, a calcium or vitamin D deficiency.)
2. Spirochetal diseases, such as Lyme disease and relapsing fevers.
3. Bacterial diseases, such as tularemia..
4. Viral diseases, such as tick-borne encephalitis, Powassan encephalitis, Crimean Congo hemorrhagic fever, and Colorado tick fever.

As many as 43 species of ticks can cause tick paralysis. Tick paralysis is an ascending paralysis, starting from the legs. It may result after a female hard tick has attached for several days to the base of a person’s neck or the back of the head on or near the hairline, making detection difficult. The tick transmits a neurotoxin to the host.

Rocky Mountain spotted fever

Mammals are natural reservoirs of Rocky Mountain spotted fever. Both rodents and stray dogs can be important reservoirs. The disease is transmitted to humans by an infected tick. There are several vector species that transmit this disease: the brown dog tick (*Rhipicephalus sanguineus*), the American dog tick (*Dermacentor variabilis*) and the Rocky Mountain wood tick (*Dermacentor andersoni*).

Rocky Mountain spotted fever has a sudden onset with fever, chills, pain (in the muscles, joints, and bones), and rashes. The disease lasts about two weeks, with mild symptoms the first week and more severe problems the second week. If the nervous system is affected, the patient could become agitated, act delirious, suffer insomnia, or lapse into a coma. Circulatory and pulmonary complications could also occur. This disease can be fatal if untreated.

Lyme disease

Lyme disease is the most frequently reported arthropod-borne disease in the USAF. Lyme disease occurs throughout most of the temperate regions of the world including the USA. Cases are most frequently reported in the Northeast and northern Midwest, and a small portion of the Pacific Coast. Lyme disease is the third most commonly reported disease in New England. Cases have been reported in every state. Lyme disease is a tick-borne disease caused by the spirochete *Borrelia burgdorferi*.

It is also known as erythema chronicum migrans and tick-borne meningopolyneuritis in Europe. This is a chronic disease that affects several body systems if not treated and cured. Lyme disease begins with mild to severe flu-like symptoms, often with a characteristic “bull’s-eye” skin lesion at the site of the tick bite. Initial symptoms are followed by a latent period where the individual is apparently disease free, but months to years later some patients develop chronic symptoms, including joint and muscle (Lyme arthritis) pain, and potential heart and nervous system complications.

Diagnosis is by laboratory tests and clinical findings. Treatment is by antibiotics as soon after diagnosis as possible. Post exposure treatments with low doses of doxycycline are used in some states. Lyme disease may require long-term antibiotic treatment for cases diagnosed late in their course.

There is no person-to-person transmission of Lyme disease. It is spread only by the bite of an infected tick. The Lyme disease cycle is naturally maintained by larval ticks feeding on infected rodents. Larvae become infected and molt to infected nymphs and then adults. These feed on rodents, larger mammals, and occasionally humans; then transmit Lyme disease. Deer are important to maintain tick populations, but are resistant to Lyme disease. Ticks do not lay infected eggs.

Transmission of disease

Most ticks transmit disease while feeding from their vertebrate hosts. Ticks serve as reservoirs of viruses, bacteria, and protozoa. Several rickettsial pathogens may be transmitted from infected adults to the egg (transovarial transmission) to the subsequent larva, nymph, and adult stages (transstadial transmission).

Integrated pest management for ticks

You can use cultural, chemical, and mechanical control measures against ticks.

1. Cultural—remove brush and ground litter from yards and recreational areas and keep grass mowed. Remove food sources for rodents, deer, and other animals that may serve as hosts for the ticks. Avoid transition zones from clearings to woods.
2. Chemical—permethrin treated uniforms offer excellent protection against ticks as do insect repellents. Treat the infested area with a residual pesticide for use against ticks (acaricide).
3. Mechanical—hard ticks spend the majority of their life cycle on a host, therefore, excluding non-human hosts from human populated areas should reduce tick populations. Where possible, use proper fencing and gating to eliminate wildlife from entering human populated areas.

Personal protection

The best way to prevent tick-borne disease is to practice proper personal protection. This includes wearing the permethrin treated uniform properly, using insect repellents such as DEET, or picaridin, and performing thorough buddy checks after field work.

Proper tick removal

If you find an embedded tick on a human or animal, you must remove it to prevent transmission of disease and illness. To remove an embedded tick, take care not to crush it or leave mouthparts in the skin. Ticks are removed most effectively with small forceps or tweezers—grasp as far forward on the mouthparts as possible, and carefully pull them out with steady even upward force. Ticks should not be grasped by the abdomen, since squeezing the abdomen may inject pathogens into the host. Safely dispose of the removed tick. Wash or disinfect the bite site. Watch for signs or symptoms of disease for at least two weeks, especially the lesion associated with Lyme disease (bull’s eye or target lesion).

131. Mites

Mites are found throughout the world in practically all climates. Although many mites feed on plants, some feed on humans and animals.

Larval mites

Most mites lay eggs but some give live birth. The eggs hatch into six-legged larvae, in general these molt to protonymph, deutonymph, and tritonymph before becoming adults. Certain mites, such as chiggers, feed on humans and animals only in the larval stage. Adult mites have eight legs.

Species

There are many species of mites. Common names for some species of medical importance include itch mites, chiggers, house mouse mites, tropical rat mites, chicken mites, northern fowl mites, straw-itch mites, and grain and flour mites.

Transmission of diseases

Mites transmit diseases or cause numerous conditions that make them medically important. Outside of disease transmission, mites are primarily important as sources of allergens or as annoying biting pests. Mites are responsible for the transmission of two diseases of public health significance scrub typhus (agent *Orientia tsutsugamushi*) and rickettsial-pox (agent *Rickettsia akari*).

Scrub typhus

Scrub typhus is a significant vector-borne disease. It is a major cause a febrile illness and is potentially fatal. In South East Asia and parts of the Pacific and Australia, some chiggers transmit scrub typhus (also known as Tsutsugamushi disease). It is a rickettsial disease. The chigger bites sometimes leave a black eschar (scab) which can help identify the disease.

Scrub typhus is zoonotic and transmitted by chiggers that tend to live in short "scrub" habitats and tall grass. It is a common disease in Japan, Korea, Thailand, and other counties with a USAF military presence.

Rickettsia pox

Rickettsia pox is transmitted by the house mouse mite. Certain rodent mites also are involved in the transmission of rickettsia pox; this is a rare, nonfatal disease occurring primarily in homeless people living in large cities in the US and Russia.

Conditions caused by mites

Some of the diseases spread by mites include scabies or mange, dermatitis, body infestations, and scrub typhus. Typically you will not deal with mites, but you must be familiar with issues associated with mites to educate personnel how to effectively deal with mite issues.

Scabies or mange

Scabies is caused by scabies mites (*Sarcoptes scabiei*). Mange-like conditions are produced by mange or itch mites. Scabies mites burrow and live in the skin of humans, and cause a condition called scabies (or the seven-year itch). This condition is rarely fatal, but causes great discomfort due to intense itching, especially at night. Scabies mites are easily transferred from person to person by personal contact or by using or wearing infested clothes, bedding, or towels. Scabies is more common among homeless populations. Hospital personnel may become infested after caring for infested patients.

Dermatitis

Dermatitis is produced primarily by direct attack from chiggers, bird and rat mites, straw-itch mites, and cheese and flour mites. Bites from chigger mites and some rodent mites also may cause severe itching, and infection could result from scratching these areas. Chiggers often live in tall grass or scrub vegetation, and appear when land has been cleared and abandoned. People entering these mite-infested areas may be attacked by chiggers.

Allergic reactions

Allergic reactions can occur from exposure to mites or mite fecal particles or dry dead mites, as well as, their excreta. These conditions may be similar to asthma.

Integrated pest management for mites

All three control methods (cultural, chemical, and mechanical) can be very effective in controlling mites. However, there are literally thousands of mite species so it is imperative to know the species you are dealing with before control is initiated. Control could range from cleaning up moldy stored food, sulfur treatments, regular grass mowing, removing or discouraging bird, bat, or rodent nesting, or even feed through insecticides.

132. Cockroaches

Cockroaches are generally flattened, running insects that are nocturnal. Cockroaches seek warm, dark, secluded areas. They develop from egg to adult through gradual metamorphosis, with the number of instar (developmental) stages ranging from 6 to 13. Some species live for three months, while others live more than a year; some have been reported to live longer than three years.

Species of cockroaches

There are over 3,000 species of cockroaches in the world, but only a few are actually a problem for people in domestic situations (fig. 3–13).

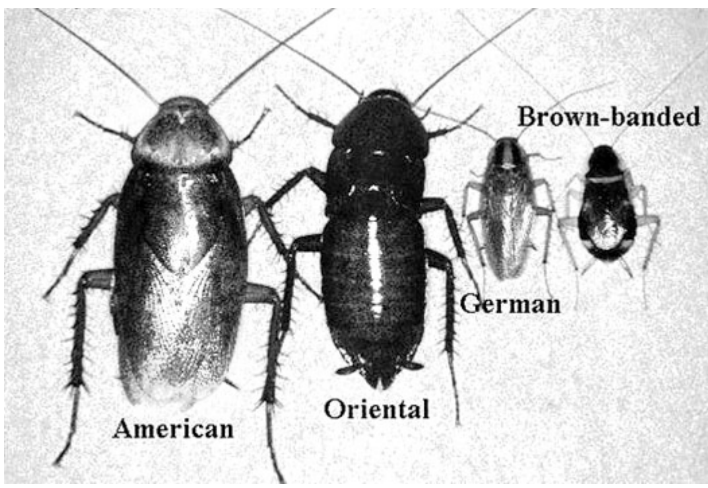

Figure 3–13. Various species of cockroaches.

German cockroach (Blattella germanica)

The German cockroaches are the most abundant cockroach species in the US, and it is the most common pest in food facilities across the Air Force. They are found in homes, apartments, restaurants, and hospitals where warmth, moisture, and food are readily available. They are found under stoves, ranges, refrigerators, in the insulation of appliances, under sinks, in dead spaces behind the sink, around water heaters, in and around cabinets or pantries, behind baseboards and moldings, and in other dark protected areas. They average 12 to 16 millimeters in length, and they are pale yellowish brown or tan in color. Like most cockroaches, the German cockroaches are nocturnal, and search for food and water at night.

American cockroach (Periplaneta americana)

The American cockroach is the second most abundant species of cockroach in the United States. They are found mostly in commercial establishments, such as restaurants, hotels, packinghouses, bakeries, hospitals, prisons, office buildings and grocery stores. These cockroaches are about 30 to 40 millimeters in length, and they are chestnut (reddish) brown in color. They are not found very often in houses or apartments. An American cockroach infestation may begin in sewer systems where they can enter into an establishment looking for food.

Oriental cockroach (Blatta orientalis)

The Oriental cockroaches are much larger and darker in color than the German cockroaches. They are dark brown to black in color and about 22 to 27 millimeters in length. They are found in cooler climates, and can adapt better to the outdoors than other species, even in extreme weather conditions. The Oriental cockroaches reproduce at a slower rate than the other species, which keeps the populations at a somewhat lower level. These cockroaches typically are found in damp basements and crawl spaces of buildings. When infestations are heavy, a typical roach odor is more noticeable in these cockroaches than the other species.

Brown banded cockroach (Supella longipalpa)

The brown banded cockroach is far less important than the German cockroach in the US. This insect is usually found in cupboards, pantries, TV cabinets, picture moldings, and shelves in closets. The color of the brown banded cockroach is similar to the German cockroach, except for two light brown cross bands. The size of the male averages 13 to 14 millimeters, while the female averages 11 to 12 millimeters. Often, the difference in size of the sexes causes people to think there are two species of cockroaches infesting an area.

Transmission of diseases

Cockroaches are not known to transmit disease directly. However, they do travel through filth, picking up pathogenic organisms on their bodies and mechanically transferring these organisms to unprotected food. For this reason, infestations are considered a potential health hazard.

Integrated pest management for cockroaches

The most effective method of controlling cockroaches is through denying them access to food or moisture; however, once there is an infestation, the use of pesticides is usually necessary. Again, insecticides will not work well if housekeeping is not maintained. Clutter such as piles of magazines, newspapers, boxes, and paper bags are breeding areas for cockroaches and should be removed to prevent harborage. Also, cluttered areas protect the cockroaches from insecticide applications.

Cultural control

Area sanitation is the single most important aspect of cockroach control. Remove food, water, and harborage; and the cockroaches will go away. In food facilities that operate around the clock, this may not be an easy task. It is important that you educate the facility manager so they understand the importance of good sanitation.

Chemical control

Chemical treatment should be based on surveillance only—not on an inflexible schedule. Usually Pest Management will apply residuals in places where the cockroaches will contact them. This technique is called “crack and crevice” treatment, and is common in food preparation and consumption areas.

Insecticides should not act as a repellent to cockroaches; rather insecticides should go unnoticed until they effectively control the exposed insect. One example of this type of insecticide is boric acid, which attaches to the body; it is ingested by the insect and acts as a stomach poison to kill the cockroach.

Cockroaches have developed resistance to some chemical insecticides; therefore, it is important to work with your CE pest management personnel to rid an establishment of cockroaches. Make sure cultural controls are implemented to the maximum extent possible to increase efficacy of chemical controls.

Mechanical control

Seal entrances, such as cracks in walls and windows, wall voids, and holes around water pipes. Caulk joints and seams and use sticky traps to monitor progress.

133. Venomous arthropods and animals

Air Force personnel face a greater risk of coming in contact with a venomous arthropod than the average US resident does because of the following:

1. Many bases are located in the southern half of the United States where venomous arthropods are most numerous.
2. Facilities such as radar, communications, security, and missile sites are located in remote areas where venomous arthropods are not controlled.
3. Numerous Air Force training and work activities are performed outside.
4. Many military structures, such as older wooden buildings, storage buildings and field training facilities, provide excellent habitats for venomous arthropods.
5. Military personnel deploy to austere locations thorough out the world including Africa, Asia, and South America.

It is important, therefore, that your medical facility has current information on the most important venomous arthropods in your area.

Species of venomous arthropods

Venomous arthropods include bees, wasps, hornets, spiders (such as black widow and brown recluse), scorpions, ants, centipedes, and certain caterpillars.

Species of venomous animals

Venomous animals are a threat to USAF personnel worldwide. Numerous venomous reptiles are found throughout Africa, Australia, the Americas, Asia, and Europe. There are more than 20 venomous species of snakes and one venomous lizard in the USA. Furthermore, at least one venomous species of snake is found in every state in the United States, except Alaska and Hawaii. Snakes are not the only venomous animals to be concerned with. Public health personnel might have to provide information or mitigations for marine animals such as cone snails, stingrays, corals, and jellyfish.

Medical importance

Most people know about the pain and discomfort associated with contacting a venomous arthropod. However, many are not aware that ants, bees, wasps, spiders, and scorpions cause more human deaths in the US each year than any other group of venomous animals, including snakes. OCONUS threats include all of the above with additional novel threats such as seasonal stinging caterpillars in Asia, terrestrial leeches in Asia, large wasps, deadly Australian tarantulas, cone snails, jellyfish, and so forth.

Arthropod venom

There are five basic types of venom you must be familiar with to effectively educate personnel. They are as follows:

1. Hemolytic toxin—it breaks down the red blood cells. It may also kill large blocks of tissue in the area of envenomation.
2. Neurotoxin—it affects the nervous system. It inhibits reflexes or muscle response and may cause difficulty breathing, cardiac failure, loss consciousness, shock, and death in severe cases.

3. Urticating toxin—it may produce wheals or raised areas on the skin (*Urticaria* is hives). These areas may itch or be intensely painful.
4. Vesicating toxin—it may produce blisters on the skin (similar to chemical blister agents).
5. Hemorrhagic toxin—it prevents normal blood clotting and cause reddening of the skin in the affected area.

Venomous arthropods can sting (like a bee or wasp), bite with mouthparts (like a spider or centipede), or produce fluids (like vesicating blister beetles) that can cause pain and swelling, as well as, other severe medical problems. Venomous animals either bite (as is the case with the venomous reptiles) or have stinging cells or stingers (as is the case in jellyfish, corals, cone snails, and stingrays).

Control measures

Cultural controls are some of the most effective in dealing with the majority of venomous threats. This is because the number of venomous animals is often relatively small and can be avoided. Public Health can provide briefings and public awareness documents, signs (such as beach signs), and so forth to describe many threats. Control measures for these different varieties of arthropods vary depending upon the species. However, there is one effective control measure that works well for almost all venomous arthropods—avoidance! If you know venomous arthropods are around, stay away or use insecticides.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

127. Lice

1. What are the common names for the three distinct varieties of lice that infect humans?

2. What is the most medically important louse?

3. How are pathogens for typhus and trench fever spread from lice to humans?

4. How are the bacteria of relapsing fever spread from lice to humans?

5. What is the *most effective* method of prevention for all lice?

128. Flies

1. What are the two major categories of flies?

2. To which of the two major groups of flies does a sand fly belong?

3. What are the five ways flies spread diseases?

4. What is the *most* effective fly control measure?

129. Fleas

1. In what insect order are fleas classified?

2. What diseases are fleas responsible for transmitting?

3. How is murine typhus (endemic typhus) fever transmitted to humans?

130. Ticks

1. What are the two major groups of ticks?

2. To which of the two major groups does the American dog tick belong?

3. What are the four major groups of diseases that are spread by ticks?

4. What is meant by “transovarial transmission” of pathogens?

5. What is the most effective method for removing a tick?

131. Mites

1. What stage are chiggers in when they feed on humans and animals?

2. What are the two major groups of diseases transmitted by mites?

3. What species of mite transmits scrub typhus?

4. Which mites burrow and live in human skin?

132. Cockroaches

1. What is the most abundant species of cockroach in the United States?

2. What color are German cockroaches?

3. Where are American cockroaches most often found?

4. Why are Oriental cockroach populations at a somewhat lower level?

5. What is the *most* effective method of control for cockroaches?

133. Venomous arthropods and animals

1. How many *venomous* snakes are there in the United States?

2. What are the five basic types of venom that arthropods and snakes produce?

3. What three things do venomous arthropods do to cause pain and swelling?

4. What type of venom produces blisters on the skin?

5. What is the one control method that is effective against *all* venomous arthropods?

3–4. Rodents

A rodent is an animal in the order Rodentia, such as a mouse (family Muridae or family Cricetidae), rat (genus *Rattus*), squirrel (family Sciuridae), or beaver (family Castoridae). Rodents are characterized by large incisor teeth that are adapted for gnawing or nibbling. These two groups are further divided into species.

134. Types of rodents and methods of control

Domestic rodents are nocturnal. Ordinarily, they do not move about during the day preferring the cover of darkness to forage for food and water. They move in narrow runs along buildings, walls, pipes, and overhead beams. Rodents gnaw through materials to obtain food and harborage. Wood is not a barrier to rodents, since they have very sharp teeth that quickly cut through it. These pests damage far more food than they eat. For example, they commonly take one bite out of many potatoes instead of eating one entire potato. They sample bags of flour, eat many pieces of meat, and contaminate food items with urine and feces.

House mouse (*Mus musculus*)

The most common mouse is the house mouse. The house mouse is the smallest of the domestic rodents and is widespread throughout the world. It is found from the tropics to the Arctic. It is dusky gray in color, and it has smaller feet and a smaller head than a young rat. Its droppings (feces) are small and rod shaped.

Rats

The most common rat species include the Norway rat and the roof rat. The domestic rats are serious threats to buildings when they directly damage structures, eat electrical insulation, and destroy stored products.

Norway rat (*Rattus norvegicus*)

The Norway rats are predominantly burrowing rodents and are the most common and largest domestic rat. Their fur is coarse and its color ranges from reddish brown with black to light gray or tan. Their droppings are large (up to three-fourths of an inch long) and capsule-shaped. Norway rats live one to seven years and burrow in the ground, under building foundations, and in rubbish dumps. They normally travel up to 100 feet from their dens.

Roof rat (*Rattus rattus*)

The roof rats are agile climbers. They are medium sized rodents found in the tropical or temperate regions of the world. They exhibit three different color patterns, which indicate the subspecies. The black rat is black to slate gray; the Alexandrine rat is tawny above with a grayish white belly; and the fruit rat is tawny above with a white to lemon-colored belly.

The roof rat’s droppings are medium sized and spindle shaped. Roof rats live one to seven years, nest indoors in attics and between walls, and outdoors in trees and dense vine growth. Their travel distance is about the same as the Norway rat, up to 100 feet from their dens.

Wild rodents

Wild rodents are also a nuisance, serve as disease reservoirs, and they can spread disease to other animals and to human populations. Wild mice include the white-footed mouse (or vole, *Peromyscus leucopus*), meadow mouse (genus *Microtus*), and the pine mouse (or vole, *Pitymys pinetorum*); wild rats include wood rats (genus *Neotoma*) and cotton rats (genus *Sigmodon*). These rodents serve as vectors of disease agents to humans. Rodents such as prairie dogs (genus Cynomys) and other ground squirrels are reservoirs of plague. They can infest food supplies. Other wild rodents include ground squirrels, prairie dogs, and gophers.

Integrated pest management for rodents

In severe rodent infestations multiple, if not all, IPM techniques may be necessary. A combination of cleaning up trash, preventing entry into buildings and using chemical baits provides a well-rounded control plan. Sanitation and exclusion (cultural and mechanical) are the best methods for long-term rodent control and prevention.

Cultural

Frequent and thorough cleanup of trash and debris, proper waste disposal, proper food storage, and elimination of food sources and harborage are all preventive measures in rodent control. Removing water source is an important step in cultural control for rodents. A common water source in food facilities are leaky pipes in and around dishwashers. Leaky pipes should be fixed as soon as possible.

Mechanical

Rat-proofing is a fundamental physical control method to prevent rodent infestations in buildings. Rat-proofing should be included in the plans for all new construction. On existing structures, this consists of changing building structural details to prevent rodent entry. Openings as small as one-half inch allows entry of mice and young rats. Rat-proofing includes sealing holes, replacing screens and doors to ensure tight closures, and replacing rotten wood or other material that rodents can get through to enter the building. Specific rodent barriers are available such as space filling wire and some foam.

Chemical

Chemical control can be achieved with rodenticide bait stations. These are normally placed outside of facilities and routinely checked and stocked with fresh bait. Only certified applicators using baits labeled for kitchens can apply these in food preparation areas in accordance with the Tri-Service Food Code.

135. Diseases attributed to rodents

There are many diseases that can be related to rodent infestations some of the more important ones are plague (*Yersinia pestis*), leptospirosis (*Leptospira interrogans*), hantaviruses, scrub typhus (Orientia tsutsugamushi), tularemia (*Francisella tularensis*), salmonellosis (*Salmonella* species) and rat-bite fever (typically *Streptobacillus moniliformis*), and rat meningeal worms. Here, we will only cover, plague, leptospirosis, hantavirus, and rat meningeal worms. You will also learn something about measures that can be used to prevent and/or control rodent infestation, thus reducing the incidence of these diseases.

Plague

Plague is a pathogen of rodents primarily restricted to cool tropical regions or temperate climates. It is primarily a disease of rodents, but humans are sometimes infected. Typically, a flea feeds on an infected rodent then transmits plague when the same flea subsequently bites a human. However, fleas are capable of transmitting the disease from human to human and pet to human. Plague can also be transmitted in respiratory droplets (pneumonic).

Symptoms

Three types of plague that affect humans are are bubonic, septicemic, and pneumonic. The following explains each:

1. Bubonic, which affects the lymph nodes.
2. Septicemic, which affects the blood stream.
3. Pneumonic, which involves the lungs.

Plague is an acute, rapidly progressing disease. All three forms of plague begin with similar symptoms, such as fever, malaise, headache, sore throat, shock, restlessness, mental confusion, and prostration. If the disease progresses without treatment, there is a 50-percent chance of death from bubonic plague and 90- to 95-percent chance of death from other forms of the plague. The percentages drop if the disease is detected and treated quickly.

Surveillance program

The Air Force established the Plague Surveillance and Prevention Program in 1977, and program guidelines are updated periodically. Program guidance is location specific and can be obtained from your MAJCOM public health officer (PHO).

Bases in the United States near or west of the 100th meridian conduct surveillance which includes five main elements: (1) program coordination with Pest Management, CE Natural Resources and local health agencies, (2) education of the base population plague prevention; (3) surveillance of rodent populations to determine any changes in size (may be accomplished by CE); (4) Pest Management controls rodents, wild animals, and domestic animal fleas; and (5) diagnosis/treatment of plague patients by the MTF.

Leptospirosis

Leptospirosis is a threat to USAF personnel worldwide but is of higher threat levels in Hawaii, Guam, the UK and parts of Asia. Infections result from either direct or indirect contact with the urine of infected rodents or other animals. The spirochetes, that cause leptospirosis, can contaminate water or food, or they may enter the body through mucous membranes, minute cuts or skin abrasions.

Leptospirosis symptoms vary from case to case. Classical case symptoms begin suddenly and include fever, headache, myalgia, conjunctivitis, nausea, vomiting, diarrhea and constipation. Prostration or exhaustion may be severe and occasionally results in death. However, most cases either are asymptomatic (no symptoms) or produce mild flu-like symptoms.

Hantavirus

Hantaviruses cause acute viral diseases. The viruses become airborne in dried urine and feces. There are two primary diseases: hantavirus pulmonary syndrome and hantavirus hemorrhagic fever with renal syndrome. These syndromes are characterized by fever, muscle pain, gastrointestinal complaints, renal failure, abrupt onset of respiratory distress and hypotension. The illness progresses rapidly to severe respiratory or renal failure and cardiogenic shock. The case fatality proportion is approximately 40 to 70 percent. In survivors, recovery is rapid, with apparent full restoration of normal lung function but potentially permanent renal damage. Several hantaviruses have been identified in the Americas, including the following:

- Sin Nombre virus.
- Bayou virus.
- Black Creek Canal virus.
- New York virus.
- Seoul virus

Hantaviruses are a significant threat in Korea and parts of Asia where hantavirus hemorrhagic fever with renal syndrome is endemic. In CONUS, there have been several epidemics. Sin Nombre virus is the agent responsible for the 1993 epidemic in southwest United States and for most of the other cases of hantavirus identified in North America. The major reservoir of Sin Nombre virus appears to be the deer mouse, Peromyscus maniculatus. Aerosol inhalation transmission from rodent excreta and saliva is presumed. There is no evidence of human-to-human spread. Incubation is approximately two weeks, with a range from a few days to six weeks.

Hantavirus pulmonary syndrome was first recognized in the spring and summer of 1993 in the Four Corners area of New Mexico and Arizona among resident Native American populations. Since then, cases have been confirmed in 20 predominantly western states and Canada. Also, sporadic cases have occurred in eastern regions of the United States, including Florida, Rhode Island, New York, and Indiana. Cases appear to increase with seasonal increases in the number of the carrier rodents.

Rat meningeal worms (Angiostrongylus cantonensis)

While over looked by military public health the threat posed by rat meningeal worms is potentially serious. These “brain worms” naturally infect rat species. They use giant African land snails as hosts (essentially vectors). Infected snails infest vegetables while feeding and leave eggs on them. When humans eat poorly washed food they can be infested with *Angiostrongylus cantonensis* larvae. These larvae will migrate to the brain and cause meningitis. The rats, worms, and snails are common in Guam and Okinawa where the USAF has bases. Numerous fatal rat meningeal worm infections are reported in civilian populations and these parasites pose a threat to USAF personnel.

136. The nature of rodent surveillance

To detect rodent activity, you need to be aware of surveillance methods, such as sight, sound, droppings, runways and rub marks, tracks, and evidence of gnawing. You also need to know how to collect, pack, and ship ectoparasite specimens. In this lesson, you will learn something about each of these topics.

Surveillance methods

You may be required to work with CE pest management personnel to identify a rodent infestation. To decide what type of rodent is involved and the size of the problem, you need to know what to look for. Let’s take a look at how you would investigate a rodent infestation.

NOTE: If you are working in an area with endemic plague (for example, parts of WA, OR, CA, NV, ID, MT, WY, UT, CO, AZ, NM or TX), consult with USAFSAM before working near wild rodents or prairie dogs to ensure that appropriate precautions are taken so you can avoid becoming infected with plague.

Sight

The most positive proof of an infestation, of course, is the sighting of a live rat or mouse. Since they are nocturnal and secretive in their habits, however, you seldom see them alive. As a rule, it is only in very heavy infestations that they show themselves around humans. These creatures are especially secretive if there is much human activity in the area.

Dead animals indicate either a current or a past infestation. If the carcass is dried or reduced to a skeleton, it may mean only a former infestation. If there are many recently dead rodents, find out if poisons were used in the area. If no poisons were used, there could be a zoonotic disease, such as plague, among the rodents. Never handle dead rodents with your bare hands! If possible, place them in cloth, paper, or plastic bags to prevent the escape of fleas and other ectoparasites.

In most lighting, rodent urine may cause dark staining due to blood breakdown products in the urine. Black lights can be used to illuminate rodent urine, because rodent urine will fluoresce under black light.

Sound

Various rat and mice noises may give clues as to their presence and location. These noises are rarely heard unless the area is quiet. When you enter a building you suspect is infested, stand still and listen for rodent activity. You may hear sounds of running, gnawing, and scratching, especially from double walls and floors. Rodents also produce various squeaks and noises. The squeaking may accompany fighting and occur intermittently for several minutes, or it may be youngsters in the nest. Sounds from birds, some reptiles, amphibians, and other mammals can easily be confused for those from rodents.

Droppings

Presence of rat and mouse feces is one of the best indicators of an infestation. The droppings may be a key to the species and abundance. Although the color varies according to the kind of food eaten, it is usually black.

The quality and sizes of fresh droppings may suggest how many animals are in an area. Fresh droppings mean there is at least one rat or mouse. Droppings are most numerous along runways, near harborage, in secluded corners, and near food supplies. In contrast, the burrows and nests are usually very clean without droppings.

Pathways

Since rats and mice generally occupy only a limited area, they may use the same pathway many times. These pathways are about 2 to 3 inches wide. Outdoors the earth looks clean swept and packed. Indoors, rats and mice leave dark smears or rub marks on large objects, such as walls and rafters, from their natural body oils and dirt. Rub marks are found most often along walls, under boards, behind stored objects and accumulated litter, and in similar places. It is important to search such places carefully.

You can find the rub marks around gnawed holes, along pipes and beams, on the edges of stairs, along walls, or anywhere else that the rodent travels. Swing marks, which are made by rats that pass along a beam under floor joists, generally indicate the presence of roof rats. Norway rat runs are found more often near the floor. House mouse runs can be found anywhere, but they are the most difficult to locate because they are small and often very faint. It is especially important to search behind vertical pipes and columns, since they are the favorite means for rats and mice to change floors.

You often can tell how old a rat or mouse run is. Fresh rub marks and smears are soft when you scratch them; old ones are brittle and may flake off. By tracing rat and mouse runs, you can find the harborage, food and water supply, and means of entry into buildings. This information will help you take the right control measures.

Tracks

Tracks are footprints found along indoor and outdoor rat and mouse runs. You can see tracks more clearly with side illumination from a flashlight than from above direct light. It is helpful to use a fine dust for tracking. Dust a fine powder, such as flour, on a suspected runway and inspect it later for footprints. Spread the powder smoothly to a depth of no more than 1/8 inch. Then when you inspect, look for prints of the five-toed hind feet and the four-toed front feet.

Collecting specimens

The easiest way to collect rodents is to trap them. Rodents must be trapped alive so that all the ectoparasites remain attached. (**NOTE:** If you kill prairie dogs that are infected with plague, the fleas will leave the prairie dogs and may infect humans.) There are a few different types of traps, including steel traps, wire-live traps, and multiple catch box traps. Different baits should be used to attract the rodents. Place these traps in or on their runways or pathways. Although this is not the preferred method of many pest controllers, another type of trap is a glue board. The glue board may be tacked down to the floor to prevent the rodent from dragging the board around. This type of trap can be used where rodenticides are not recommended, such as around children and food service areas. The glue board catches the rodent and the rodent remains alive for several hours. If only one leg is caught, a rat might chew off that leg to escape.

Consult CE pest management personnel if you identify problems with trapping rodents. Your base pest management personnel will probably do the trapping for you if you ask them to. If necessary, you can consult with PHR consultant, Wright-Patterson AFB, Ohio for further information on trapping rodents.

Packing and shipping specimens

Contact an expert at USAFSAM for advice if you wish to engage in this process. There are regulations pertaining to shipping live rodents. There are shipping regulations on the shipping of live rodents. To collect ectoparasites for shipment for identification, you must check rodent traps each morning, because the ectoparasites will not remain on dead rodents. If you wish to ship only the rodent ectoparasites, kill the rodent and comb the rodent to remove the ectoparasites or pick sticktight fleas or ticks off with forceps.

Packing

The most important requisite for preparation and shipment is that your ectoparasite specimens arrive at the laboratory in a condition that will permit proper identification; that is, you must ensure the identification characteristics are as complete and undamaged as possible. Prepare the ectoparasites for shipment by placing them in a 5-ml blood-collection vial containing 70 percent ethyl alcohol. As you push the rubber stopper into the neck of the tube, a bubble of air is usually trapped. Since this bubble will damage specimens as it passes over them during shipment, remove the bubble by topping off the alcohol.

Be very careful to prevent breakage of specimen slides or bottles containing preservatives when you prepare specimens for shipment. In the tropics, store insects in alcohol. This will prevent mold. You can quick-freeze or use dry ice to lengthen the time specimens can be in transit.

Shipping

Do not ship live specimens without first contacting the laboratory and making prior arrangements for the shipment. Properly tag or label all specimens for shipment. Include all information on locality, date and elevation at which the collection was made. Also, include the collector’s name and other pertinent information such as habitat, abundance and distribution of the specimens. If there are any questions concerning shipment of any specimens for identification, contact the USAFSAM/PHR Consultant, 2510 5th Street, Wright-Patterson, Ohio, 45431, or contact your MAJCOM or theater entomology consultants.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

134. Types of rodents and methods of control

1. What is the *most* common species of mouse?

2. What do the droppings (feces) of a house mouse look like?

3. What is the largest and *most* common domestic rat?

4. What are the three color patterns found in roof rats?

5. What is the *best* control method for long-term control of rodents?

135. Diseases attributed to rodents

1. What are some of the more important rodent-borne diseases that can be related to rodent infestations?

2. What are the three types of plague that affect humans?

3. Which of the three types of plague affects the lymph nodes?

4. When did the Air Force establish the Plague Surveillance Prevention Program?

5. How does one acquire leptospirosis?

6. What are the symptoms with *most* cases of leptospirosis?

7. What is the case fatality proportion for hantavirus infections?

8. Where in CONUS have cases of hantavirus occurred?

136. The nature of rodent surveillance

1. Besides sighting a rodent, what is one of the *best* indicators of a rodent infestation?

2. What color are rodent feces, typically?

3. How wide are rat and mouse pathways?

4. Where are most rodent rub marks found?

5. How can you determine if a rodent run is new or old?

6. To identify tracks, how deep do you spread powder (or flour) on a rodent run?

7. What type of trap is recommended for trapping rodents around children and in food service facilities?

8. How do you pack ectoparasites for shipment to a laboratory?

Answers to Self-Test Questions

120

1. Prevent and control vector-borne diseases by eliminating disease vectors, reservoirs, blocking transmission of pathogens to susceptible hosts, and protecting susceptible hosts.
2. AFI 32–1053.
3. AFI 48–102.
4. Aerospace Medicine Council.
5. Educating the public and pre- and post-treatment vector surveillance.
6. Provide technical information concerning the safe storage and use of pesticides and review integrated pest management plan before submission to MAJCOM/CE. BE monitors acquisition, storage, and environmental impact of pesticides for CE pest management shop, commissary and Base Exchange.

121

1. The science of classification.
2. Class.
3. Family.
4. Family.
5. Species.
6. Exoskeleton.
7. The head, thorax, and abdomen.
8. Egg, larva, pupa, and adult.
9. A brief description of anatomical features used to identify insects.

122

1. Organisms that are in the wrong place at the wrong time.
2. A combination of control techniques to prevent or suppress pests.
3. Cultural.
4. Using methods to kill or separate arthropods from their food source.
5. A certified applicator, or someone under the supervision of a certified applicator.
6. Pyrethroids.

123

1. Culex.
2. In water.
3. 50 (Half).
4. Male.

124

1. Culex and Aedes.
2. West Nile encephalitis.
3. California.
4. Wild birds.
5. Break bone fever.
6. Aedes.
7. Education, vector avoidance, and environmental clean up.
8. Fever, headache, backache, jaundice, and internal bleeding.
9. *P. falciparum, P. vivax, P. malariae, P. ovale, and P. Knowelsi.*
10. Cold, hot, and profuse sweating.
11. 10 to 18 days.
12. Falciparum malaria.
13. Vivax, malariae, and ovale.
14. Malarone® and Doxycycline.

125

1. Conduct a baseline entomology survey.
2. Locate them between populated areas and breeding sources, away from competing light sources, protected from wind, and approximately 6 feet above ground.
3. A net.
4. Light, CO_2, or light and CO_2.
5. CO_2 traps attract more species of mosquitoes, larger numbers of mosquitoes and more female mosquitoes.
6. To catch the species of mosquitoes that are active in the late morning and early evening.
7. Weekly.
8. *Aedes aegypti* and *Aedes albopictus*.
9. The average number of females caught per trap night.
10. The average population of a specific species or particular group of mosquitoes caught in a trap per trap night.

126

1. Cultural, mechanical, chemical, and biological.
2. Filling in low-lying wet areas with gravel and dirt to eliminate breeding sites.
3. Residual treatment and fogging.
4. *Gambusia affinis*.
5. Personal protection.

127

1. Head, body, and crab or pubic lice.
2. Body louse.
3. Bacteria-laden fecal dropping are scratched into the bite/wound or stuck onto fingers, which could then contaminate mucous membranes or the conjunctiva.
4. Crushed lice that are rubbed into a wound or into mucous membranes or conjunctiva.
5. Education.

128

1. Biting flies and filth flies.
2. Biting.

3. On or by their mouthparts, through vomitus, on their body hairs, on the sticky pads of their feet, and through their feces.
4. Proper sanitation to eliminate breeding places.

129

1. Siphonaptera.
2. Plague and endemic typhus.
3. By the flea bite or when flea or rodent louse feces are scratched into an open wound or inhaled.

130

1. Hard and soft.
2. Hard.
3. Rickettsial bacteria, spirochete bacteria, other bacteria and viruses.
4. Pathogens are passed from infected adult to the eggs.
5. Use small forceps or tweezers to grasp as far forward on the mouthparts as possible, and then carefully pull it off with an upward even pressure.

131

1. Larval.
2. Scrub typhus and rickettsial pox.
3. Chigger.
4. Scabies.

132

1. German.
2. Pale yellowish brown or tan.
3. In commercial establishments.
4. They reproduce at a slower rate than the other species.
5. Denying access to food or moisture.

133

1. More than 20.
2. Hemolytic toxin, neurotoxin, urticating toxin, vesicating toxin, and hemorrhagic toxin.
3. Bite, sting, or produce fluids.
4. Vesicating toxin.
5. Avoidance.

134

1. House mouse.
2. Small and rod shaped.
3. Norway rat.
4. Black to slate gray; tawny above with a grayish white belly; and tawny above with a white to lemon-colored belly.
5. Cultural and mechanical.

135

1. Plague leptospirosis, hantaviruses, scrub typhus, tularemia, salmonellosis, rat-bite fever, and rat meningeal worms.
2. Bubonic, septicemic, and pneumonic.
3. Bubonic.
4. 1977.

5. By either direct or indirect contact with the urine of infected rodents or other animals.
6. Either there are no symptoms, or symptoms are mild and flu-like.
7. 40 to 70 percent.
8. 20 western states and sporadically in eastern regions.

136

1. The presence of rat or mouse feces.
2. The color varies according to the kind of food eaten, but it is usually black.
3. 2 to 3 inches.
4. Along walls, under boards, behind stored objects and accumulated litter, and in similar places.
5. Fresh rub marks and smears are soft when you scratch them; old ones are brittle and may flake off.
6. 1/8-inch or less.
7. Glue board.
8. Place them into a 5-ml blood-collection vial containing 70-percent alcohol; push rubber stopper into neck of the vile; and remove the air bubble by topping off the alcohol.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field Scoring Answer Sheet.

Do not return your answer sheet to AFCDA.

35. (120) Who determines the effectiveness of aerial spraying of pesticides to control vectors or medically important pests?
    a. Bioenvironmental Engineering.
    b. Aerospace Medicine Council.
    c. Base Civil Engineering.
    d. Public Health.

36. (120) Who provides vector identification for bases in the continental United States (CONUS)?
    a. Public Health at each base.
    b. Base Civil Engineering at each base.
    c. United States Air Force School of Aerospace Medicine.
    d. United States Air Force Headquarters Entomology Support Division.

37. (121) What is the first classification or grouping within the animal or plant kingdom?
    a. Family.
    b. Phylum.
    c. Class.
    d. Order.

38. (121) In *most* cases, what is the lowest major division in the classification system of insects?
    a. Order.
    b. Class.
    c. Species.
    d. Phylum.

39. (121) Which has an endoskeletal structure?
    a. Tick.
    b. Mite.
    c. Human.
    d. Scorpion.

40. (121) Which type of metamorphosis is a growth cycle that includes four stages: egg, larva, pupa, and adult?
    a. Complete metamorphosis.
    b. Incomplete metamorphosis.
    c. Gradual metamorphosis.
    d. No metamorphosis.

41. (121) Flies, mosquitoes, midges, and punkies belong to which order of insects?
    a. Diptera.
    b. Coleoptera.
    c. Siphonaptera.
    d. Hymenoptera.

42. (122) Who monitors all pest control activities for the entire Air Force installation?
    a. Civilian contractors.
    b. Pest Management section.
    c. Military treatment facility (MTF) commander.
    d. Public Health, with assistance from Bioenvironmental Engineering.

43. (122) Which type of pest control consists of using predators, pathogens, or genetic engineering to control arthropods?
    a. Cultural.
    b. Chemical.
    c. Biological.
    d. Sanitation and physical.

44. (123) Which mosquito genus deposits its eggs so they are attached together to form rafts that float on the water?
    a. Aedes.
    b. Culex.
    c. Anopheles.
    d. Mansonia.

45. (123) During which stage do mosquitoes abstain from feeding?
    a. Egg.
    b. Larval.
    c. Pupal.
    d. Adult.

46. (124) Which disease sometimes resembles the pain of broken bones?
    a. Western equine encephalitis.
    b. Yellow fever.
    c. Dengue fever.
    d. Malaria.

47. (124) Which mosquitoes transmit all four forms of malaria?
    a. Aedes.
    b. Culex.
    c. Mansonia.
    d. Anopheles.

48. (124) Where do *most* complications develop when a human is infected with malaria?
    a. Liver.
    b. Heart.
    c. Brain.
    d. Spleen.

49. (125) How many feet above the ground should solid-state Army miniature (SSAM) traps be located to attract the *most* mosquitoes?
    a. 2.
    b. 4.
    c. 6.
    d. 8.

50. (125) What type of surveillance method uses a paper-towel-wrapped tongue depressor emerged in a one-pint, black jar that has been half-filled with water?
    a. Larva collection site.
    b. Ovitrap for mosquito eggs.
    c. Artificial resting site for adult mosquitoes.
    d. Collection device for mosquitoes in the pupal stage.

51. (126) Which is an example of cultural control for mosquitoes?
    a. Filling in the low-lying areas with dirt.
    b. Placing Gambusia minnows in the base pond.
    c. Spraying the base with low doses of malathion.
    d. Depositing larvacide in the stagnant water areas.

52. (126) Whose responsibility is it to fill low-lying areas with dirt to control mosquitoes?
    a. Civil engineer.
    b. Base commander.
    c. Base medical service.
    d. Local mosquito control.

53. (126) Replacing the weather stripping on a door and patching screens are two examples of which type of mosquito control?
    a. Mechanical.
    b. Biological.
    c. Chemical.
    d. Cultural.

54. (127) How are epidemic typhus and trench fever transmitted?
    a. Head lice.
    b. Louse bite.
    c. Mechanically from insect hairs.
    d. Infected louse feces or crushed lice.

55. (128) What is the condition in which living tissue is infested with maggots?
    a. Vagabond's disease.
    b. Pediculosis.
    c. Tularemia.
    d. Myiasis.

56. (129) Which disease is transmitted by fleas?
    a. Dengue fever.
    b. Leishmaniasis.
    c. Malaria.
    d. Plague.

57. (129) How is endemic typhus (murine typhus) transmitted?
    a. Bite of a flea.
    b. Flea eggs laid in an open wound.
    c. Feces of a flea rubbed into a wound.
    d. Flea vomitus rubbed into an open wound.

58. (130) Which is an example of a hard tick?
    a. South coast tick.
    b. Balkan deer tick.
    c. American dog tick.
    d. Relapsing fever tick.

59. (130) Which disease is a bacterial disease spread by ticks?
    a. Dengue.
    b. Tularemia.
    c. Relapsing fever.
    d. Colorado tick fever.

60. (130) What do you call the transmission of rickettsial pathogens from adult ticks through the egg?
    a. Chemical.
    b. Mechanical.
    c. Transovarial.
    d. Infection through interrupted feeding.

61. (132) What is the *most* abundant cockroach species in the United States?
    a. Oriental.
    b. German.
    c. American.
    d. Brownbanded.

62. (132) What is the *most* effective method of controlling cockroaches?
    a. Using insecticides.
    b. Using roach traps/motels.
    c. Practicing good housekeeping.
    d. Denying access to food or moisture.

63. (133) Which type of venom produces raised areas on the skin that may itch or be intensely painful?
    a. Hemorrhagic toxin.
    b. Hemolytic toxin.
    c. Urticating toxin.
    d. Neurotoxin.

64. (133) What control measures are the *most* effective against venomous animals?
    a. Biological.
    b. Physical.
    c. Genetic.
    d. Cultural.

65. (134) Which is the largest and *most* common domestic rat?
    a. Roof.
    b. House.
    c. Norway.
    d. Scandinavian.

66. (134) Which is the *best* method for long-term control of rodents?
    a. Mechanical and physical.
    b. Chemical and sanitation.
    c. Biological and mechanical.
    d. Cultural and mechanical.

67. (135) Which disease results from either direct or indirect contact with the urine of infected rodents or other animals?
    a. Leptospirosis.
    b. Scrub typhus.
    c. Tularemia.
    d. Plague.

68. (136) What is the *most* positive proof of a rodent infestation?
    a. Sighting a live rodent.
    b. Rodent damage to foods.
    c. Rodent feces on the floor.
    d. Rodent rub marks on a wall.

69. (136) Swing marks made along a beam under floor joists generally indicate the presence of which type of rodent?
    a. House mouse.
    b. Norway rat.
    c. Fruit rat.
    d. Roof rat.

70. (136) If you powder a floor to survey for tracks, the hind feet prints of a rodent will show how many toes?
    a. Three.
    b. Four.
    c. Five.
    d. Six.

Glossary

Abbreviations and Acronyms

AAR	After Action Report
ABU	Airman battle uniform
AFH	Air Force Handbook
AFI	Air Force Instruction
AFJI	Air Force Joint Instruction
AFPAM	Air Force Pamphlet
AFPMB	Armed Forces Pest Management Board
AIDS	acquired immunodeficiency syndrome
ANFO	ammonium nitrate fuel oil
AOR	area of responsibility
APHIS	Animal and Plant Health Inspection Service
AS	allowance standard
ATNAA	antidote treatment, nerve agent autoinjector
AW	airlift wing
BE	bioenvironmental engineer
BEAR	base expeditionary airfield resources
BW	biological warfare
CANA	convulsant antidote for nerve agent
CBRNE	chemical, biological, radiological, nuclear, and high-yield explosives
CDC	Centers for Disease Control and Prevention
CE	California encephalitis or civil engineering
CFU	coliform forming unit
CNS	central nervous system
CO_2	carbon dioxide
CONUS	continental United States
CPM	contingency preventive medicine
CW	chemical warfare
DDT	Dichloro-diphenyl-trichloroethane
DEET	N-Diethyl-meta-toluamide
DI	disease and injury
DIA	Defense Intelligence Agency

DLA	Defense Logistics Agency
DOD	Department of Defense
DODI	Department of Defense Instruction
DPD	N, N-Diethyl-P-Phenylenediamine Sulfate
DVEP	Disease Vector Ecology Profile
EEE	eastern equine encephalitis
EMP	electromagnetic pulse
EPA	Environmental Protection Agency
Epi	epinephrine
º F	degrees Fahrenheit
FAC	free available chlorine
FBI	Federal Bureau of Investigation
FM	Field Manual
ft	foot or feet
gal	gallon
GI	gastrointestinal illness
gph	gallons per hour
HE	high explosive
HIV	human immunodeficiency virus
IAW	in accordance with
IDA	individual dynamic absorption
IDK	initial deployment kitchen
IED	improvised explosive device
IGR	insect growth regulator
IPM	integrated pest management
JCS	Joint Chiefs of Staff
JOPES	Joint Operation Planning and Execution System
lb	pounds
LE	low-order explosive
MAJCOM	major command
MI	medical intelligence
MIO	medical intelligence officer
ml	milliliter
MMWR	Morbidity, Mortality Weekly Report

mph	miles per hour
MRE	meal ready-to-eat
MTBI	mild traumatic brain injury
MTF	medical treatment facility
MURT	medical unit readiness training
NAVMED	Navy Medicine
NBC	nuclear, biological, chemical
NCMI	National Center for Medical Intelligence
NCO	noncommiossioned office
NCOIC	noncommissioned officer in charge
NGO	nongovernmental organizations
OCONUS	outside the continental United States
OIC	officer in charge
OOTW	operations other than war
PACAF	Pacific Air Forces
PAM	Preventive and Aerospace Medicine
ph	chlorine
pH	symbol for hydrongen
PH	public health
PHO	public health officer
PHR	Public Health Consultation Service
POC	point of contact
POW	prisoner of war
PPE	personal protective equipment
ppm	parts per million
PVO	private volunteer organization
qt	quart
RBC	red blood cells
R&D	research and development
ROWPU	reverse osmosis water purification unit
SLE	Saint Louis encephalitis
SSAM	solid-state Army miniature trap
STI	specific trap index
TA	table of allowances

TI	trap index
TM	tympanic membrane
TNT	trinitrotoluene
TPFDD	Time-Phased Force and Deployment Data
T-rats	tray pack rations
TWDS	tactical water distribution system
ULV	ultra-low volume
URI	upper respiratory illness
USAFE	United States Air Forces in Europe
USAFSAM	United States Air Force School of Aerospace Medicine
USAPHC	United States Army Public Health Command
USCENTCOM	United States Central Command
USDA	United States Department of Agriculture
USSR	Union of Soviet Socialist Republicans
USTRANSCOM	United States Transportation Command
UTC	unit type code
VEE	Venezuelan equine encephalitis
WBC	white blood cells
WEE	western equine encephalitis
WMP	War and Mobilization Plan
WN	West Nile
WNV	West Nile virus
yd	yard

Student Notes

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