

CHAPTER 4

EMERGENCY MEDICAL CARE PROCEDURES

For a Navy Corpsman, the terms “first aid” and “emergency medical procedures” relate to the professional care of the sick and injured before in-depth medical attention can be obtained. Appropriate care procedures may range from providing an encouraging word to performing a dramatic struggle to draw a person back from the brink of death. Always remember, however, that first aid measures are temporary expedients to save life, to prevent further injury, and to preserve resistance and vitality. These measures are not meant to replace proper medical diagnosis and treatment procedures. Hospital Corpsmen will be able to provide the competent care that makes the difference between life or death, temporary or permanent injury, and rapid recovery or long-term disability if they

- understand the relationship between first aid and proper medical diagnosis and treatment,
- know the limits of the professional care Corpsmen can offer, and
- keep abreast of new emergency medical equipment.

GENERAL FIRST AID RULES

LEARNING OBJECTIVE: *Recall general first aid rules.*

There are a few general first aid rules that you should follow in any emergency:

1. Take a moment to get organized. On your way to an accident scene, use a few seconds to remember the basic rules of first aid. Remain calm as you take charge of the situation, and act quickly but efficiently. Decide as soon as possible what has to be done and which one of the patient’s injuries needs attention first.

2. Unless contraindicated, make your preliminary examination in the position and place you find the victim. Moving the victim before this check could gravely endanger life, especially if the neck, back, or ribs are broken. Of course, if the situation is such that you or the victim is in danger, you must weigh this threat

against the potential damage caused by premature transportation. If you decide to move the victim, do it quickly and gently to a safe location where proper first aid can be administered.

3. In a multivictim situation, limit your preliminary survey to observing for airway patency, breathing, and circulation, the **ABCs** of basic life support. Remember, irreversible brain damage can occur within 4 to 6 minutes if breathing has stopped. Bleeding from a severed artery can lethally drain the body in even less time. If both are present and you are alone, quickly handle the major hemorrhage first, and then work to get oxygen back into the system. Shock may allow the rescuer a few minutes of grace but is no less deadly in the long run.

4. Examine the victim for fractures, especially in the skull, neck, spine, and rib areas. If any are present, prematurely moving the patient can easily lead to increased lung damage, permanent injury, or death. Fractures of the hip bone or extremities, though not as immediately life-threatening, may pierce vital tissue or blood vessels if mishandled.

5. Remove enough clothing to get a clear idea of the extent of the injury. Rip along the seams, if possible, or cut. Removal of clothing in the normal way may aggravate hidden injuries. Respect the victim’s modesty as you proceed, and do not allow the victim to become chilled.

6. Keep the victim reassured and comfortable. If possible, do not allow the victim to see the wounds. The victim can endure pain and discomfort better if confident in your abilities. This is important because under normal conditions the Corpsman will not have strong pain relief medications right at hand.

7. Avoid touching open wounds or burns with your fingers or unsterile objects, unless clean compresses and bandages are not available and it is imperative to stop severe bleeding.

8. Unless contraindicated, position the unconscious or semiconscious victim on his side or back, with the head turned to the side to minimize choking or the aspirating of vomitus. Never give an unconscious person any substance by mouth.

9. Always carry a litter patient feet first so that the rear bearer can constantly observe the victim for respiratory or circulatory distress.

TRIAGE

LEARNING OBJECTIVE: *Recognize the protocols for tactical and nontactical triage.*

Triage, a French word meaning “to sort,” is the process of quickly assessing patients in a multiple-casualty incident and assigning patient a priority (or classification) for receiving treatment according to the severity of his illness or injuries. In the military, there are two types of triage, tactical and nontactical, and each type uses a different set of prioritizing criteria. The person in charge is responsible for balancing the human lives at stake against the realities of the tactical situation, the level of medical stock on hand, and the realistic capabilities of medical personnel on the scene. Triage is a dynamic process, and a patient’s priority is subject to change as the situation progresses.

SORTING FOR TREATMENT (TACTICAL)

The following discussion refers primarily to battalion aid stations (BAS) (where neither helicopter nor rapid land evacuation is readily available) and to shipboard battle-dressing stations.

Immediately upon arrival, sort the casualties into groups in the order listed below.

- Class I** Patients whose injuries require minor professional treatment that can be done on an outpatient or ambulatory basis. These personnel can be returned to duty in a short period of time.
- Class II** Patients whose injuries require immediate life-sustaining measures or are of a moderate nature. Initially, they require a minimum amount of time, personnel, and supplies.
- Class III** Patients for whom definitive treatment can be delayed without jeopardy to life or loss of limb.
- Class IV** Patients whose wounds or injuries would require extensive treatment beyond the immediate medical capabilities. Treatment of these casualties would be to the detriment of others.

SORTING FOR TREATMENT (NONTACTICAL)

In civilian or nontactical situations, sorting of casualties is not significantly different from combat situations. There are four basic classes (priorities) of injuries, and the order of treatment of each is different.

- Priority I** Patients with correctable life-threatening illnesses or injuries such as respiratory arrest or obstruction, open chest or abdomen wounds, femur fractures, or critical or complicated burns.
- Priority II** Patients with serious but non-life-threatening illnesses or injuries such as moderate blood loss, open or multiple fractures (open increases priority), or eye injuries.
- Priority III** Patients with minor injuries such as soft tissue injuries, simple fractures, or minor to moderate burns.
- Priority IV** Patients who are dead or fatally injured. Fatal injuries include exposed brain matter, decapitation, and incineration.

As mentioned before, triage is an ongoing process. Depending on the treatment rendered, the amount of time elapsed, and the constitution of the casualty, you may have to reassign priorities. What may appear to be a minor wound on initial evaluation could develop into a case of profound shock. Or a casualty who required initial immediate treatment may be stabilized and downgraded to a delayed status.

SORTING FOR EVACUATION

During the Vietnam war, the techniques for helicopter medical evacuation (MEDEVAC) were so effective that most casualties could be evacuated to a major medical facility within minutes of their injury. This considerably lightened the load of the Hospital Corpsman in the field, since provision for long-term care before the evacuation was not normally required. However, rapid aeromedical response did not relieve the Corpsman of the responsibility for giving the best emergency care within the field limitations to stabilize the victim before the helicopter arrived. Triage was seldom needed since most of the injured could be evacuated quickly.

New developments in warfare, along with changes in the theaters of deployment, indicate that the helicopter evacuation system may no longer be viable

in future front-line environments. If this becomes the case, longer ground chains of evacuation to the battalion aid station or division clearing station may be required. This will increase the need for life-stabilizing activities before each step in the chain and in transit. Evacuation triage will normally be used for personnel in the Class II and Class III treatment categories, based on the tactical situation and the nature of the injuries. Class IV casualties may have to receive treatment at the BAS level, and Class I personnel will be treated on the line.

Remember, triage is based on the concept of saving the maximum number of personnel possible. In some cases, a casualty may have the potential to survive, but to ensure that casualty's survival, the treatment necessary may require a great deal of time and supplies. As difficult as it may be, you may have to forsake this patient to preserve the time and supplies necessary to save others who have a greater potential for survival.

PATIENT ASSESSMENT IN THE FIELD

LEARNING OBJECTIVE: *Recognize the assessment sequence for emergency medical care in the field, and identify initial equipment and supply needs.*

Patient assessment is the process of gathering information needed to help determine what is wrong with the patient. Assessments that you conduct in the field (at the emergency scene) or during transport are known as a field assessments.

Field assessments are normally performed in a systematic manner. The formal processes are known as the **primary survey** and the **secondary survey**. The primary survey is a rapid initial assessment to detect and treat life-threatening conditions that require immediate care, followed by a status decision about the patient's stability and priority for immediate transport to a medical facility. The secondary survey is a complete and detailed assessment consisting of a subjective interview and an objective examination, including vital signs and head-to-toe survey. (Both types of surveys will be discussed in more detail later in this chapter.)

BEFORE ARRIVAL AT THE SCENE

Before or during transit to an emergency scene, you may learn about the patient's illness or injury.

Although this information could later prove to be erroneous, you should use this time to consider what equipment you may need and what special procedures you should use immediately upon arrival.

ARRIVAL AT THE SCENE

When you arrive at an emergency scene, you need to start gathering information immediately. First, make sure the scene is safe for yourself, then for the patient or patients. Do not let information you received before your arrival form your complete conclusion concerning the patient's condition. Consider all related factors before you decide what is wrong with the patient and what course of emergency care you will take.

You can quickly gain valuable information as to what may be wrong with the patient. Observe and listen as you proceed to your patient. Do not delay the detection of life-threatening problems. Be alert to clues that are obvious or provided to you by others. Some immediate sources of information may come from the following:

- **The scene**—Is it safe or hazardous? Does the patient have to be moved? Is the weather severe?
- **The patient**—Is the patient conscious, trying to tell you something, or pointing to a part of his body?
- **Bystanders**—Are they trying to tell you something? Listen. They may have witnessed what happened to the patient or have pertinent medical history of the patient (for example, prior heart attacks).
- **Medical identification device**—Is the patient wearing a medical identification device (necklace or bracelet)? Medical identification devices can provide you with crucial information on medical disorders, such as diabetes.
- **Mechanism of injury**—Was there a fire? Did the patient fall or has something fallen on the patient? Is the windshield of vehicle cracked or the steering wheel bent?
- **Deformities or injuries**—Is the patient lying in a strange position? Are there burns, crushed limbs, or other obvious wounds?
- **Signs**—What do you see, hear, or smell? Is there blood around the patient? Has the patient vomited? Is the patient having convulsions? Are the patient's clothes torn?

PRIMARY SURVEY

As stated earlier, the primary survey is a process carried out to detect and treat **life-threatening conditions**. As these conditions are detected, lifesaving measures are taken immediately, and early transport may be initiated. The information acquired before and upon your arrival on the scene provides you with a starting point for the primary survey. The primary survey is a “treat-as-you-go” process. As each major problem is detected, it is treated immediately, before moving on to the next.

During the primary survey, you should be concerned with what are referred to as the **ABCDEs** of emergency care: airway, breathing, circulation, disability, and expose.

A=Airway. An obstructed airway may quickly lead to respiratory arrest and death. Assess responsiveness and, if necessary, open the airway.

B=Breathing. Respiratory arrest will quickly lead to cardiac arrest. Assess breathing, and, if necessary, provide rescue breathing. Look for and treat conditions that may compromise breathing, such as penetrating trauma to the chest.

C=Circulation. If the patient’s heart has stopped, blood and oxygen are not being sent to the brain. Irreversible changes will begin to occur in the brain in 4 to 6 minutes; cell death will usually occur within 10 minutes. Assess circulation, and, if necessary, provide cardiopulmonary resuscitation (CPR). Also check for profuse bleeding that can be controlled. Assess and begin treatment for severe shock or the potential for severe shock.

D=Disability. Serious central nervous system injuries can lead to death. Assess the patient’s level of consciousness and, if you suspect a head or neck injury, apply a rigid neck collar. Observe the neck before you cover it up. Also do a quick assessment of the patient’s ability to move all extremities.

E=Expose. You cannot treat conditions you have not discovered. Remove clothing—especially if the patient is not alert or communicating with you—to see if you missed any life-threatening injuries. Protect the patient’s privacy, and keep the patient warm with a blanket if necessary.

As soon as the ABCDE process is completed, you will need to make what is referred to as a **status decision** of the patient’s condition. A status decision is a judgment about the severity of the patient’s condition and whether the patient requires immediate transport to a medical facility without a secondary survey at the scene. Ideally, the ABCDE steps, status, and transport decision should be completed within 10 minutes of your arrival on the scene.

SECONDARY SURVEY

The object of a secondary survey is to detect medical and injury-related problems that do not pose an immediate threat to survival but that, if left untreated, may do so. Unlike the primary survey, the secondary survey is not a “treat-as-you-go” process. Instead, you should mentally note the injuries and problems as you systematically complete the survey. Then you must formulate priorities and a plan for treatment.

The secondary survey for a patient who presents with medical illness is somewhat different from that of an injured patient. Usually the **trauma assessment** is about 20 percent patient interview and 80 percent physical exam. On the other hand, the **medical assessment** is 80 percent patient interview and 20 percent physical exam. Both the physical exam and patient interview should always be done for all medical and trauma patients.

NOTE: Remember, if the patient’s condition deteriorates, it may not be possible to complete the secondary survey before starting to transport the patient.

Subjective Interview

The subjective interview is similar to the interview physicians make before they perform a physical examination. The main objective of the interview is to gather needed information from the patient. Other objectives of the interview are to reduce

the patient's fear and promote cooperation. Whenever possible, conduct the subjective interview while you are performing the physical examination.

Relatives and bystanders at the emergency scene may also serve as sources of information, but you should not interrupt interviewing the patient to gather information from a bystander. If the patient is unconscious, you may obtain information from bystanders and medical identification devices while you are conducting the physical examination.

When conducting a patient interview, you should take the following steps:

1. **Place yourself close to the patient.** Position yourself, when practical, so the patient can see your face. If at all possible, position yourself so that the sun or bright lights are not at your back. The glare makes it difficult for the patient to look at you.
2. **Identify yourself and reassure the patient.** Identify yourself and maintain a calm, professional manner. Speak to the patient in your normal voice.
3. **Learn your patient's name.** Once you learn the patient's name, you should use it during the rest of your interview. Children will expect you to use their first name. For military adults, use the appropriate rank. If civilian, use "Mr." or "Ms." unless they introduce themselves by their first name.
4. **Learn your patient's age.** Age information will be needed for reports and communications with the medical facility. You should ask adolescents their age to be certain that you are dealing with a minor. With minors, always ask how you can contact their parent or guardian. Sometimes this question upsets children because it intensifies their fear of being sick or injured. Be prepared to offer comfort and assure children that someone will contact their parents or guardians.
5. **Seek out what is wrong.** During this part of the interview, you are seeking information about the patient's symptoms and what the patient feels or senses (such as pain or nausea). Also, find out what the patient's chief complaint is. Patients may give you several complaints, so ask what is bothering them most. Unless there is a spinal injury that has interrupted nerve pathways, most injured individuals will be able to tell you of painful areas.

6. Ask the PQRST questions if the patient is experiencing pain or breathing difficulties.

P=Provocation—What brought this on?

Q=Quality—What does it feel like?

R=Region—Where is it located?

R=Referral—Does it go anywhere (e.g., "into my shoulder")?

R=Recurrence—Has this happened before?

R=Relief—Does anything make it feel better?

S=Severity—How bad is it on a scale of 1 to 10?

T=Time—When did it begin?

7. Obtain the patient's history by asking the AMPLE questions.

A=Allergies—Are you allergic to any medication or anything else?

M=Medications—Are you currently taking any medication?

P=Previous medical history—Have you been having any medical problems? Have you been feeling ill? Have you been seen by a physician recently?

L=Last meal—When did you eat or drink last? (Keep in mind, food could cause the symptoms or aggravate a medical problem. Also, if the patient requires surgery, the hospital staff will need to know when the patient has eaten last.)

E=Events—What events led to today's problem (e.g., the patient passed out and then got into a car crash)?

Objective Examination

The objective examination is a comprehensive, hands-on survey of the patient's body. During this examination, check the patient's vital signs and observe the signs and symptoms of injuries or the effects of illness.

When you begin your examination of the patient, you should heed the following rules:

1. Obtain the patient's consent (if the patient is alert).
2. Tell the patient what you are going to do.

3. Always assume trauma patients have a spinal injury, especially unconscious trauma patients, unless you are certain you are dealing with a patient free from spinal injury (e.g., a medical patient with no trauma).

HEAD-TO-TOE SURVEY.—The head-to-toe survey is a systematic approach to performing a physical examination. This survey is designed so nothing important is missed during the examination of the patient. There may be variations in the head-to-toe survey depending on local guidelines. Traditionally, the examination is started with the head. However, most medical authorities now recommend that the neck be examined first in an effort to detect possible spinal injuries and any serious injury to the trachea that may lead to an airway obstruction.

During the head-to-toe survey, you should

- **look** for discolorations, deformities, penetrations, wounds, and any unusual chest movements;
- **feel** for deformities, tenderness, pulsations, abnormal hardness or softness, spasms, and skin temperature;
- **listen** for changes in breathing patterns and unusual breathing sounds; and
- **smell** for any unusual odors coming from the patient’s body, breath, or clothing.

The head-to-toe survey may appear to be a long process, but as you practice the procedure you will find that it can be done in just a few minutes. All necessary personal protective equipment, such as exam gloves and eye protection, should be worn during your examination.

Begin the survey by kneeling at the side of the patient’s head. Quickly take an overview of the patient’s body (i.e., general appearance, demeanor, behavior, skin color and characteristics, etc.), then perform the 26 steps described in the following sections.

Step 1.—Check the cervical spine for point tenderness and deformity. To perform this procedure, gently slide your hands, palms up, under both sides of the patient’s neck. Move your fingertips toward the cervical midline. Check the back of the neck from the shoulders to the base of the skull. Apply gentle finger pressure. A painful response to this pressure is **point tenderness**.

If there are signs of possible spinal injury, such as midline deformities, point tenderness, or muscle spasms, stop the survey and provide stabilization of the head and neck.

NOTE: If a rigid cervical collar is to be applied, make sure you have examined the posterior, anterior, and sides of the neck before applying the collar.

Step 2.—Inspect the anterior neck for indications of injury and neck breathing. This procedure consists of exposing the anterior neck to check for injury and to detect the presence of a surgical opening (stoma) or a metal or plastic tube (tracheostomy). The presence of a stoma or tracheostomy indicates the patient is a neck breather. Also, if you have not already done so in the primary survey, check for a medical identification necklace. A necklace may state the patient has a stoma or tracheostomy.

Look for signs of injury, such as the larynx or trachea deviated from the midline of the neck, bruises, deformities, and penetrating injuries. Also, check for distention of the jugular vein. If the jugular vein is distended, there may be an airway obstruction, a cervical spine injury, damage to the trachea, or a serious chest injury. All of these conditions require immediate medical care.

After the anterior neck is inspected and if a spinal injury is suspected, apply a rigid cervical or extrication collar. If the patient is unconscious, assume the patient has a spinal injury.

Step 3.—Inspect the scalp for wounds. Use extreme caution when inspecting the scalp for wounds. Pressure on the scalp from your fingers could drive bone fragments or force dirt into wounds. Also, DO NOT move the patient’s head, as this could aggravate possible spinal injuries. To inspect the scalp, start at the top of the head and gently run your gloved fingers through the patient’s hair. If you come across an injury site, DO NOT separate strands of the hair. To do this could restart bleeding. When the patient is found lying on his back, check the scalp of the back of the head by placing your fingers behind the patient’s head. Then slide your fingers upward toward the top of the head. Check your fingers for blood. If a spinal or neck injury is suspected, delay this procedure until the head and neck have been immobilized. Furthermore, if you suspect a neck injury, DO NOT lift the head off the ground to bandage it.

NOTE: You may find upon inspection that the patient is wearing a hairpiece or wig. Hairpieces and wigs may be held in place by adhesive, tape, or permanent glue, so DO NOT remove them unless you suspect profuse bleeding. Attempting removal may aggravate injury or restart bleeding.

Step 4.—Check the skull and face for deformities and depressions. As you feel the scalp, check for depressions or bony projections. Visually examine facial bones for signs of fractures. Unless there are obvious signs of injury, gently palpate the cheekbones, forehead, and lower jaw.

Step 5.—Examine the patient’s eyes. After examining the face and scalp, move back to a side position. Begin your examination of the eyes by looking at the patient’s eyelids. Do not open the eyelids of patients with burns, cuts, or other injuries to the eyelid(s). Assume there is damage to the eye and treat accordingly. If eyelids are not injured, have patients open their eyes. To examine the eyes of unconscious patients, gently open their eyes by sliding back the upper eyelids. Keep in mind, pressure applied to the eyelid may cause further injury. When the eye has been opened, visually check the globe of the eye.

Step 6.—Check the pupils for size, equality, and reactivity. Using a penlight or flashlight, examine both eyes. Note pupil size and if both pupils are equal in size. Also, see if the pupils react to the beam of light. Note a slow pupil reaction to the light. Look for eye movement. Both eyes should move as a pair when they observe moving persons or objects.

NOTE: Check unconscious patients for contact lenses. Prompt removal of contact lenses is recommended. If removal of the lens is impractical, close the patient's eyes so the contact lenses stay lubricated.

Table 4-1 lists pupil characteristics you may encounter and the possible causes of abnormalities.

Step 7.—Inspect the inner surfaces of the eyelids. If there is no obvious injury to the eye, gently pull the upper lid up and the lower eyelid down, and check the color of the inner surface. Normally, the inner surfaces of the eyelids are pink. However, with blood loss they become pale; with jaundice, the surface is yellow. The inner surface of the eyelid is an excellent location to detect cyanosis (skin discoloration due to lack of

Table 4-1.—Listing of Pupil Characteristics and the Possible Cause of Abnormality

PUPIL CHARACTERISTICS	POSSIBLE CAUSE OF ABNORMALITY
Dilated and unresponsive	<ul style="list-style-type: none"> • Cardiac arrest • Influence of drugs (e.g., LSD and amphetamines)
Constricted and unresponsive	<ul style="list-style-type: none"> • Central Nervous System disease or disorder • Influence of narcotics (e.g., heroin, morphine, or codeine)
Unequal	<ul style="list-style-type: none"> • Stroke • Head injury
Lackluster (dull) and pupils do not appear to focus	<ul style="list-style-type: none"> • Shock • Coma

oxygen), especially for patients with dark skin pigmentation. Cyanosis is denoted by a blue color.

Step 8.—Inspect the ears and nose for injury and the presence of blood or clear fluids. Without rotating the patient’s head, inspect the ears and nose for cuts, tears, or burns. Use a penlight to look in the ears and nose for blood, clear fluids, or bloody fluids. Blood in the ears and clear fluids (cerebrospinal fluid) in the ears or nose are strong indicators of a skull fracture. Also, check for bruises behind the ears, commonly referred to as **Battle’s sign**. Bruises behind the ears are strong indicators of skull fracture and cervical spine injury. Burned or singed nasal hairs indicate possible burns in the airway.

Step 9.—Inspect the mouth. Look inside the mouth for signs of airway obstruction that may not have been observed during the primary survey (e.g., loose or broken teeth, dentures, and blood). When you inspect the mouth, remember not to rotate the patient’s head.

Step 10.—Smell for odd breath odors. Place your face close to the patient’s mouth and nose and note any unusual odors. A fruity smell indicates diabetic coma or prolonged vomiting and diarrhea; a petroleum odor indicates ingested poisoning; and an alcohol odor indicates possible alcohol intoxication.

Step 11.—Inspect the chest for wounds. Expose the chest. For unconscious and trauma patients, you should completely remove clothing to expose the chest. (Try to provide as much privacy as possible for patients.) Look for obvious chest injuries, such as cuts, bruises, penetrations, objects impaled in the chest, deformities, burns, or rashes. If puncture or bullet wounds are found, check for exit wounds when inspecting the back.

Step 12.—**Examine the chest for possible fracture.** Before you begin examining the chest for fractures, warn the patient that the examination may be painful. Begin your examination by gently feeling the clavicles (collarbones). Next, feel the sternum (breastbone). Then examine the rib cage by placing your hands on both sides of the rib cage and applying gentle pressure. This process is known as **compression**. If the patient has a fracture, compression of the rib cage will cause pain. Finally, slide your hands under the patient’s scapulae (shoulder blades) to feel for deformities or tenderness.

Point tenderness, painful reaction to compression, deformity, or grating sounds indicate a fracture. If air is felt (like crunching popcorn) or heard (crackling sounds) under the skin, this indicates that at least one rib is fractured or that there is a pneumothorax (punctured lung). You may also observe air escaping the chest cavity and the wound when the patient has a punctured lung.

Step 13.—**Check for equal expansion of the chest.** Check chest movements and feel for equal expansion by placing your hand on both sides of the chest. Be alert to sections of the chest that seem to be “floating” (flail chest) or moving in a direction opposite to the rest of the chest during respiration.

Step 14.—**Listen for sounds of equal air entry.** Using a stethoscope, listen to both sides of the anterior and lateral chest. The sounds of air entry will usually be clearly present or clearly absent. The absence of air movement indicates an obstruction, injury, or illness to the respiratory system. Bubbling, wheezing, rubbing, or crackling sounds may indicate the patient has a medical problem or a trauma-related injury.

Step 15.—**Inspect the abdomen for wounds.** Look for obvious signs of injury (e.g., abdominal distension, cuts, bruises, penetrations, open wounds with protruding organs (evisceration), or burns) in all four quadrants and sides.

Step 16.—**Palpate the abdomen for tenderness.** Look for attempts by the patient to protect his abdomen

(e.g., patient drawing up the legs). Gently palpate the entire abdomen. If the patient complains of pain in an area of the abdomen, palpate that area last. Do not palpate over an obvious injury site or where the patient is having severe pain. While palpating the abdomen, check for any tight (rigid) or swollen (distended) areas. Performing abdominal palpation is important because tender areas do not normally hurt until palpated. Note if pain is localized, general, or diffused.

Step 17.—**Feel the lower back for point tenderness and deformity.** Gently slide your hands under the void created by the curve of the spine. Apply gentle pressure to detect point tenderness or any deformities.

NOTE: This examination of the lower back may be performed later, when the patient’s entire back is exposed in preparation to being placed on a backboard or stretcher.

Step 18.—**Examine the pelvis for injuries and possible fractures.** Examine the pelvic area for obvious injuries. Next, gently slide your hand down both sides of the small of the patient’s back and apply compression downward and then inward to check the stability of the pelvic girdle. Note any painful responses or deformities. If a grating sound is heard, the injury may involve the hip joint, or the pelvis may be fractured.

Step 19.—Note any obvious injury to the genital region. Look for obvious injuries, such as bleeding wounds, objects impaled in the area, or burns. Also, check for **priapism** in male patients. Priapism is a persistent erection of the penis often brought about by spinal injury or certain medical problems, such as sickle cell crisis.

Step 20.—**Examine the lower extremities.** DO NOT move, lift, or rearrange the patient’s lower extremities (legs and feet) before or during the examination as further injury to the patient may occur. Check for signs of injury by inspecting each limb, one at a time, from hip to foot. Rearrange or remove clothing and footwear to observe the entire examination site. Pants should be removed in a manner that does not aggravate injuries. Cutting along the seams to remove pants is the best method. If the injury is not obvious, remove the shoe(s) and palpate any suspected fracture sites for point tenderness. Before palpating the site, warn the patient that this examination may cause pain. Before the patient is

moved, all suspected or known fractures should be stabilized (with splints, traction splints, or the like).

Step 21.—Check for a distal pulse and capillary refill. To make sure there are no circulatory problems in the legs or feet, check the distal pulse and capillary refill. The **distal pulse** is a pulse taken at the foot or wrist. It is called distal because the pulse is located at the distal end of the limb. The distal pulse of the foot, also referred to as **pedal pulse**, may be taken at either of two sites: the posterior tibial pulse (located behind the medial ankle) or the dorsalis pedis pulse (located on the anterior surface of the foot, lateral to the large tendon of the great toe).

You should compare the quality of the pulses in each lower limb. Absence of a distal pulse usually indicates that a major artery supplying the limb has been pinched or severed. This condition may be caused by a broken or displaced bone end or a blood clot. An absent or weak distal pulse may also result from splints or bandages being applied too tightly.

Check capillary refill by squeezing a toe (usually, the big toe) with your thumb and forefinger. The skin and nail where pressure is applied should blanch (lighten). When you release the pressure, the color (blood) should return immediately. If it takes more than 2 seconds for the color to return, capillary refill is considered delayed.

NOTE: After splints or bandages are applied, check capillary refill to make sure circulation has not been impaired.

Step 22.—Check for nerve function and possible paralysis of the lower extremities (conscious patient). Check the lower extremities of conscious patients for nerve function or paralysis. First, touch a toe and ask the patient which toe it is. Do this to both feet. If the patient cannot feel your touch or if the sensations in each foot are not the same, assume that nerve damage in the limb or a spinal injury has occurred.

If sensations appear normal and no injuries are present, have the patient wave his feet. Finally, ask the patient to gently press the soles of his feet against your hand. The inability of the patient to perform any of these tasks indicates the possibility of nerve damage. When nerve damage is suspected, assume the patient has a spinal injury.

Step 23.—Examine the upper extremities for injury. Check for signs of injury to the upper

extremities (arms and hands) by inspecting each limb, one at a time, from clavicle to fingertips. Rearrange or remove items of clothing to observe the entire examination site. Check for point tenderness, swelling, or bruising. Any of these symptoms may indicate a fracture. Immobilize any limb where a fracture is suspected.

Step 24.—Check for a distal pulse and capillary refill. To make sure the circulation to the upper extremities has not been compromised, confirm distal (radial) pulse. Initial check of radial pulse was performed during the primary survey. Check capillary refill of fingers or palm of hand (see step 21 for procedure). If there is no pulse or if capillary refill is delayed, the patient may be in shock or a major artery supplying the limb has been pinched, severed, or blocked.

Step 25.—Check for nerve function and possible paralysis of the upper extremities (conscious patient). Check the upper extremities of conscious patients for nerve function or paralysis. Have the patient identify the finger you touch, wave his hand, and grasp your hand. Do this to both hands. If the patient cannot feel your touch or the sensations in each hand are not the same, assume nerve damage in the limb or a spinal injury has occurred.

WARNING: Be alert for a rapid onset of difficult breathing or respiratory arrest. These conditions may occur to patients who have sustained a cervical injury.

Step 26.—Inspect the back and buttocks for injury. If there is no indication of injury to the skull, neck, spine, or extremities, and you have no evidence of severe injury to the chest or abdomen, gently roll the conscious patient as a unit toward your knees and inspect the surface of the back for bleeding or obvious injuries. The back surface may be inspected prior to positioning the patient for transport or delayed until the patient is transferred to a spineboard or other immobilization device.

VITAL SIGNS.—Vital signs (which generally are taken after primary, secondary, and head-to-toe surveys have been completed) include taking the patient's pulse, respiration, blood pressure, and temperature. Depending on local protocols, the patient's level of consciousness as well as eye pupil size and reactivity may be recorded with vital signs. Skin characteristics, such as temperature, color, and

moistness or dryness, can also be conveniently determined at this time.

Pulse.—When taking a patient’s pulse, you should be concerned with two factors: rate and character. For **pulse rate**, you will have to determine the number of beats per minute. Pulse rate is classified as normal, rapid, or slow. A normal pulse rate for adults is between 60 to 80 beats per minute. Any pulse rate above 100 beats per minute is rapid (**tachycardia**), while a rate below 60 beats per minute is slow (**bradycardia**).

NOTE: An athlete may have a normal at-rest pulse rate between 40 and 50 beats per minute. This is a slow pulse rate, but is not an indication of poor health.

Pulse character is the rhythm and force of the pulse. **Pulse rhythm** is evaluated as regular or irregular. When intervals between beats are constant, the pulse is regular, and when intervals are not constant, the pulse is described as irregular. **Pulse force** refers to the pressure of the pulse wave as it expands the artery. Pulse force is determined as full or thready. A full pulse feels as if a strong wave has passed under your fingertips. When the pulse feels weak and thin, the pulse is described as thready.

The pulse rate and character can be determined at a number of points throughout the body. The most common site to determine a patient’s pulse is the **radial pulse**. The radial pulse (wrist pulse) is named after the radial artery found in the lateral aspect of the forearm.

Respiration.—Respiration is the act of breathing. A single breath is the complete process of breathing in (**inhalation**) followed by breathing out (**exhalation**). When observing respiration in connection to vital signs, you should be concerned with two factors: rate and character.

Respiration rate is the number of breaths a patient takes in 1 minute. The rate of respiration is classified as normal, rapid, or slow. The normal respiration rate for an adult at rest is 12 to 20 breaths per minute. A rapid respiration rate is more than 28 respirations per minute, and a slow respiration rate is less than 10 breaths per minute. A rapid or slow respiration rate indicates the patient is in need of immediate medical attention and should be transported to a medical treatment facility as soon as possible.

Respiration character includes rhythm, depth, ease of breathing, and sound. **Respiration rhythm** refers to the manner in which a person breathes. Respiration rhythm is classified as regular or irregular. A regular rhythm is when the interval between breaths is constant, and an irregular rhythm is when the interval between breaths varies.

Respiration depth refers to the amount of air moved between each breath. Respiration depth is classified as normal, deep, or shallow.

Ease of breathing can be judged while you are judging depth. Ease of breathing may be judged as labored, difficult, or painful.

Sounds of respiration include **snoring**, **wheezing**, **crowing** (birdlike sounds), and **gurgling** (sounds like breaths are passing through water).

You should count respirations as soon as you have determined the pulse rate. Count the number of breaths taken by the patient during 30 seconds and multiply by 2 to obtain the breaths per minute. While you are counting breaths, note the rhythm, depth, ease of breathing, and sounds of respiration.

Blood Pressure.—The measurement of the pressure blood exerts against the wall of blood vessels is known as blood pressure. The pressure created in the arteries when the heart pumps blood out into circulation (heart beat) is called the **systolic** blood pressure. The pressure remaining in the arteries when the heart is relaxed (between beats) is called the **diastolic** blood pressure. The systolic pressure is always reported first and the diastolic pressure second (e.g., 120 over 80).

Blood pressure varies from one person to another and is measured with a stethoscope and a sphygmomanometer (BP cuff). Low blood pressure (**hypotension**) is considered to exist when the systolic pressure falls below 90 millimeters of mercury (mm Hg) and/or the diastolic falls below 60. “Millimeters of mercury” refers to the units of the BP cuff’s gauge. High blood pressure (**hypertension**) exists once the pressure rises above 150/90 mm Hg. Keep in mind that patients may exhibit a temporary rise in blood pressure during emergency situations. More than one reading will be necessary to determine if a high or low reading is only temporary. If a patient’s blood pressure drops, the patient may be going into shock. You should report major changes in blood pressure immediately to medical facility personnel.

Temperature.—Body temperatures are determined by the measurement of oral, rectal, axillary

(armpit), and aural (ear) temperatures. In emergency situations, taking a traditional body temperature may not be indicated, so a relative skin temperature may be done. A relative skin temperature is a quick assessment of skin temperature and condition. To assess skin temperature and condition, feel the patient's forehead with the back of your hand. In doing this, note if the patient's skin feels normal, warm, hot, cool, or cold. At the same time, see if the skin is dry, moist, or clammy. Also check for "goose pimples," indicating chills.

BASIC LIFE SUPPORT

LEARNING OBJECTIVE: *Recall basic life support techniques for upper airway obstruction, respiratory failure, and cardiac arrest.*

Basic life support is the emergency technique for recognizing and treating upper airway obstruction and failures of the respiratory system and heart. The primary emphasis should be on the **ABCs** of basic life support: maintaining an open **airway** to counter upper airway obstruction; restoring **breathing** to counter respiratory arrest; and restoring **circulation** to counter cardiac arrest.

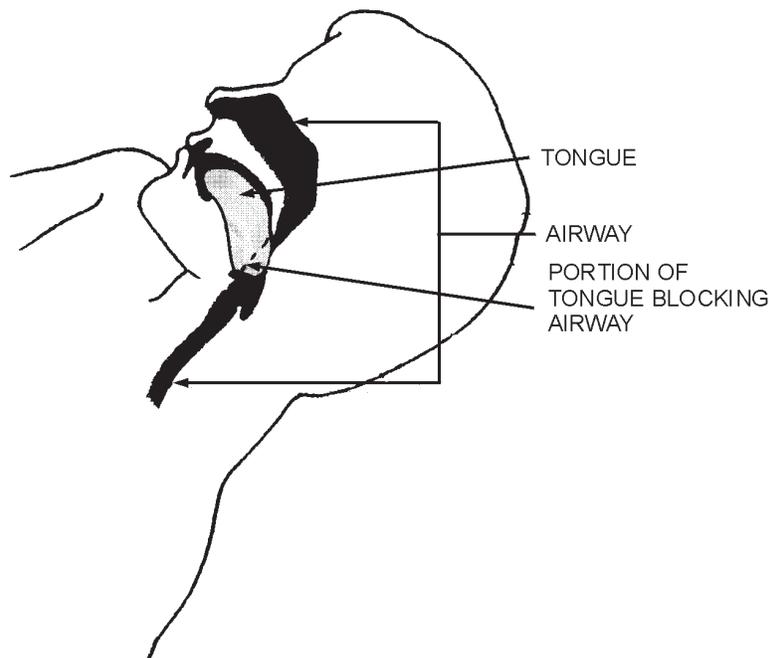
UPPER AIRWAY OBSTRUCTION

The assurance of breathing takes precedence over all other emergency measures. The reason for this is simple: If a person cannot breathe, he cannot survive.

Many factors may cause a person's airway to become fully or partially obstructed. A very common cause of obstruction with both adults and children is improperly chewed food that becomes lodged in the airway (an event commonly referred to as a "cafe coronary"). Additionally, children have a disturbing tendency to swallow foreign objects while at play. Another cause for upper airway obstruction occurs during unconsciousness, when the tongue may fall back and block the pharynx (fig. 4-1). When the upper airway is obstructed, the heart will normally continue to beat until oxygen deficiency becomes acute. Periodic checks of the carotid artery must be made to ensure that circulation is being maintained.

Partial Airway Obstruction

The signs of partial airway obstruction include unusual breath sounds, cyanosis, or changes in breathing pattern. Conscious patients will usually make clutching motions toward their neck, even when the obstruction does not prevent speech. Encourage conscious patients with apparent partial obstructions



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Figure 4-1.—Tongue blocking airway.

to cough. If the patient is unable to cough, begin to treat the patient as if this were a complete obstruction. (This also applies to patients who are cyanotic.)

Complete Airway Obstruction

Conscious patients will attempt to speak but will be unable to do so. Nor will they be able to cough. Usually, patients will display the universal distress signal for choking by clutching their neck. The unconscious patient with a complete airway obstruction exhibits none of the usual signs of breathing: rise and fall of the chest and air exchange through the nose and/or mouth. A complete blockage is also indicated if a correctly executed attempt to perform artificial ventilation fails to instill air into the lungs.

Opening the Airway

Many problems of airway obstruction, particularly those caused by the tongue, can be corrected simply by repositioning the head and neck. If repositioning does not alleviate the problem, more aggressive measures must be taken.

POSITIONING THE PATIENT.—When a patient is unresponsive, you must determine if he is breathing. This assessment requires the patient to be positioned properly with the airway opened.

Before repositioning patients, it is imperative that you remember to check them for possible spinal injuries. If there is no time to immobilize these injuries and the airway cannot be opened with the victim in the present position, then great care must be taken when repositioning. The head, neck, and back must be moved as a single unit. To do this, adhere to the following four steps (see figure 4-2).

Step 1—Kneel to the side of the victim in line with the victim's shoulders, but far enough away so that the victim's body will not touch yours when it is rolled toward you. Straighten the victim's legs, gently but quickly. Then move the victim's closer arm along the floor until it reaches straight out past the head.

Step 2—Support the back of the victim's head with one hand while you reach over with the other hand to grasp under the distant armpit.

Step 3—Pull the patient toward you while at the same time keeping the head and neck in a natural straight line with the back. Resting the head on the extended arm will help you in this critical task.

Step 4—Roll the patient onto his back and reposition the extended arm.

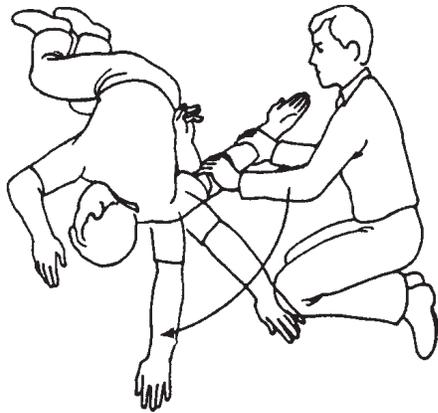
Once the patient is supine with the arms alongside the body, you should position yourself at the patient's side. By positioning yourself at the patient's side, you can more easily assess whether the patient is breathing. If the patient is not breathing, you are already positioned to perform artificial respirations (also referred to as rescue breathing) and chest compressions.

Either one of two maneuvers—the head tilt-chin lift maneuver or the jaw-thrust maneuver—may be used to open an obstructed airway. When performing these maneuvers, you may discover foreign material or vomitus in the mouth that needs to be removed. Do not spend very much time to perform this task. Liquids or semiliquids should be wiped out with the index and middle finger covered by a piece of cloth. Solid material should be extracted with a hooked index finger.

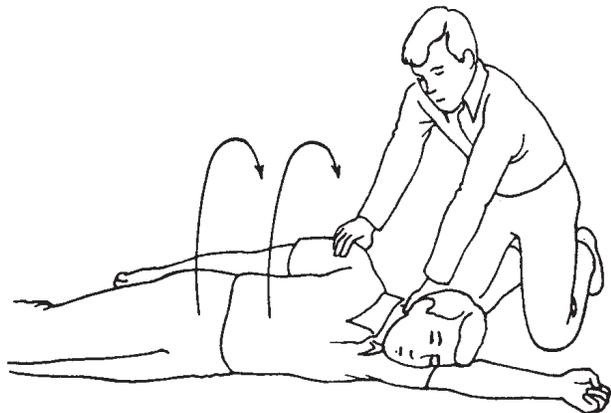
HEAD TILT-CHIN LIFT MANEUVER.—The head tilt-chin lift maneuver is the primary method used to open the airway. To perform the head tilt-chin lift maneuver, place one of your hands on the patient's forehead and apply gentle, firm, backward pressure using the palm of your hand. Place the fingers of the other hand under the bony part of the chin. Lift the chin forward and support the jaw, helping to tilt the head back. See figure 4-3. This maneuver will lift the patient's tongue away from the back of the throat and provide an adequate airway.

PRECAUTIONS: When performing the head tilt-chin lift maneuver, do not press too deeply into the soft tissue under the chin. Undue pressure in this location may obstruct the airway. In addition, make sure the mouth is kept open so exhalation and inhalation are not hindered.

JAW-THRUST MANEUVER.—The jaw-thrust maneuver is considered an alternate method for opening the airway. This maneuver is accomplished by kneeling near the top of the victim's head, grasping the angles of the patient's lower jaw, and lifting with both hands, one on each side. This will displace the mandible (jawbone) forward while tilting the head backward. Figure 4-4 illustrates the jaw-thrust maneuver. If the lips close, retract the lower lip with your thumb. If mouth-to-mouth breathing is necessary, close the nostrils by placing your cheek tightly against them.



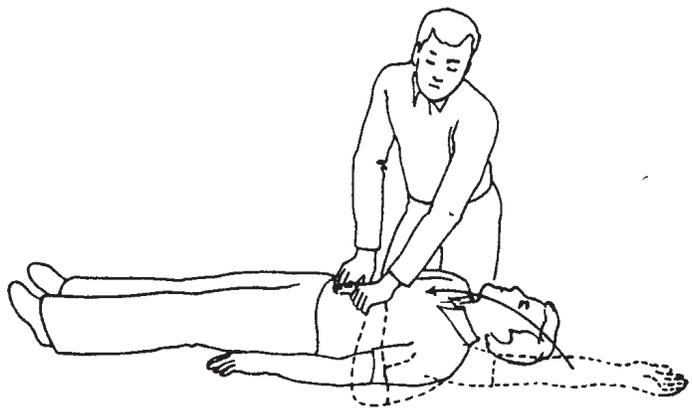
STEP 1



STEP 3



STEP 2



STEP 4

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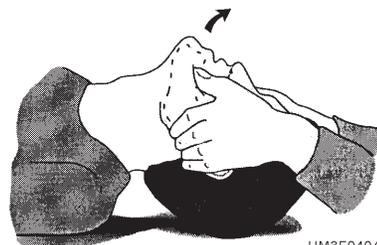
Figure 4-2.—The four steps to reposition the victims of spinal injuries.

NOTE: The jaw-thrust technique without head tilt is considered the safest approach to opening the airway of patients with suspected neck injuries because it usually can be done without extending the neck.



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Figure 4-3.—Head tilt-chin lift maneuver.



HM3F0404

Figure 4-4.—Jaw-thrust maneuver.

Foreign-Body Airway Obstruction Management

Foreign-body airway obstruction should be considered in any victim—especially a younger victim—who suddenly stops breathing, becomes cyanotic, or loses consciousness for no apparent reason.

The **Heimlich maneuver** (subdiaphragmatic abdominal thrusts) is recommended for relieving foreign-body airway obstruction. By elevating the diaphragm, the Heimlich maneuver can force air from the lungs to create an artificial cough intended to expel a foreign body obstructing the airway. Each individual thrust should be administered with the intent of relieving the obstruction. It may be necessary to repeat the thrust several times to clear the airway. Five thrusts per sequence is recommended.

When you perform this maneuver, you should guard against damage to internal organs, such as rupture or laceration of abdominal or thoracic viscera. To minimize this possibility, your hands should never be placed on the xiphoid process of the sternum or on the lower margins of the rib cage. They should be below this area but above the navel and in the midline.

Regurgitation may occur as a result of abdominal thrusts. Be prepared to position the patient so aspiration does not occur.

HEIMLICH MANEUVER WITH VICTIM STANDING OR SITTING.—To perform the Heimlich maneuver with victim standing or sitting, stand behind the victim, wrap your arms around the victim's waist, and proceed as follows:

Step 1—Make a fist with one hand.

Step 2—Place the thumb side of the fist against the victim's abdomen, in the midline slightly above the navel and well below the tip of the xiphoid process.

Step 3—Grasp the fist with the other hand and press the fist into the victim's abdomen with a quick upward thrust. See figure 4-5.

Step 4—Repeat the thrusts and continue until the object is expelled from the airway or the patient becomes unconscious. Each new thrust should be a separate and distinct movement.

HEIMLICH MANEUVER WITH VICTIM LYING DOWN.—To perform the Heimlich maneuver with victim lying down, proceed as follows:

Step 1—Place the victim in the supine position (face up).



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Figure 4-5.—Administering the Heimlich maneuver to a conscious victim who is standing.

Step 2—Kneel astride the victim's thighs and place heel of one hand against the victim's abdomen, in the midline slightly above the navel and well below the tip of the xiphoid.

Step 3—Place the second hand directly on top of the first.

Step 4—Press into the abdomen with a quick upward thrust. See figure 4-6.



HM3F0406

Figure 4-6.—Administering the Heimlich maneuver to an unconscious victim who is lying down.

If you are in the correct position, you will have a natural midabdominal position and are unlikely to direct the thrust to the right or left. A rescuer too short to reach around the waist of an unconscious victim can use this technique. The rescuer can use their body weight to perform the maneuver.

CHEST THRUSTS WITH VICTIM STANDING OR SITTING.—This technique is used only in the late stages of pregnancy or in the markedly obese victim. To perform chest thrusts with victim standing or sitting, proceed as follows:

Step 1—Stand behind the victim, with your arms directly under the victim’s armpits, and encircle the victim’s chest.

Step 2—Place the thumb side of your fist on the middle of the victim’s sternum (breastbone), taking care to avoid the xiphoid process and the margins of the rib cage.

Step 3—Grab your fist with the other hand and perform backward thrust until the foreign body is expelled or the victim becomes unconscious. See figure 4-7.



HM3F0407

Figure 4-7.—Administering the chest thrust to a conscious victim who is standing.

CHEST THRUSTS WITH VICTIM LYING DOWN.—Chest thrusts should be used only for victims in the late stages of pregnancy and when the Heimlich maneuver cannot be applied effectively to the unconscious, markedly obese victim. To perform chest thrusts with victim lying down, proceed as follows:

Step 1—Place the victim on his back and kneel close to the victim’s side.

Step 2—Place the heel of your hand on the lower portion of the sternum (in the same manner as you would when performing chest compressions).

Step 3—Deliver each thrust firmly and distinctly, with the intent of relieving the obstruction.

MANUAL REMOVAL OF FOREIGN BODY.—A foreign body can be removed by performing a “finger sweep.” This procedure, however, **must be performed on unconscious victims only** (though not on seizure victims). To perform a finger sweep, proceed as follows:

Step 1—With the victim’s face up, open the victim’s mouth by grasping both the tongue and lower jaw between the thumb and fingers and lifting the jaw. This action draws the tongue away from the back of the throat and away from a foreign body that may be lodged there. This step alone may partially relieve the obstruction.

Step 2—Insert the index finger of the other hand down along the inside of the cheek and deeply into the throat to the base of the tongue.

Step 3—Use a hooking action to dislodge the foreign body and maneuver it into the mouth so that it can be removed. See figure 4-8.



HM3F0408

Figure 4-8.—Finger sweep.

It is sometimes necessary to use the index finger to push a foreign body against the opposite side of the throat to dislodge and remove it. Be careful not to force the object deeper into the airway. If the foreign body comes within reach, grasp and remove it.

BREATHING

The second aspect of basic life support is to restore breathing in cases of respiratory arrest. Failure of the breathing mechanism may be caused by various factors. They include complete airway obstruction, insufficient oxygen in the air, inability of the blood to carry oxygen (e.g., carbon monoxide poisoning), paralysis of the breathing center of the brain, and external compression of the body. Respiratory arrest is usually but not always immediately accompanied by cardiac arrest. Periodic checks of the carotid pulse must be made, and you must be prepared to start cardiopulmonary resuscitation (CPR).

Signs of respiratory arrest are an absence of respiratory effort, a lack of detectable air movement through the nose or mouth, unconsciousness, and a cyanotic discoloration of the lips and nail beds.

Determining Breathlessness

To assess the presence or absence of breathing (fig. 4-9), you should use the following procedures:

Step 1—Place your ear over the patient’s mouth and nose, while maintaining an open airway.

Step 2—While observing the patient’s chest,

- **look** for the chest to rise and fall,
- **listen** for air escaping during exhalation, and
- **feel** for the flow of air.

Recovery Position

If the patient is unresponsive, has no evidence of trauma, and is obviously breathing adequately, place the patient in the “recovery position.” See figure 4-10. In the recovery position, the airway is more likely to remain open, and an unrecognized airway obstruction caused by the tongue is less likely to occur. It is important to continue close observation of the patient who has been placed in the recovery position until he becomes responsive.

To place a patient in the recovery position, roll the patient onto his side so that the head, shoulders, and

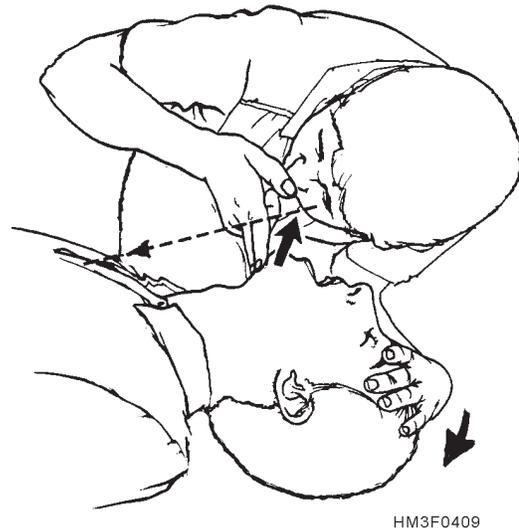


Figure 4-9.—Determining breathlessness.

torso move simultaneously without twisting. If the patient has sustained trauma or trauma is suspected, the patient should NOT be moved.

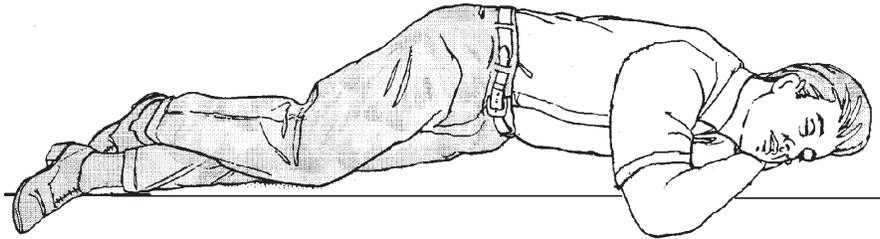
Artificial Ventilation

If a patient is in respiratory arrest, artificial ventilations must be started immediately. Any delay could result in brain damage or death. The purpose of artificial ventilation is to provide air exchange until natural breathing is re-established. Artificial ventilation should be given only when natural breathing has been suspended; **it must not be given to a person who is breathing naturally**. Do not assume that a person’s breathing has stopped merely because the person is unconscious or has been rescued from water, from poisonous gas, or from contact with an electric wire.

Techniques of artificial ventilation include **mouth-to-mouth**, **mouth-to-nose**, **mouth-to-stoma**, and **mouth-to-mask**. These techniques as they apply to adult patients are discussed in the following sections.

MOUTH-TO-MOUTH.—Artificial ventilation with the mouth-to-mouth technique is a quick, effective way to provide oxygen to the patient. The exhaled air contains enough oxygen to supply the patient’s needs.

To perform mouth-to-mouth ventilation, the airway must be open. To open the airway, perform the head tilt-chin lift or jaw-thrust maneuver. If there is no spontaneous breathing, start artificial ventilation by pinching the nose closed with your thumb and index



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Figure 4-10.—A patient in the recovery position.

finger. Take a deep breath and seat your lips around the patient's mouth (creating an airtight seal), and give two slow ventilations (1 ½ to 2 seconds per breath). See figure 4-11. Allow enough time for the lungs to deflate between ventilations. If the patient still does not respond, continue mouth-to-mouth ventilations at the rate of 10 to 12 ventilations per minute or one breath every 5 seconds. Periodically, check the pupils for reaction to light; constriction is a sign of adequate oxygenation.

NOTE: When performing artificial ventilation and the lungs cannot be inflated adequately, repeat head tilt-chin lift or jaw-thrust maneuver, and again attempt ventilation. If the lungs still do not inflate adequately, assume the airway is obstructed by a foreign object.

MOUTH-TO-NOSE.—Mouth-to-nose ventilation is effective when the patient's mouth cannot be opened (lockjaw), extensive facial or dental injuries occur, or an airtight seal of the mouth cannot be achieved. Figure 4-12 shows an example of this procedure.

To administer this technique, tilt the head back with one hand on the patient's forehead and use the other hand to lift the jaw (as in the head tilt-chin lift maneuver). Close the victim's mouth. Take a deep



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Figure 4-11.—Mouth-to-mouth ventilation.



HM3F0412

Figure 4-12.—Mouth-to-nose ventilation.

breath, seal your lips around the patient's nose, and give two ventilations. Allow the victim's lungs to deflate passively after each ventilation. If the victim does not respond, then you must fully inflate the lungs at the rate of 10 to 12 ventilations per minute or one breath every 5 seconds until the victim can breathe spontaneously.

MOUTH-TO-STOMA.—A casualty who has had surgery to remove part of the windpipe will breathe through an opening in the front of the neck called a **stoma**. Cover the casualty's mouth with your hand, take a deep breath, and seal your mouth over the stoma. Breathe slowly, using the procedures for mouth-to-mouth breathing. **Do not tilt the head back.** (In some situations, a person may breathe through the stoma as well as his nose and mouth. If the casualty's chest does not rise, cover his mouth and nose, and continue breathing through the stoma.)

MOUTH-TO-MASK.—The mouth-to-mask breathing device includes a transparent mask with a one-way valve mouth piece. The one-way valve directs the rescuer's breath into the patient's airway while diverting the patients's exhaled air away from the rescuer. Some devices have an oxygen adaptor that permits the administration of supplemental oxygen.

Mouth-to-mask is a reliable form of ventilation since it allows the rescuer to use two hands to create a seal. Follow the steps below to perform the mouth-to-mask technique.

Step 1—Place the mask around the patient’s mouth and nose, using the bridge of the nose as a guide for correct position. Proper positioning of the mask is critical because gaps between the mask and the face will result in air leakage.

Step 2—Seal the mask by placing the heel and thumb of each hand along the border of the mask and compressing firmly to provide a tight seal around the margin of the mask.

Step 3—Place your remaining fingers along the bony margin of the jaw and lift the jaw while performing a head tilt.

Step 4—Give breaths in the same sequence and at the same rate as in mouth-to-mouth resuscitation; observe the chest for expansion.

Gastric Distention

Sometimes during artificial ventilation, air is forced into the stomach instead of into the lungs. The stomach becomes distended (bulges), indicating that the airway is blocked or partially blocked, or that ventilations are too forceful. This problem is more common in children but can occur with adults as well. A slight bulge is of little worry, but a major distention can cause two serious problems. First, it reduces lung volume: the distended stomach forces the diaphragm up. Second, there is a strong possibility of vomiting.

The best way to avoid gastric distention is to position the head and neck properly and/or limit the volume of ventilations delivered.

NOTE: THE AMERICAN RED CROSS (ARC) STATES THAT NO ATTEMPT SHOULD BE MADE TO FORCE AIR FROM THE STOMACH UNLESS SUCTION EQUIPMENT IS ON HAND FOR IMMEDIATE USE.

If suction equipment is ready and the patient has a marked distention, you can turn the patient on his side facing away from you. With the flat of your hand, apply gentle pressure between the navel and the rib cage. Be prepared to use suction should vomiting occur.

CIRCULATION

Cardiac arrest is the complete stoppage of heart function. If the patient is to live, action must be taken immediately to restore heart function. The symptoms of cardiac arrest include absence of carotid pulse, lack of heartbeat, dilated pupils, and absence of breathing.

A rescuer knowing how to administer cardiopulmonary resuscitation (CPR) greatly increases the chances of a victim’s survival. CPR consists of external heart compression and artificial ventilation. External heart compression is performed on the outside of the chest, and the lungs are ventilated by the mouth-to-mouth, mouth-to-nose, mouth-to-stoma, or mouth-to-mask techniques. To be effective, CPR must be started within 4 minutes of the onset of cardiac arrest. The victim should be supine on a firm surface.

CPR should not be attempted by a rescuer who has not been properly trained. If improperly done, CPR can cause serious damage. It must never be practiced on a healthy individual. For training purposes, use a training aid instead. To learn this technique, see your medical education department or an American Heart Association- or American Red Cross-certified Hospital Corpsman, nurse, or physician.

One-Rescuer CPR

The rescuer must not assume that a cardiac arrest has occurred solely because the victim is lying on the floor and appears to be unconscious. First, try to rouse the victim by gently shaking the shoulders and trying to obtain a response (e.g., loudly ask: “Are you OK?”). If there is no response, place the victim supine on a firm surface. **Always assume neck injuries in unconscious patients.** Kneel at a right angle to the victim, and open the airway using the head tilt-chin lift or jaw-thrust methods described previously. Attempt to ventilate. If unsuccessful, reposition the head and again attempt to ventilate. If still unsuccessful, deliver five abdominal thrusts (Heimlich maneuver) or chest thrusts to open the airway. Repeat the thrust sequence until the obstruction is removed.

DETERMINING PULSELESSNESS.—Once the airway has been opened, check for the carotid pulse. The carotid artery is most easily found by locating the larynx at the front of the neck and then sliding two fingers down the side of the neck toward you (fig. 4-13). The carotid pulse is felt in the groove between the larynx and the sternocleidomastoid

muscle. If the pulse is present, ventilate as necessary. If the pulse is absent, locate the sternum and begin chest compressions.

PROPER POSITIONING OF HANDS ON STERNUM.—To locate the sternum, use the middle and index fingers of your lower hand to locate the lower margin of the victim’s rib cage on the side closest to you (fig. 4-14). Then move your fingers up along the edge of the rib cage to the notch where the ribs meet the sternum in the center of the lower chest. Place your middle finger on the notch and your index finger next to it. Place the heel of your other hand along the midline of the sternum next to your index finger. Remember to keep the heel of your hand off the xiphoid (tip of the sternum). A fracture in this area may damage the liver, causing hemorrhage and death.

CHEST COMPRESSIONS.—Place the heel of one hand directly on the sternum and the heel of the other on top of the first. Interlock your fingers or extend them straight out and **KEEP THEM OFF THE VICTIM’S CHEST!** Effective compression is



Figure 4-14.—Proper position of hands on the sternum for chest compressions.

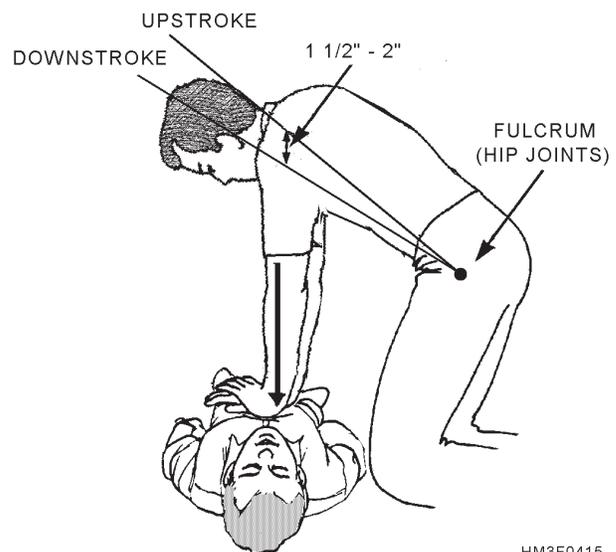
accomplished by locking your elbows into position, straightening your arms, and positioning your shoulders directly over hands so that the thrust for each chest compression is straight down on the sternum. See figure 4-15. The sternum should be depressed approximately 1 ½ to 2 inches (for adults). Release chest compression pressure between each compression to allow blood to flow into the chest and heart. When releasing chest compression pressure, remember to keep your hands in place on the chest.

Not only will you feel less fatigue if you use the proper technique, but a more effective compression



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Figure 4-13.—Locating the carotid pulse.



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Figure 4-15.—Proper position of the rescuer.

will also result. Ineffective compression occurs when the elbows are not locked, the rescuer is not directly over the sternum, or the hands are improperly placed on the sternum.

PERFORMANCE AND REASSESSMENT OF CPR.—When one rescuer performs CPR, the ratio of compressions to ventilations is 15 to 2, and it is performed at a rate of 80 to 100 compressions per minute. Vocalize: “one and, two and, three and,...” until you reach 15. After 15 compressions, you must give the victim two slow ventilations (1 ½ to 2 seconds). Continue for four full cycles. Quickly check for the carotid pulse and spontaneous breathing. If there are still no signs of recovery, continue CPR with compressions. Reassess the patient every few minutes thereafter.

If a periodic check reveals a return of pulse and respiration, discontinue CPR and place the victim in the recovery position. Continue monitoring the victim and be prepared to restart CPR .

Two-Rescuer CPR

If there are two people trained in CPR on the scene, one should perform chest compressions while the other performs ventilations. The compression rate for two-rescuer CPR is the same as it is for one-rescuer CPR: 80 to 100 compressions per minute. However, the compression-ventilation ratio is 5 to 1, with a pause for ventilation of 1 ½ to 2 seconds consisting primarily of inspiration. Exhalation occurs during chest compressions.

Two-rescuer CPR should be performed with one rescuer positioned at the chest area and the other positioned beside the victim’s head. The rescuers should be on opposite sides of the victim to ease position changes when one rescuer gets tired. Changes should be made on cue without interrupting the rhythm.

The victim’s condition must be monitored to assess the effectiveness of the rescue effort. The person ventilating the patient assumes the responsibility for monitoring pulse and breathing. To assess the effectiveness of the partner’s chest compressions, the rescuer should check the pulse during compressions. To determine if the victim has resumed spontaneous breathing and circulation, chest compressions must be stopped for 5 seconds at the end of the first minute (20 cycles) and every few minutes thereafter.

NOTE: Although it has fallen out to favor with some agencies, two-person CPR remains a viable method of resuscitation.

CPR for Children and Infants

CPR for children (1 to 8 years old) is similar to that for adults. The primary differences are that the heel of only one hand is used to apply chest compressions, and ventilations are increased to a rate of 20 breaths per minute (once every 3 seconds). Chest compressions are performed on the lower half of the sternum (between the nipple line and the notch). The chest should be depressed approximately one-third to one-half (about 1 to 1 ½ inches) the total depth of the chest.

For infants (under 1 year old), CPR is performed with the infant supine on a hard, flat surface. The hard surface may be the rescuer’s hand or arm, although using the arm to support the infant during CPR enables the rescuer to transport the infant more easily while continuing CPR. See figure 4-16. Once the infant is positioned on a hard surface, the airway should be opened using the head tilt-chin lift or jaw-thrust maneuver. Both maneuvers, however, must be performed very carefully and gently to prevent hyperextension of the infant’s neck. Pulselessness is determined by palpating the brachial artery (fig. 4-17). If the infant has no pulse and is not breathing, CPR must be started immediately.

To perform CPR on an infant, place your mouth over the infant’s nose and mouth, creating a seal. Give two slow breaths (1 to 1 ½ seconds per breath) to the infant, pausing after the first breath to take a breath. Pausing to take a breath after the first breath of each pair of breaths maximizes oxygen content and



Figure 4-16.—Infant supported on rescuer’s arm, and proper placement of fingers for chest compressions.

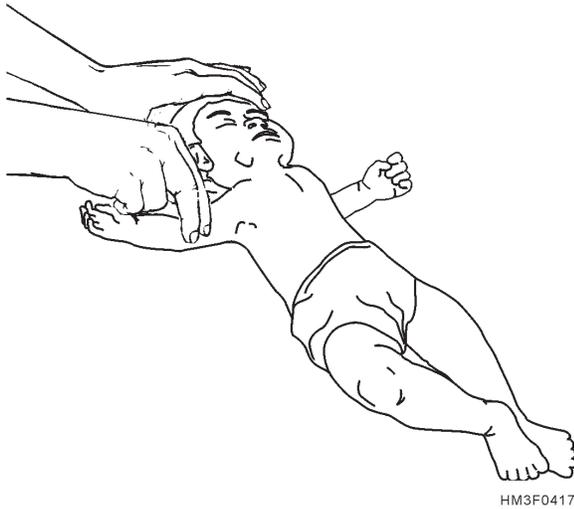


Figure 4-17.—Palpating brachial artery pulse in an infant.

minimizes carbon dioxide concentration in the delivered breaths. Perform chest compressions by using two fingers to depress the middle of the sternum approximately ½ to 1 inch. See figures 4-16 and 4-18 for proper finger positioning for chest compressions.

For both infants and children, the compression rate should be at least 100 compressions per minute. Compressions must be coordinated with ventilations at a 5-to-1 ratio. The victim should be reassessed after 20 cycles of compressions and ventilations (approximately 1 minute) and every few minutes thereafter for any sign of resumption of spontaneous breathing and pulse. If the child or infant resumes effective breathing, place the victim in the recovery position.

SHOCK

LEARNING OBJECTIVE: *Recognize the signs and symptoms of shock, and determine treatment by the type of shock presented.*

Shock is the collapse of the cardiovascular system, characterized by circulatory deficiency and the depression of vital functions. There are several types of shock:

- **Hypovolemic shock**—caused by the loss of blood and other body fluids.
- **Neurogenic shock**—caused by the failure of the nervous system to control the diameter of blood vessels.



Figure 4-18.—Locating proper finger position to perform chest compressions in infants.

- **Cardiogenic shock**—caused by the heart failing to pump blood adequately to all vital parts of the body.
- **Septic shock**—caused by the presence of severe infection.
- **Anaphylactic shock**—caused by a life-threatening reaction of the body to a substance to which a patient is extremely allergic.

Multiple types of shock may be present in varying degrees in the same patient at the same time. The most frequently encountered and most important type for the Hospital Corpsman to understand is **hemorrhagic shock**, a type of hypovolemic shock which will be discussed later in this chapter.

Shock should be expected in all cases of major injury, including gross hemorrhage, abdominal or chest wounds, crash or blast injuries, extensive large-muscle damage (particularly of the extremities), major fractures, traumatic amputations, or head injuries, or in burns involving more than 10 percent of the body surface area.

SYMPTOMS OF SHOCK

The symptoms of shock vary from patient to patient and even within an individual during the course of illness. Evaluation of the whole situation is more important than one particular sign or symptom.

Degrees of Shock

Table 4-2 provides a generalized overview of the degrees of shock and their symptoms correlated to the approximate volume deficit.

Table 4-2.—Correlation of Magnitude of Volume Deficit and Clinical Presentation

Approximate Deficit (ml)	Decrease in Blood Volume %	Degree	Signs
0-500	0-10	None	None
500-1200	10-25	Mild	Slight tachycardia Postural changes in blood pressure Mild peripheral vasoconstriction Increased respirations
1200-1800	25-35	Moderate	Thready pulse 100-120 Systolic blood pressure 90-100 Marked vasoconstriction Labored breathing Diaphoresis (profuse perspiration) Anxiety and restlessness Decreased urine output
1800-2500	35-50	Severe	Thready pulse > 120 Systolic blood pressure < 60 Weakened respirations Increased diaphoresis Changes in levels of consciousness No urine output

Shock Control and Prevention

The essence of shock control and prevention is to recognize the onset of the condition and to start treatment before the symptoms fully develop. The following are general signs and symptoms of the development of shock (see figure 4-19):

- Restlessness and apprehension are early symptoms, often followed by apathy.
- Eyes may be glassy and dull. Pupils may be dilated. (These are also the symptoms of morphine use.)
- Breathing may be rapid or labored, often of the gasping, “air hunger” type. In the advanced stages of shock, breathing becomes shallow and irregular.
- The face and skin may be very pale or ashen gray; in the dark complexioned, the mucous membranes may be pale. The lips are often cyanotic.
- The skin feels cool and is covered with clammy sweat. The skin’s coolness is related to a decrease in the peripheral circulation.
- The pulse tends to become rapid, weak, and thready. If the blood pressure is severely lowered, the peripheral pulse may be absent. The pulse rate in hemorrhagic shock may reach 140 or higher. In neurogenic shock, however, the pulse rate is slowed, often below 60.
- The blood pressure is usually lowered in moderately severe shock; the systolic pressure drops below 100, while the pulse rises above 100. The body is compensating for circulatory fluid loss by peripheral vasoconstriction. This process tends to maintain the blood pressure at a nearly normal level despite a moderately severe loss of circulating blood volume. A point comes, however, when decompensation occurs, and a small amount of additional blood loss will produce a sudden, alarming fall in blood pressure.
- There may be nausea, vomiting, and dryness of the mouth, lips, and tongue.
- Surface veins may collapse. Veins normally visible at the front of the elbow, forearms,

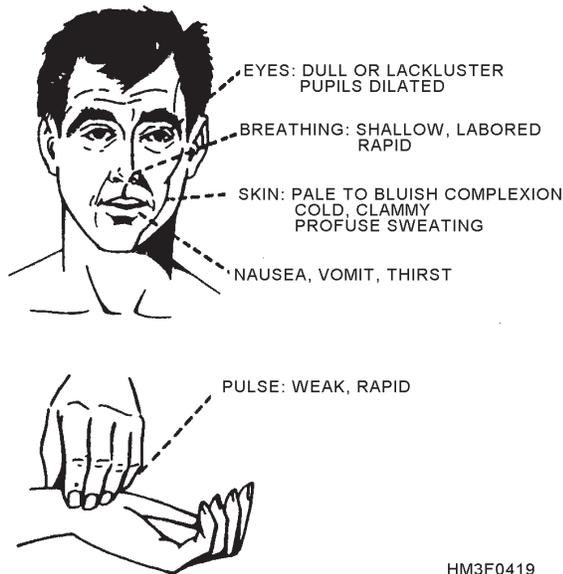


Figure 4-19.—Symptoms of shock.

and the back of the hands will be hard to distinguish.

- There are frequent complaints of thirst. Even the severely wounded may complain of thirst rather than pain.
- The kidneys may shut down. Urine formation either ceases or greatly diminishes if the systolic blood pressure falls below 80 for long periods of time.
- The person may faint from inadequate venous blood return to the heart. This may be the result of a temporary gravitational pooling of the blood associated with standing up too quickly.

HYPOVOLEMIC SHOCK

Hypovolemic shock is also known as oligemic or hematogenic shock. The essential feature of all forms of hypovolemic shock is loss of fluid from the circulating blood volume, so that adequate circulation to all parts of the body cannot be maintained.

Hemorrhagic Shock

In cases where there is internal or external hemorrhage due to trauma (hemorrhagic shock), there is a loss of whole blood, including red blood cells. The diminished blood volume causes a markedly lessened cardiac output and reduced peripheral circulation. This results in reduction of oxygen transported to the tissues (hypoxia); reduction of perfusion, the circulation of blood within an organ; and reduction of

waste products transported away from the tissue cells. Under these conditions, body cells are able to carry on their normal functions for only a short period of time. The body tries to restore the circulatory volume by supplying fluid from the body tissues. The result is a progressive fall in the hematocrit (ratio of red blood cells to plasma) and in the red blood cell count.

Burn Shock

In burn shock, on the other hand, there is a progressive increase in the hematocrit and red blood cell count. This increase is due to hemoconcentration from loss of the plasma fraction of the blood into and through the burned area.

NEUROGENIC SHOCK

Neurogenic shock, sometimes called vasogenic shock, results from the disruption of autonomic nervous system control over vasoconstriction. Under normal conditions, the autonomic nervous system keeps the muscles of the veins and arteries partially contracted. At the onset of most forms of shock, further constriction is signaled. However, the vascular muscles cannot maintain this contraction indefinitely. A number of factors, including increased fluid loss, central nervous system trauma, or emotional shock, can override the autonomic nervous system control. The veins and arteries immediately dilate, drastically expanding the volume of the circulatory system, with a corresponding reduction of blood pressure.

Simple fainting (syncope) is a variation of neurogenic shock. It often is the result of a temporary gravitational pooling of the blood as a person stands up. As the person falls, blood again rushes to the head, and the problem is solved. Neurogenic shock may also be induced by fear or horror, which will override the autonomic nervous system control.

Shell shock and bomb shock are other variations of neurogenic shock that are important to the Hospital Corpsman. These are psychological adjustment reactions to extremely stressful wartime experiences and do not relate to the collapse of the cardiovascular system. Symptoms range from intense fear to complete dementia and are manifestations of a loss of nervous control. Care is limited to emotional support of the patient and his evacuation to the care of a psychiatrist or psychologist.

CARDIOGENIC SHOCK

Cardiogenic shock is caused by inadequate functioning of the heart, not by loss of circulating blood volume. If the heart muscle is weakened by disease or damaged by trauma or lack of oxygen (as in cases of pulmonary disease, suffocation, or myocardial infarction), the heart will no longer be able to maintain adequate circulatory pressure, even though the volume of fluid is unchanged. Shock will develop as the pressure falls. Heart attack is an extreme medical emergency all Hospital Corpsmen must be ready to handle. It will be discussed in greater detail in the "Common Medical Emergencies" section of this chapter.

SEPTIC SHOCK

Septic shock usually does not develop for 2 to 5 days after an injury and the patient is not often seen by the Corpsman in a first aid situation. Septic shock may appear during the course of peritonitis caused by penetrating abdominal wounds or perforation of the appendix. Gross wound contamination, rupture of an ulcer, or complications from certain types of pneumonia may also cause septic shock. Septic shock is the result of vasodilation of small blood vessels in the wound area, or general vasodilation if the infection enters the bloodstream. In addition to increasing circulatory system volume, the walls of the blood vessels become more permeable, which allows fluids to escape into the tissues. This type of shock carries a poor prognosis and should be treated under the direct supervision of a medical officer.

ANAPHYLACTIC SHOCK

Anaphylactic shock occurs when an individual is exposed to a substance to which his body is particularly sensitive. In the most severe form of anaphylactic shock, the body goes into an almost instantaneous violent reaction. A burning sensation, itching, and hives spread across the skin. Severe edema affects body parts and the respiratory system. Blood pressure drops alarmingly, and fainting or coma may occur.

The causative agent may be introduced into the body in a number of ways. The injection of medicines (especially penicillin and horse- or egg-cultured serums) is one route. Another method is the injection of venoms by stinging insects and animals. The inhalation of dusts, pollens, or other materials to which a person is sensitive is a third route. Finally, a slightly

slower but no less severe reaction may develop from the ingestion of certain foods and medications. Specific treatment of venoms and poisons will be discussed in chapter 5, "Poisoning, Drug Abuse, and Hazardous Material Exposure."

GENERAL TREATMENT PROCEDURES

Intravenous fluid administration is the most important factor in the treatment of all types of shock except cardiogenic shock. Ringer's lactate is the best solution to use, although normal saline is adequate until properly cross-matched whole blood can be administered. The electrolyte solutions replace not only the lost blood volume, but also lost extracellular fluid that has been depleted. If the shock is severe enough to warrant immediate administration of intravenous fluids, or if transportation to a medical facility will be delayed and a medical officer is not available to write an administrative order, be conservative: Start the intravenous fluids and let them run at a slow rate of 50 to 60 drops per minute. If intravenous solutions are unavailable or transportation to a medical treatment facility will be delayed, and there are no contraindications (such as gastrointestinal bleeding or unconsciousness), you may give the patient an electrolyte solution by mouth. An electrolyte solution may be prepared by adding a teaspoon of salt and half a teaspoon of baking soda to a quart or liter of water. Allow the patient to sip the solution.

Other treatment procedures for shock are as follows:

- Maintain an open airway. Oxygen may also be administered if proper equipment is available.
- Control hemorrhages.
- Check for other injuries that may have been sustained. Remove the victim from the presence of identifiable causative agents.
- Place the victim in a supine position, with the feet slightly higher than the head (shock position). Certain problems, such as breathing difficulties or head injuries, may require other positioning.
- Reduce pain by splinting fractures, providing emotional support, and attending to the victim's comfort. Unless contraindicated, aspirin may be dispensed.
- Conserve the patient's body heat.

- Avoid rough handling of the victim, and transport to a medical treatment facility.
- If transportation to a definitive care facility will be lengthy or delayed, seek the radio or phone advice of a medical officer on whether to give fluids by mouth or to start an intravenous line. If this consultation is impossible, use your own judgment. In the case of cardiogenic shock, DO NOT start intravenous fluids since blood volume is sufficient and only function is impaired.
- Constantly monitor the patient and record vital signs every 15 minutes so that you are able to keep track of the patient's progress.

PNEUMATIC COUNTER-PRESSURE DEVICES (MAST)

Commonly known as Medical Anti-Shock Trousers or Military Anti-Shock Trousers (MAST), pneumatic counter-pressure devices are designed to correct or counteract certain internal bleeding conditions and hypovolemia. The garment does this by developing an encircling pressure up to 120 mm Hg around both lower extremities, the pelvis, and the abdomen. The pressure created

- slows or stops venous and arterial bleeding in areas of the body enclosed by the pressurized garment;
- forces available blood from the lower body to the heart, brain, and other vital organs;
- prevents pooling of blood in the lower extremities; and
- stabilizes fractures of the pelvis and lower extremities.

Some indications for use of the pneumatic counter-pressure devices are when

- systolic blood pressure is less than 80 mm Hg,
- systolic blood pressure is less than 100 mm Hg and the patient exhibits the classic signs of shock, or
- fracture of the pelvis or lower extremities is present.

Although the only absolute contraindication in the use of these devices is in the case of pulmonary edema, other conditional contraindications include congestive heart failure, heart attack, stroke, pregnancy, abdominal evisceration, massive bleeding into the

thoracic cavity, and penetrating wounds where the object is still impaled in the victim.

Application of the anti-shock garment is a simple procedure, but it requires some important preliminary steps. When the garment is laid out flat, ensure that there are no wrinkles. If the patient is to remain clothed, remove all sharp and bulky objects from the patient's pockets. Take vital signs before applying the MAST garment. When applying the garment, inflate sufficiently so the patient's systolic blood pressure is brought to and maintained at 100 mm Hg. Once the garment is inflated, take the patient's vital signs every 5 minutes. The garment should be removed only under the direct supervision of a physician.

BREATHING AIDS

LEARNING OBJECTIVE: *Recognize breathing aids and their uses.*

As a Hospital Corpsman, you should become familiar with the breathing aids that may be available to help you maintain an open airway and to restore breathing in emergency situations. Breathing aids include oxygen, artificial airways, bag-valve mask ventilator, pocket face mask, and suction devices.

USE OF OXYGEN (O₂)

In an emergency situation, you will probably have a size E, 650-liter cylinder of oxygen available. The oxygen cylinder is usually fitted with a yoke-style pressure-reducing regulator, with gauges to show tank pressure and flow rate (adjustable from 0 to 15 liters per minute). A humidifier can be attached to the flowmeter nipple to help prevent tissue drying caused by the water-vapor-free oxygen. An oxygen line can be connected from the flowmeter nipple or humidifier to a number of oxygen delivery devices that will be discussed later.

When available, oxygen should be administered, as described below, to cardiac arrest patients and to self-ventilating patients who are unable to inhale enough oxygen to prevent **hypoxia** (oxygen deficiency). Hypoxia is characterized by tachycardia, nervousness, irritability, and finally cyanosis. It develops in a wide range of situations, including poisoning, shock, crushing chest injuries, cerebrospinal accidents, and heart attacks.

Oxygen must never be used near open flames since it supports burning. Oxygen cylinders must be handled carefully since they are potentially lethal missiles if punctured or broken.

ARTIFICIAL AIRWAYS

The oropharyngeal and nasopharyngeal airways are primarily used to keep the tongue from occluding (closing) the airway.

Oropharyngeal Airway

The oropharyngeal airway can be used only on unconscious victims because a conscious person will gag on it. This airway comes in various sizes for different age groups and is shaped to rest on the contour of the tongue and extend from the lips to the pharynx. Selecting the correct size oropharyngeal airway is very important to its effectiveness. An airway of proper size will extend from the corner of the patient's mouth to the tip of the earlobe on the same side of the patient's face.

One method of insertion is to depress the tongue with a tongue blade and slide the airway in. Another method is to insert the airway upside down into the victim's mouth; then rotate it 180° as it slides into the pharynx (fig. 4-20).

Nasopharyngeal Airway

The nasopharyngeal airway may be used on conscious victims since it is better tolerated because it generally does not stimulate the gag reflex. Since it is

made of flexible material, it is designed to be lubricated and then gently passed up the nostril and down into the pharynx. If the airway meets an obstruction in one nostril, withdraw it and try to pass it up the other nostril. See figure 4-21 for proper insertion of the nasopharyngeal airway.

BAG-VALVE MASK VENTILATOR

The bag-valve mask ventilator (fig. 4-22) is designed to help ventilate an unconscious victim for long periods while delivering high concentrations of oxygen. This system can be useful in extended CPR attempts because, when using external cardiac compressions, the cardiac output is cut to 25 to 30 percent of the normal capacity, and artificial ventilation does not supply enough oxygen through the circulatory system to maintain life for a long period.

Various types of bag-valve-mask systems that come in both adult and pediatric sizes are in use in the Navy. Essentially, they consist of a self-filling ventilation bag, an oxygen reservoir, plastic face masks of various sizes, and tubing for connecting to an oxygen supply.



Figure 4-20.—The rotation method of inserting an oropharyngeal airway.



Figure 4-21.—Proper insertion of a nasopharyngeal airway.

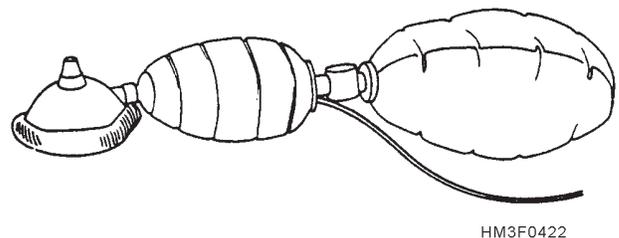


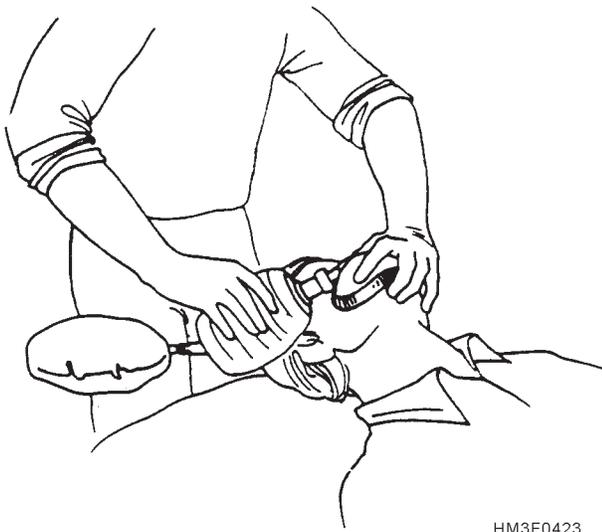
Figure 4-22.—Bag-valve mask ventilator.

Limitations of the Bag-Valve Mask Ventilator

The bag-valve mask ventilator is difficult to use unless the user has had sufficient practice with it. It must not be used by inexperienced individuals. The system can be hard to clean and reassemble properly; the bagging hand can tire easily; and an airtight seal at the face is hard to maintain, especially if a single rescuer must also keep the airway open. In addition, the amount of air delivered to the victim is limited to the volume that the hand can displace from the bag (approximately 1 liter per compression).

Procedures for Operating the Bag-Valve Mask Ventilator

To use the bag-valve mask ventilator, hook the bag up to an oxygen supply and adjust the flow in the range of 10 to 15 liters per minute, depending on the desired concentration (15 liters per minute will deliver an oxygen concentration of 90 percent). After opening the airway or inserting an oropharyngeal airway, place the mask over the face and hold it firmly in position with the index finger and thumb, while keeping the jaw tilted upward with the remaining fingers (fig. 4-23). Use the other hand to compress the bag once every 5 seconds. Observe the chest for expansion. If none is observed, the face mask seal may not be airtight, the



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Figure 4-23.—Bag-valve mask ventilator in use.

airway may be blocked, or some component of the bag-valve mask ventilator may be malfunctioning.

POCKET FACE MASK

A pocket face mask designed with an oxygen-inlet flow valve for mouth-to-mask ventilation can be used to give oxygen-enriched artificial ventilation. Although a pocket face mask system cannot achieve oxygen concentrations as high as the bag-valve mask system, it has the advantages of providing greater air volume (up to 4 liters per breath) and of being much easier to use (since both hands are free to maintain the airway and keep the mask firmly in place). See figure 4-24. The pocket face mask also acts as a barrier device. It prevents the rescuer from coming in contact with the patient's body fluids and breath, which are possible sources of infection.

To use the pocket face mask, stand behind the head of the victim, and open the airway by tilting the head backward. Place the mask over the victim's face (for adults, the apex goes over the bridge of the nose; for infants, the apex fits over the chin, with the base resting on the bridge of the nose). Form an airtight seal between the mask and the face, and keep the airway open by pressing down on the mask with both thumbs while using the other fingers to lift the jaw up and back. Ventilate into the open chimney of the mask.



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Figure 4-24.—Providing mouth-to-mask ventilations with pocket face mask.

Oxygen can be added by hooking the valve up to an oxygen supply. Since the rescuer's breath dilutes the oxygen flow in artificial ventilation, adjust the flow rate to increase oxygen concentration. At 5 liters per minute, the oxygen concentration will be approximately 50 percent. At 15 liters per minute, this concentration will increase to 55 percent.

The mask has an elastic strap so it can be used on conscious, self-ventilating patients to increase oxygen concentration.

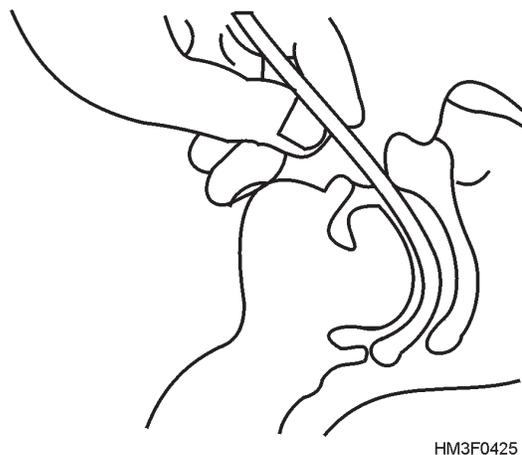
SUCTION DEVICES

The patient's airway must be kept clear of foreign materials, blood, vomitus, and other secretions. Materials that remain in the airway may be forced into the trachea and eventually into the lungs. This will cause complications ranging from severe pneumonia to a complete airway obstruction. Use suction to remove such materials.

In the field, a Hospital Corpsman may have access to a fixed (installed) suction unit or a portable suction device. Both types of suction devices are equipped with flexible tubing, suction tips and catheters, and a non-breakable collection container.

Maintenance of suction devices consists of testing the suction pressure regularly and cleaning the device after each use.

Before using a suction device, always test the apparatus. Once the suction pressure has been tested, attach a suction catheter or tip. Position the patient on his side, and open the patient's mouth. This position permits secretions to flow from the patient's mouth while suction is being delivered. Use caution in patients with suspected neck or spinal injuries. If the patient is fully and securely immobilized on a backboard, the backboard may be tilted to place the patient on his side. If you suspect such injuries but the patient is not immobilized, suction as best you can without turning the patient. Carefully insert the suction tip or catheter at the top of the throat (fig. 4-25). **DO NOT** push the tip down into the throat or into the larynx. Apply suction, but for no more than a few seconds, since supplemental oxygen or ventilations cease while suctioning, keeping oxygen from the patient. Suction may be repeated after a few breaths.

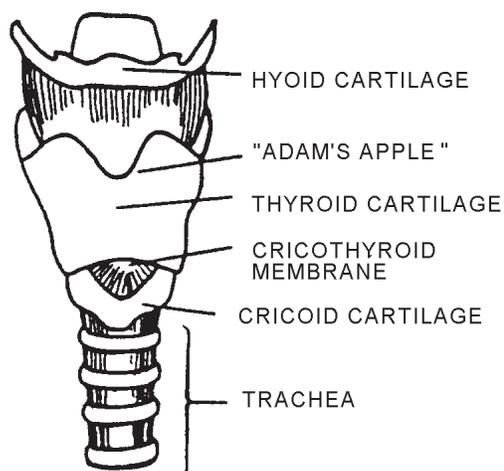


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Figure 4-25.—Proper insertion of suction tip.

CRICOTHYROIDOTOMY

A cricothyroidotomy, often called an emergency tracheotomy, consists of incising the cricothyroid membrane, which lies just beneath the skin between the thyroid cartilage and the cricoid cartilage. In most cases, the cricothyroid membrane can be easily located by hyperextending the neck so that the thyroid notch (Adam's apple) becomes prominent anteriorly. Identify the position of the thyroid notch with the index finger. This finger descends in the midline to the prominence of the cricoid cartilage. The depression of the cricothyroid membrane is identified above the superior margin of the cricoid cartilage (fig. 4-26). Make a small lateral incision at the base of the thyroid cartilage to expose the cricothyroid membrane. Excise this membrane (taking care not to go too deeply) and insert a small-bore air line into the trachea.



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Figure 4-26.—Anatomical structures of the neck to identify the cricothyroid membrane.

An alternate method is to use a 12- to 16-gauge inter catheter. Locate the cricothyroid membrane as described above and insert the needle into the trachea. Immediately upon penetration of the cricothyroid membrane, thread the plastic catheter into the trachea and remove the needle. Then connect the catheter to an oxygen line for translaryngeal oxygen jet insufflation.

Do not attempt a cricothyroidotomy except as a last resort when other methods of opening the airway have been unsuccessful.

SOFT TISSUE INJURIES

LEARNING OBJECTIVE: *Recognize the different types of wounds, and determine management and treatment procedures for open and internal soft-tissue injuries.*

The most common injuries seen by the Corpsman in a first aid setting are soft tissue injuries with the accompanying hemorrhage, shock, and danger of infection. Any injury that causes a break in the skin, underlying soft tissue structures, or body membranes is known as a **wound**. This section will discuss the classification of wounds, the general and specific treatment of soft tissue injuries, the use of dressings and bandages in treating wounds, and the special problems that arise because of the location of wounds.

CLASSIFICATION OF WOUNDS

Wounds may be classified according to their general condition, size, location, the manner in which the skin or tissue is broken, and the agent that caused the wound. It is usually necessary for you to consider these factors to determine what first aid treatment is appropriate for the wound.

General Condition of the Wound

If the wound is fresh, first aid treatment consists mainly of stopping the flow of blood, treating for shock, and reducing the risk of infection. If the wound is already infected, first aid consists of keeping the victim quiet, elevating the injured part, and applying a warm wet dressing. If the wound contains foreign objects, first aid treatment may consist of removing the objects if they are not deeply embedded. **DO NOT** remove objects embedded in the eyes or the skull, and **do not** remove impaled objects. Stabilize impaled

objects with a bulky dressing before transporting the victim.

Size of the Wound

In general, since large wounds are more serious than small ones, they usually involve more severe bleeding, more damage to the underlying organs or tissues, and a greater degree of shock. However, small wounds are sometimes more dangerous than large ones since they may become infected more readily due to neglect. The depth of the wound is also important because it may lead to a complete perforation of an organ or the body, with the additional complication of entrance and exit wounds.

Location of the Wound

Since a wound may involve serious damage to the deeper structures, as well as to the skin and the tissue immediately below it, the location of the wound is important. For example, a knife wound to the chest may puncture a lung and cause interference with breathing. The same type of wound in the abdomen may result in a dangerous infection in the abdominal cavity, or it might puncture the intestines, liver, kidneys, or other vital organs. A knife wound to the head may cause brain damage, but the same wound in a less vital spot (such as an arm or leg) might be less important.

Types of Wounds

When you consider the manner in which the skin or tissue is broken, there are six general kinds of wounds: abrasions, incisions, lacerations, punctures, avulsions, and amputations. Many wounds, of course, are combinations of two or more of these basic types.

ABRASIONS.—Abrasions are made when the skin is rubbed or scraped off. Rope burns, floor burns, and skinned knees or elbows are common examples of abrasions. This kind of wound can become infected quite easily because dirt and germs are usually embedded in the tissues.

INCISIONS.—Incisions, commonly called cuts, are wounds made by sharp cutting instruments such as knives, razors, and broken glass. Incisions tend to bleed freely because the blood vessels are cut cleanly and without ragged edges. There is little damage to the surrounding tissues. Of all classes of wounds, incisions are the least likely to become infected, since

the free flow of blood washes out many of the microorganisms (germs) that cause infection.

LACERATIONS.—These wounds are torn, rather than cut. They have ragged, irregular edges and masses of torn tissue underneath. These wounds are usually made by blunt (as opposed to sharp) objects. A wound made by a dull knife, for instance, is more likely to be a laceration than an incision. Bomb fragments often cause lacerations. Many of the wounds caused by accidents with machinery are lacerations; they are often complicated by crushing of the tissues as well. Lacerations are frequently contaminated with dirt, grease, or other material that is ground into the tissue. They are therefore very likely to become infected.

PUNCTURES.—Punctures are caused by objects that penetrate into the tissues while leaving a small surface opening. Wounds made by nails, needles, wire, and bullets are usually punctures. As a rule, small puncture wounds do not bleed freely; however, large puncture wounds may cause severe internal bleeding. The possibility of infection is great in all puncture wounds, especially if the penetrating object has tetanus bacteria on it. To prevent anaerobic infections, primary closures are not made in the case of puncture wounds.

AVULSIONS.—An avulsion is the tearing away of tissue from a body part. Bleeding is usually heavy. In certain situations, the torn tissue may be surgically reattached. It can be saved for medical evaluation by wrapping it in a sterile dressing and placing it in a cool container, and rushing it—along with the victim—to a medical facility. Do not allow the avulsed portion to freeze, and do not immerse it in water or saline.

AMPUTATIONS.—A traumatic amputation is the nonsurgical removal of the limb from the body. Bleeding is heavy and requires a tourniquet (which will be discussed later) to stop the flow. Shock is certain to develop in these cases. As with avulsed tissue, wrap the limb in a sterile dressing, place it in a cool container, and transport it to the hospital with the victim. Do not allow the limb to be in direct contact with ice, and do not immerse it in water or saline. The limb can often be successfully reattached.

Causes of Wounds

Although it is not always necessary to know what agent or object has caused the wound, it is helpful. Knowing what has caused the wound may give you some idea of the probable size of the wound, its general nature, the extent to which it is likely to become

contaminated with foreign matter, and what special dangers must be guarded against. Of special concern in a wartime setting is the velocity of wound-causing missiles (bullets or shrapnel). A low-velocity missile damages only the tissues it comes into contact with. On the other hand, a high-velocity missile can do enormous damage by forcing the tissues and body parts away from the track of the missile with a velocity only slightly less than that of the missile itself. These tissues, especially bone, may become damage-causing missiles themselves, thus accentuating the destructive effects of the missile.

Having classified the wound into one or more of the general categories listed, the Corpsman will have a good idea of the nature and extent of the injury, along with any special complications that may exist. This information will aid in the treatment of the victim.

MANAGEMENT OF OPEN SOFT-TISSUE INJURIES

There are three basic rules to be followed in the treatment of practically all open soft tissue injuries: to control hemorrhage, to treat the victim for shock, and to do whatever you can to prevent infection. These will be discussed, along with the proper application of first aid materials and other specific first aid techniques.

Hemorrhage

Hemorrhage is the escape of blood from the vessels of the circulatory system. The average adult body contains about 5 liters of blood. Five hundred milliliters of blood, the amount given by blood donors, can usually be lost without any harmful effect. The loss of 1 liter of blood usually causes shock, but shock may develop if small amounts of blood are lost rapidly, since the circulatory system does not have enough time to compensate adequately. The degree of shock progressively increases as greater amounts of blood escape. Young children, sick people, or the elderly may be especially susceptible to the loss of even small amounts of blood since their internal systems are in such delicate balance.

Capillary blood is usually brick red in color. If capillaries are cut, the blood oozes out slowly. Blood from the veins is dark red. Venous bleeding is characterized by a steady, even flow. If an artery near the surface is cut, the blood, which is bright red in color, will gush out in spurts that are synchronized with the heartbeats. If the severed artery is deeply buried,

however, the bleeding will appear to be a steady stream.

In actual practice, you might find it difficult to decide whether bleeding is venous or arterial, but the distinction is not usually important. The important thing to know is that all bleeding must be controlled as quickly as possible.

External hemorrhage is of greatest importance to the Corpsman because it is the most frequently encountered and the easiest to control. It is characterized by a break in the skin and visible bleeding. Internal hemorrhage (which will be discussed later) is far more difficult to recognize and to control.

Control of Hemorrhage

The best way to control external bleeding is by applying a compress to the wound and exerting pressure directly to the wound. If direct pressure does not stop the bleeding, pressure can also be applied at an appropriate pressure point. At times, elevation of an extremity is also helpful in controlling hemorrhage. The use of splints in conjunction with direct pressure can be beneficial. In those rare cases where bleeding cannot be controlled by any of these methods, you must use a tourniquet.

If bleeding does not stop after a short period, try placing another compress or dressing over the first and securing it firmly in place. If bleeding still will not stop, try applying direct pressure with your hand over the compress or dressing.

Remember that in cases of severe hemorrhage, it is less important to worry too much about finding appropriate materials or about the dangers of infection. The most important problem is to stop rapid exsanguination. If no material is available, simply thrust your hand into the wound. In most situations, direct pressure is the first and best method to use in the control of hemorrhage.

Pressure Points

Bleeding can often be temporarily controlled by applying hand pressure to the appropriate pressure point. A pressure point is the spot where the main artery to an injured part lies near the skin surface and over a bone. Apply pressure at this point with the fingers (digital pressure) or with the heel of the hand. No first aid materials are required. The object of the pressure is to compress the artery against the bone, thus

shutting off the flow of blood from the heart to the wound.

There are 11 principal points on each side of the body where hand or finger pressure can be used to stop hemorrhage. These points are shown in figure 4-27. If bleeding occurs on the face below the level of the eyes, apply pressure to the point on the mandible. This is shown in figure 4-27A. To find this pressure point, start at the angle of the jaw and run your finger forward along the lower edge of the mandible until you feel a small notch. The pressure point is in this notch.

If bleeding is in the shoulder or in the upper part of the arm, apply pressure with the fingers behind the clavicle. You can press down against the first rib or forward against the clavicle; either kind of pressure will stop the bleeding. This pressure point is shown in figure 4-27B.

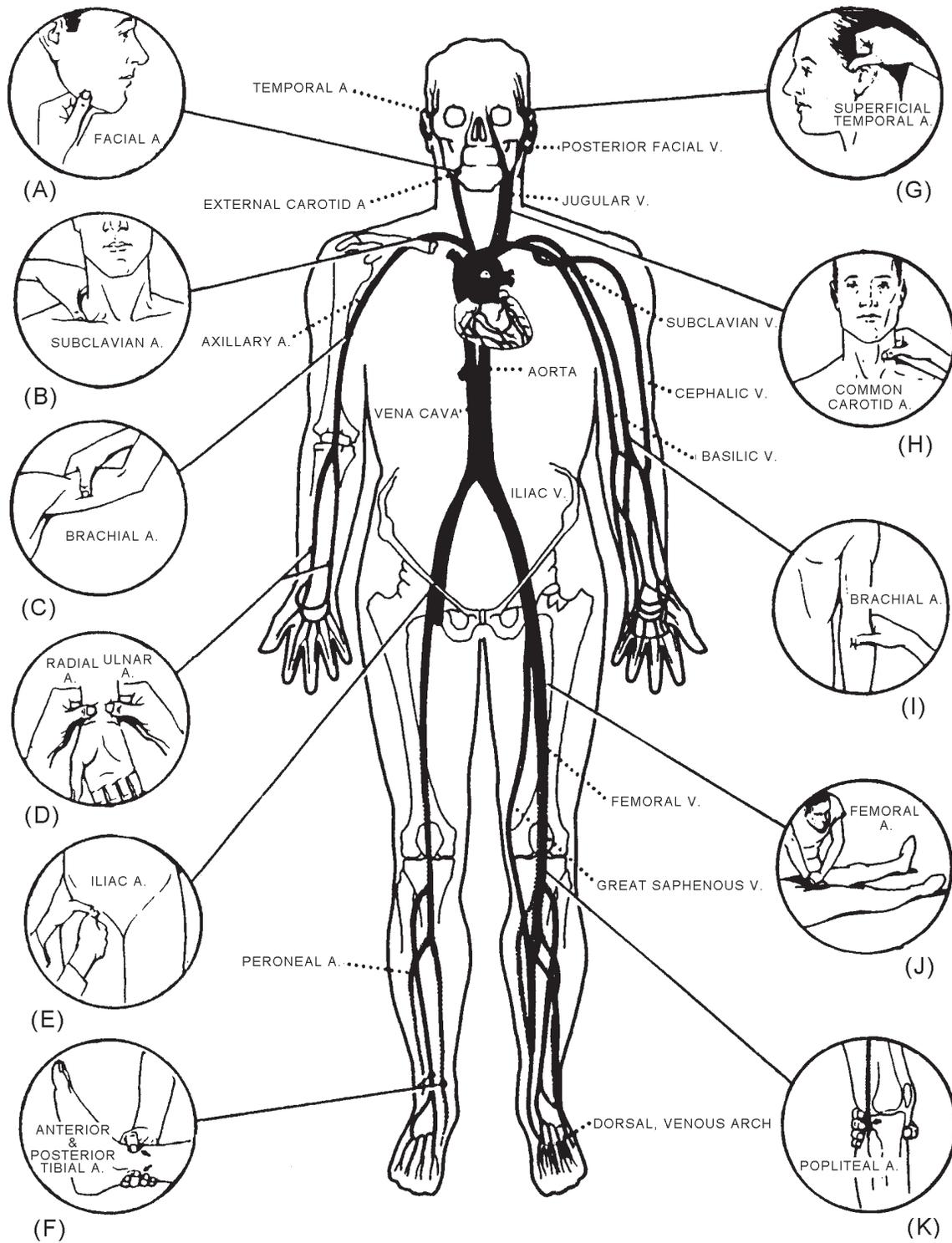
Bleeding between the middle of the upper arm and the elbow should be controlled by applying digital pressure to the inner (body) side of the arm, about halfway between the shoulder and the elbow. This compresses the artery against the bone of the arm. The application of pressure at this point is shown in figure 4-27C. Bleeding from the hand can be controlled by pressure at the wrist, as shown in figure 4-27D. If it is possible to hold the arm up in the air, the bleeding will be relatively easy to stop.

Figure 4-27E shows how to apply digital pressure in the middle of the groin to control bleeding from the thigh. The artery at this point lies over a bone and quite close to the surface, so pressure with your fingers may be sufficient to stop the bleeding.

Figure 4-27F shows the proper position for controlling bleeding from the foot. As in the case of bleeding from the hand, elevation is helpful in controlling the bleeding.

If bleeding is in the region of the temple or the scalp, use your finger to compress the main artery to the temple against the skull bone at the pressure point just in front of the ear. Figure 4-27G shows the proper position.

If the neck is bleeding, apply pressure below the wound, just in front of the prominent neck muscle. Press inward and slightly backward, compressing the main artery of that side of the neck against the bones of the spinal column. The application of pressure at this point is shown in figure 4-27H. Do not apply pressure at this point unless it is absolutely essential, since there



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Figure 4-27.—Pressure points.

is a great danger of pressing on the windpipe, thereby choking the victim.

Bleeding from the lower arm can be controlled by applying pressure at the elbow, as shown in figure 4-27I.

As mentioned before, bleeding in the upper part of the thigh can sometimes be controlled by applying digital pressure in the middle of the groin, as shown in figure 4-27E. Sometimes, however, it is more effective to use the pressure point of the upper thigh, as shown in figure 4-27J. If you use this point, apply pressure with

the closed fist of one hand and use the other hand to give additional pressure. The artery at this point is deeply buried in some of the heaviest muscle tissue in the body, so a great deal of pressure must be exerted to compress the artery against the bone.

Bleeding between the knee and the foot may be controlled by firm pressure at the knee. If pressure at the side of the knee does not stop the bleeding, hold the front of the knee with one hand and thrust your fist hard against the artery behind the knee, as shown in figure 4-27K. If necessary, you can place a folded compress or bandage behind the knee, bend the leg back, and hold it in place by a firm bandage. This is a most effective way of controlling bleeding, but it is so uncomfortable for the victim that it should be used only as a last resort.

You should memorize these pressure points so that you will know immediately which point to use for controlling hemorrhage from a particular part of the body. Remember, the correct pressure point is that which is (1) **nearest the wound**, and (2) **between the wound and the main part of the body**.

It is very tiring to apply digital pressure, and it can seldom be maintained for more than 15 minutes. Pressure points are recommended for use while direct pressure is being applied to a serious wound by a second rescuer. Using the pressure-point technique is also advised after a compress, bandage, or dressing has been applied to the wound, since this method will slow the flow of blood to the area, thus giving the direct pressure technique a better chance to stop the hemorrhage. The pressure-point system is also recommended as a stopgap measure until a pressure dressing or a tourniquet can be applied.

Elevation

The elevation of an extremity, where appropriate, can be an effective aid in hemorrhage control when used in conjunction with other methods of control, especially direct pressure. This is because the amount of blood entering the extremity is decreased by the uphill gravitational effect. Do not elevate an extremity until it is certain that no bones have been broken or until broken bones are properly splinted.

Splints

Another effective method of hemorrhage control in cases of bone fractures is splinting. The immobilization of sharp bone ends reduces further tissue trauma and allows lacerated blood vessels to

clot. In addition, the gentle pressure exerted by the splint helps the clotting process by giving additional support to compresses or dressings already in place over open fracture sites.

Later in this chapter we will go into the subject of splinting in greater detail.

Tourniquets

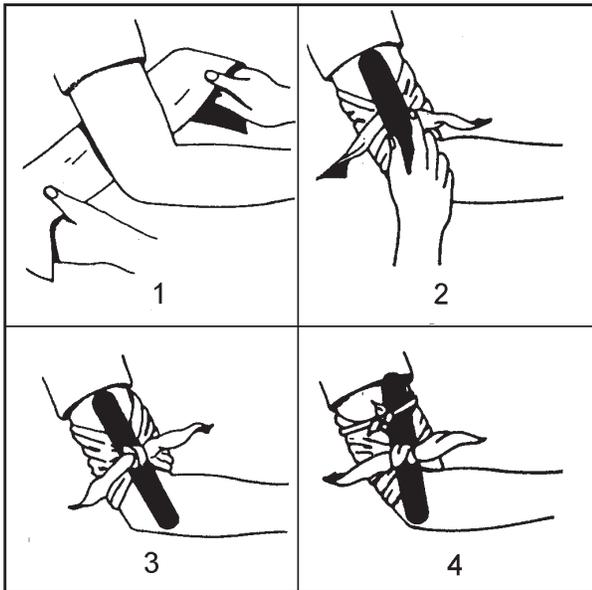
A tourniquet is a constricting band that is used to cut off the supply of blood to an injured limb. Use a tourniquet **only as a last resort** and if the control of hemorrhage by other means proves to be difficult or impossible. A tourniquet must always be applied **above** the wound (i.e., toward the trunk), and it must be applied as close to the wound as practical.

Basically, a tourniquet consists of a pad, a band, and a device for tightening the band so that the blood vessels will be compressed. It is best to use a pad, compress, or similar pressure object, if one is available. The pressure object goes under the band and must be placed directly over the artery or it will actually decrease the pressure on the artery, allowing a greater flow of blood. If a tourniquet placed over a pressure object does not stop the bleeding, there is a good chance that the pressure object is in the wrong place. If placement is not effective, shift the object around until the tourniquet, when tightened, will control the bleeding.

Any long flat material may be used as the band. It is important that the band be flat: belts, stockings, flat strips of rubber, or neckerchiefs may be used; however, rope, wire, string, or very narrow pieces of cloth should not be used because they can cut into the flesh. A short stick may be used to twist the band, tightening the tourniquet. Figure 4-28 shows the proper steps in applying a tourniquet.

To be effective, a tourniquet must be tight enough to stop the arterial blood flow to the limb. Be sure, therefore, to draw the tourniquet tight enough to stop the bleeding. Do not make it any tighter than necessary, though, since a tourniquet that is too tight can lead to loss of the limb the tourniquet is applied to.

After you have brought the bleeding under control with the tourniquet, apply a sterile compress or dressing to the wound and fasten it in position with a bandage.



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Figure 4-28.—Applying a tourniquet.

Here are the points to remember about using a tourniquet:

1. **Use a tourniquet only as a last resort!** Don't use a tourniquet unless you can't control the bleeding by any other means.
2. Don't use a tourniquet for bleeding from the head, face, neck, or trunk. Use it only on the limbs.
3. Always apply a tourniquet **above the wound** and as close to the wound as possible. As a general rule, do not place a tourniquet below the knee or elbow except for complete amputations. In certain distal areas of the extremities, nerves lie close to the skin and may be damaged by the compression. Furthermore, rarely does one encounter bleeding distal to the knee or elbow that requires a tourniquet.
4. Be sure you draw the tourniquet tight enough to stop the bleeding, but don't make it any tighter than necessary. The pulse beyond the tourniquet should disappear.
5. **Don't loosen a tourniquet after it has been applied.** Transport the victim to a medical facility that can offer proper care.
6. Don't cover a tourniquet with a dressing. If it is necessary to cover the injured person in some way, **make sure** that all the other people concerned with the case know about the

tourniquet. Using crayon, skin pencil, or blood, mark a large "T" and the time the tourniquet was applied on the victim's forehead or on a medical tag attached to the wrist.

MANAGEMENT OF INTERNAL SOFT-TISSUE INJURIES

Internal soft-tissue injuries may result from deep wounds, blunt trauma, blast exposure, crushing accidents, bone fracture, poison, or sickness. They may range in seriousness from a simple contusion to life-threatening hemorrhage and shock.

Visible Indications

Visible indications of internal soft-tissue injury include the following:

- Hematemesis (vomiting bright red blood)
- Hemoptysis (coughing up bright red blood)
- Melena (excretion of tarry black stools)
- Hematochezia (excretion of bright red blood from the rectum)
- Hematuria (passing of blood in the urine)
- Nonmenstrual (vaginal bleeding)
- Epistaxis (nosebleed)
- Pooling of the blood near the skin surface

Other Symptoms

More often than not, however, there will be no visible signs of injury, and the Corpsman will have to infer the probability of internal soft-tissue injury from other symptoms such as the following:

- Pale, moist, clammy skin
- Subnormal temperature
- Rapid, feeble pulse
- Falling blood pressure
- Dilated, slowly reacting pupils with impaired vision
- Tinnitus
- Syncope
- Dehydration and thirst
- Yawning and air hunger
- Anxiety, with a feeling of impending doom

Immediate Treatment

There is little that a Corpsman can do to correct internal soft-tissue injuries since they are almost always surgical problems. The Hospital Corpsman's goal must be to obtain the greatest benefit from the victim's remaining blood supply. The following steps should be taken:

1. Treat for shock.
2. Keep the victim warm and at rest.
3. Replace lost fluids with a suitable blood volume expander. DO NOT give the victim anything to drink until the extent of the injury is known for certain.
4. Give oxygen, if available.
5. Splint injured extremities.
6. Apply cold compresses to identifiable injured areas.
7. Transport the victim to a medical treatment facility as soon as possible.

SPECIAL CONSIDERATIONS IN WOUND TREATMENT

There are special considerations that should be observed when treating wounds. The first of these is immediate treatment to prevent shock. Next, infection should be a concern: Look for inflammation and signs of abscess. Hospital Corpsmen should be aware of these conditions and have the knowledge to treat them.

Shock

Shock is likely to be severe in a person who has lost a large amount of blood or suffered any serious wound. The causes and treatment of shock are explained earlier in this chapter.

Infection

Although infection may occur in any wound, it is a particular danger in wounds that do not bleed freely, in wounds in which torn tissue or skin falls back into place and prevents the entrance of air, and in wounds that involve the crushing of tissues. Incisions (in which there is a free flow of blood and relatively little crushing of tissues) are the least likely to become infected.

Battle wounds are especially likely to become infected. They present the problem of devitalized (dead or dying) tissue; extravasated blood (blood that has escaped its natural boundaries); foreign bodies such as missile fragments, bits of cloth, dirt, dust; and a variety of bacteria. The devitalized tissue proteins and extravasated blood provide a nutritional medium for the support of bacterial growth and thus are conducive to the development of serious wound infection. Puncture wounds are also likely to become infected by the germs causing tetanus.

COMMON INFECTION-CAUSING BACTERIA.—

There are two types of bacteria that commonly cause infection in wounds: aerobic and anaerobic. Aerobic bacteria live and multiply in the presence of air or free oxygen, while anaerobic bacteria live and multiply only in the absence of air.

Aerobic Bacteria.—The principal aerobic bacteria that cause infection, inflammation, and septicemia (blood poisoning) are streptococci and staphylococci, some varieties of which are hemolytic (destroy red blood cells). The staphylococci and streptococci may be introduced at the time of infliction, or they may be introduced to the wound later (at the time of first aid treatment or in the hospital if nonsterile instruments or dressings are employed).

Anaerobic Bacteria.—Anaerobic bacteria are widespread in soil (especially manured soil). While not invasive, anaerobic bacteria contribute to disease by producing toxins and destructive enzymes, often leading to necrosis and/or gangrene of the infected area.

MINOR WOUND CLEANING AND

DRESSING.—Wash minor wounds immediately with soap and clean water; then dry and paint them with a mild, nonirritating antiseptic. Apply a dressing if necessary. In the first aid environment, do not attempt to wash or clean a large wound, and do not apply an antiseptic to it since it must be cleaned thoroughly at a medical treatment facility. Simply protect it with a large compress or dressing, and transport the victim to a medical treatment facility. After an initial soap and water cleanup, puncture wounds must also be directed to a medical treatment facility for evaluation.

Inflammation

Inflammation is a local reaction to irritation. It occurs in tissues that are injured, but not destroyed. Symptoms include redness, pain, heat, swelling, and sometimes loss of motion.

The body's physiologic response to the irritation is to dilate local blood vessels, which increases the blood supply to the area. The increased blood flow, in turn, causes the skin to appear red and warmer. As the blood vessels dilate, their injured walls leak blood serum into surrounding tissues, causing edema and pain from increased pressure on nerve endings. In addition, white blood cells increase in the area and act as scavengers (phagocytes) in destroying bacteria and ingesting small particles of dead tissue and foreign matter.

Inflammation may be caused by trauma or mechanical irritation; chemical reaction to venom, poison ivy, acids, or alkalies; heat or cold injuries; microorganism penetration; or other agents such as electricity or solar radiation.

Inflammation should be treated by the following methods:

- Remove the irritating cause.
- Keep the inflamed area at rest and elevated.
- Apply cold for 24 to 48 hours to reduce swelling. Once swelling is reduced, apply heat to soft tissues, which hastens the removal of products of inflammation.
- Apply wet dressings and ointments to soften tissues and to rid the area of the specific causal bacteria.

Abscesses

An abscess is a localized collection of pus that forms in cavities created by the disintegration of tissue. Abscesses may follow injury, illness, or irritation. Most abscesses are caused by staphylococcal infections and may occur in any area of the body, but they are usually on the skin surface.

A **furuncle** (boil) is an abscess in the true skin caused by the entry of microorganisms through a hair follicle or sweat gland. A **carbuncle** is a group of furuncular abscesses having multiple sloughs, often interconnected under the true skin. When localized, there are several "heads." Symptoms begin with localized itching and inflammation, followed by swelling, fever, and pain. Redness and swelling localize, and the furuncle or carbuncle becomes hard and painful. Pus forms into a cavity, causing the skin to become taut and discolored.

Treatment for furuncles and carbuncles includes the following:

- **DO NOT** squeeze! Squeezing may damage surrounding healthy tissue and spread the infection.
- Use aseptic techniques when handling.
- Relieve pain with aspirin.
- Apply moist hot soaks/dressings (110°F) for 40 minutes, three to four times per day.
- Rest and elevate the infected body part.
- Antibiotic therapy may be ordered by a physician.
- Abscesses should be incised after they have localized (except on the face) to establish drainage. Abscesses in the facial triangle (nose and upper lip) should be seen by a physician.

SPECIAL WOUNDS AND THEIR TREATMENT

LEARNING OBJECTIVE: *Recall medical precautions and wound-treatment procedures for the following list of wounds: animal bites, eye wounds, head wounds, facial wounds, abdominal wounds, crushing injuries, and the removal of foreign objects.*

As a Hospital Corpsman, you should find most general wounds very easy to diagnose and treat. There are other wounds, however, that require special consideration and treatment. They are discussed below.

Eye Wounds

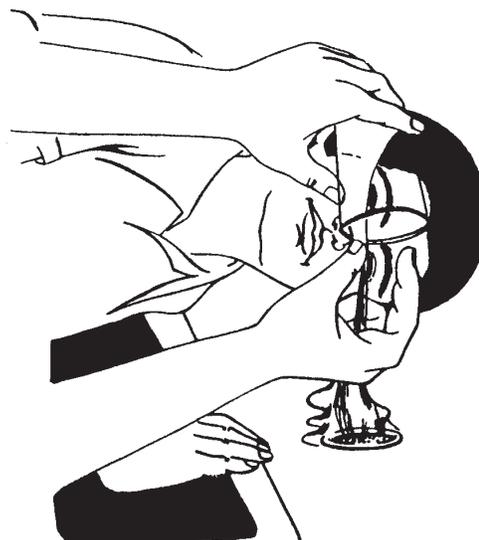
Many eye wounds contain foreign objects. Dirt, coal, cinders, eyelashes, bits of metal, and a variety of other objects may become lodged in the eye. Since even a small piece of dirt is intensely irritating to the eye, the removal of such objects is important. However, the eye is easily damaged. Impairment of vision (or even total loss of vision) can result from fumbling, inexpert attempts to remove foreign objects from the eye. The following precautions **must** be observed:

- **DO NOT** allow the victim to rub the eye.

- **DO NOT** press against the eye or manipulate it in any way that might cause the object to become embedded in the tissues of the eye. Be very gentle; roughness is almost sure to cause injury to the eye.
- **DO NOT** use such things as knives, toothpicks, matchsticks, or wires to remove the object.
- **DO NOT UNDER ANY CIRCUMSTANCES ATTEMPT TO REMOVE AN OBJECT THAT IS EMBEDDED IN THE EYEBALL OR THAT HAS PENETRATED THE EYE!** If you see a splinter or other object sticking out from the eyeball, leave it alone! Only specially trained medical personnel can hope to save the victim's sight if an object has actually penetrated the eyeball.

Small objects that are lodged on the surface of the eye or on the membrane lining the eyelids can usually be removed by the following procedures:

1. Try to wash the eye gently with lukewarm, sterile water. A sterile medicine dropper or a sterile syringe can be used for this purpose. Have the victim lie down, with the head turned slightly to one side as shown in figure 4-29. Hold the eyelids apart. Direct the flow of water to the **inside** corner of the eye, and let it run down to the **outside** corner. Do not let the water fall directly onto the eyeball.
2. Gently pull the lower lid down, and instruct the victim to look up. If you can see the object, try to remove it with the corner of a clean handkerchief or with a small moist cotton swab. You can make the swab by twisting cotton around a wooden applicator, not too tightly, and moistening it with sterile water.
CAUTION: Never use **dry** cotton anywhere near the eye. It will stick to the eyeball or to the inside of the lids, and you will have the problem of removing it as well as the original object.
3. If you cannot see the object when the lower lid is pulled down, turn the upper lid back over a smooth wooden applicator. Tell the victim to look down. Place the applicator lengthwise across the center of the upper lid. Grasp the lashes of the upper lid gently but firmly. Press gently with the applicator. Pull up on the eyelashes, turning the lid back over the applicator. If you can see the object, try to



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Figure 4-29.—Irrigating the eye.

remove it with a moist cotton swab or with the corner of a clean handkerchief.

4. If the foreign object cannot be removed by any of the above methods, **DO NOT MAKE ANY FURTHER ATTEMPTS TO REMOVE IT.** Instead, place a small, thick gauze dressing over both eyes and hold it in place with a **loose** bandage. This limits movement of the injured eye.
5. Get medical help for the victim at the earliest opportunity.

Head Wounds

Head wounds must be treated with particular care, since there is always the possibility of brain damage. The general treatment for head wounds is the same as that for other fresh wounds. However, certain special precautions must be observed if you are giving first aid to a person who has suffered a head wound.

- **NEVER GIVE ANY MEDICATIONS.**
- Keep the victim lying flat, with the head at the level of the body. Do not raise the feet if the face is flushed. If the victim is having trouble breathing, you may raise the head slightly.
- If the wound is at the back of the head, turn the victim on his side.
- Watch closely for vomiting and position the head to avoid aspiration of vomitus or saliva into the lungs.

- Do not use direct pressure to control hemorrhage if the skull is depressed or obviously fractured.

Facial Wounds

Wounds of the face are treated, in general, like other fresh wounds. However, in all facial injuries make sure neither the tongue nor injured soft tissue blocks the airway, causing breathing obstruction. Keep the nose and throat clear of any obstructing materials, and position the victim so that blood will drain out of the mouth and nose.

Facial wounds that involve the eyelids or the soft tissue around the eye must be handled carefully to avoid further damage. If the injury does not involve the eyeball, apply a sterile compress and hold it in place with a **firm** bandage. If the eyeball appears to be injured, use a **loose** bandage. (Remember that you must **NEVER** attempt to remove any object that is embedded in the eyeball or that has penetrated it; just apply a dry, sterile compress to cover both eyes, and hold the compress in place with a **loose bandage**).

Any person who has suffered a facial wound that involves the eye, the eyelids, or the tissues around the eye must receive medical attention as soon as possible. Be sure to keep the victim lying down. Use a stretcher for transport.

Chest Wounds

Since chest injuries may cause severe breathing and bleeding problems, all chest injuries must be considered as serious conditions. Any victim showing signs of difficulty in breathing without signs of airway obstruction must be inspected for chest injuries. The most serious chest injury that requires immediate first aid treatment is the **sucking chest wound**. This is a penetrating injury to the chest that produces a hole in the chest cavity. The chest hole causes the lung to collapse, preventing normal breathing functions. This is an extremely serious condition that will result in death if not treated quickly.

Victims with open chest wounds gasp for breath, have difficulty breathing out, and may have a bluish skin color to their face. Frothy-looking blood may bubble from the wound during breathing.

The proper treatment for a sucking chest wound is as follows:

1. Immediately seal the wound with a hand or any airtight material available (e.g., ID card). The

material must be large enough so that it cannot be sucked into the wound when the victim breathes in.

2. Firmly tape the material in place with strips of adhesive tape and secure it with a pressure dressing. It is important that the dressing is airtight. If it is not, it will not relieve the victim's breathing problems. The object of the dressing is to keep air from going in through the wound.

NOTE: If the victim's condition suddenly deteriorates when you apply the seal, remove it **immediately**.

3. Give the victim oxygen if it is available and you know how to use it.
4. Place the victim in a Fowler's or semi-Fowler's position. This makes breathing a little easier. During combat, lay the victim on a stretcher on the affected side.
5. Watch the victim closely for signs of shock, and treat accordingly.
6. Do not give victims with chest injuries anything to drink.
7. Transport the victim to a medical treatment facility immediately.

Abdominal Wounds

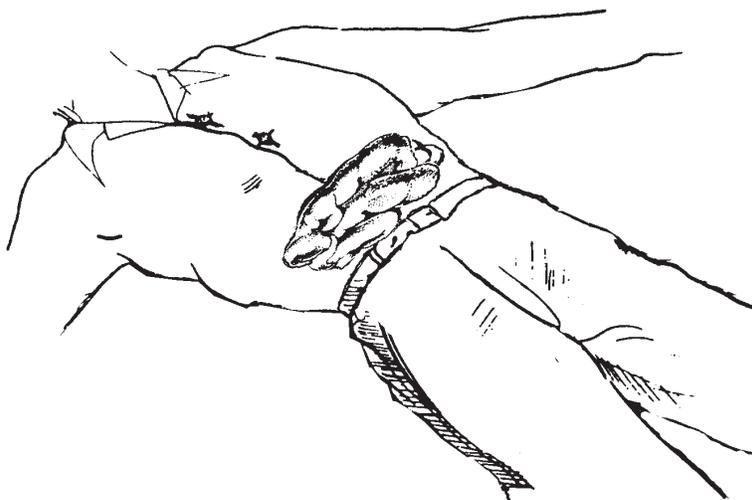
A deep wound in the abdomen is likely to constitute a major emergency since there are many vital organs in this area. Abdominal wounds usually cause intense pain, nausea and vomiting, spasm of the abdominal muscles, and severe shock. Immediate surgical treatment is almost always required; therefore, the victim must receive medical attention at once, or the chances of survival will be poor. Give only the most essential first aid treatment, and concentrate your efforts on getting the victim to a medical treatment facility. The following first aid procedures may be of help to a person suffering from an abdominal wound:

- Keep the victim in a supine position. If the intestine is protruding or exposed, the victim may be more comfortable with the knees drawn up. Place a coat, pillow, or some other bulky cloth material under the knees to help maintain this position. **DO NOT ATTEMPT TO PUSH THE INTESTINES BACK IN OR TO MANIPULATE THEM IN ANY WAY!**

- If bleeding is severe, try to stop it by applying direct pressure.
- If the intestines are not exposed, cover the wound with a dry sterile dressing. If the intestines are exposed, apply a sterile compress moistened with sterile water. If no sterile water is available, clean sea water or any water that is fit to drink may be used to moisten the compress. Figure 4-30 shows an abdominal wound with the intestine protruding. Figure 4-31 shows the application of compresses large enough to cover the wound and the surrounding area. The

compress should be held in place by a bandage. Fasten the bandage firmly so that the compress will not slip around, but do not apply any more pressure than is necessary to hold the compress in position. Large battle dressings are ideal.

- Treat for shock, but do not waste any time doing it. The victim must be transported to a hospital at the earliest possible opportunity. However, you can minimize the severity of shock by making sure that the victim is comfortably warm and kept in the supine position. **DO NOT GIVE ANYTHING TO DRINK.** If the victim is



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Figure 4-30.—Protruding abdominal wounds.



HM3F0431

Figure 4-31.—Applying compresses to a protruding abdominal wound.

thirsty, moisten the mouth with a small amount of water, but do not allow any liquid to be swallowed.

- Upon the direction of a medical officer, start an intravenous line.

Crush Injuries

Force can be transmitted from the body's exterior to its interior structure, leaving the skin intact, with a simple bruise as the only external evidence of trauma. This force can cause internal organs to be crushed or to rupture and bleed. When this happens, it is called a **crush injury**. Organs such as the liver and spleen contain a lot of blood. When crushed, these organs bleed severely, and this severe internal bleeding can cause shock. Contents of hollow organs (e.g., urine or digested food) can leak into the body cavities, causing severe inflammation and tissue damage. Bones can also be broken along with muscles, and nerves damaged. Assessment and treatment for the Hospital Corpsman can be difficult when a crush injury is involved. Treat symptomatically and evacuate to the nearest medical treatment facility as soon as possible.

Removing Foreign Objects

Many wounds contain foreign objects. Wood or glass splinters, bullets, metal fragments, bits of wire, fishhooks, nails, tacks, cinders, and small particles from grinding wheels are examples of the variety of objects or materials that are sometimes found in wounds. When such objects are near the surface and exposed, first aid treatment includes their removal. However, first aid treatment does not include the removal of deeply embedded objects, powdered glass, or any widely scattered material of this nature. You should never attempt to remove bullets, but you should try to find out whether the bullet remains in the victim. Look for both entrance and exit wounds. The general rule to remember is this: Remove foreign objects from a wound when you can do so easily and without causing further damage; but **NEVER HUNT FOR OR ATTEMPT TO REMOVE DEEPLY BURIED OR WIDELY SCATTERED OBJECTS OR MATERIALS**, except in a definitive care environment.

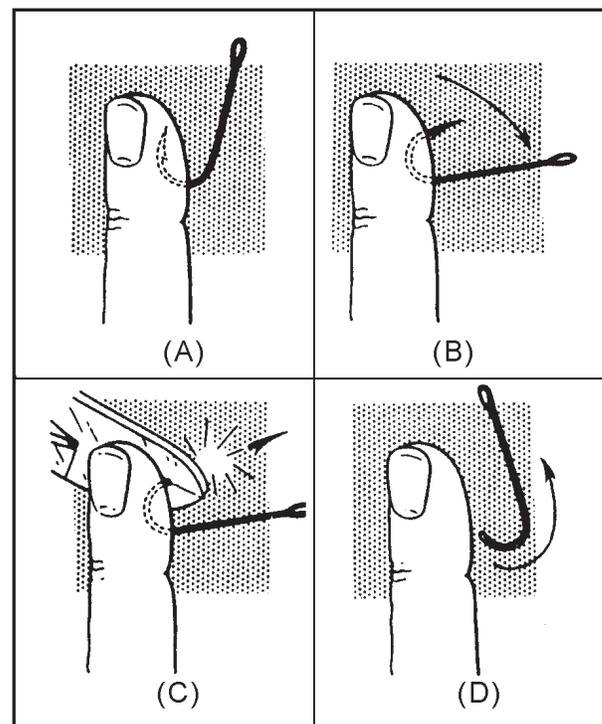
The following procedure may be used to remove a small object from the skin or tissues if the object is near the surface and clearly visible:

1. Cleanse the skin around the object with soap and water and paint with any available skin antiseptic solution.

2. If necessary, pierce the skin with a sharp instrument (a needle, razor, or sharp knife that has been sterilized by passing it through a flame several times).
3. Grasping the object at the end, remove it. Tweezers, small pincers, or forceps may be used for this purpose. (Whatever instrument you use should first be sterilized by boiling if at all possible.)
4. If the wound is superficial, apply gentle pressure to encourage bleeding.
5. Cover the wound with a dry, sterile dressing.

If the foreign object is under a fingernail or toenail, you may have to cut a V-shaped notch in the nail so that the object can be grasped by the forceps. Do not try to dig the object out from under the nail with a knife or similar instrument.

A curved or barbed object (such as a fishhook) may present special problems. Figure 4-32 shows one method of removing a fishhook that has become embedded in the flesh. As you can see from figure 4-32A, the barb on the hook prevents its direct removal. However, if you push the hook forward through the skin, as shown in figure 4-32B, you can clip off the barb with a wire cutter or similar tool, as shown in figure 4-32. The remainder of the fishhook



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Figure 4-32.—Removing a fishhook.

can then be withdrawn in the manner indicated in figure 4-32D.

Animal Bites

A special kind of infection that must be guarded against in case of animal bites is rabies (sometimes called “hydrophobia”). This disease is caused by a virus that is present in the saliva of infected animals. The disease occurs most commonly in wild animals, but it has been found in domestic animals and household pets. In fact, it is probable that all mammals are susceptible to it. The virus that causes rabies is ordinarily transmitted by a bite, but it can be transmitted by the saliva of an infected animal coming in contact with a fresh wound or with the thin mucous membrane of the lips or nose. The virus does not penetrate normal unbroken skin. If the skin is broken, **DO NOT** attempt wound closure.

If rabies develops in man, it is usually fatal. A preventive treatment is available and it is very effective, but only if it is started shortly after the bite. This treatment is outlined in BUMEDINST 6220.6. Since the vaccine can be obtained only at a medical treatment facility or a major ship, any person bitten by an animal **must** be transferred quickly to the nearest treatment facility for evaluation, along with a complete report of the circumstances surrounding the incident. Remember, prevention is of utmost importance.

Immediate local treatment of the wound should be given. Wash the wound and the surrounding area carefully, using sterile gauze, soap, and sterile water. Use sterile gauze to dry the wound, and then cover the wound with a sterile dressing. **DO NOT** use any chemical disinfectant. Do not attempt to cauterize the wound in any way.

All of the animal’s saliva must be removed from the victim’s skin to prevent further contamination of the wound.

CAUTION: DO NOT allow the animal’s saliva to come in contact with open sores or cuts on your hands.

When a person has been bitten by an animal, every effort must be made to catch the animal and to keep it confined for a minimum of 8 to 10 days. **DO NOT** kill it if there is any possible chance of catching it alive. The symptoms of rabies are not always present in the animal at the time the bite occurs, but the saliva may nevertheless contain the rabies virus. It is essential, therefore, that the animal is kept under observation

until a diagnosis can be made. The rabies treatment is given if the animal develops any definite symptoms, if it dies during the observation period, or if for any reason the animal cannot be kept under observation.

Remember that any animal bite is dangerous and **MUST** be evaluated at a treatment facility.

WOUND CLOSURE

LEARNING OBJECTIVE: *Recognize the different types of suture material and their uses; recall topical, local infiltration and nerve-block anesthetic administration procedures; and identify the steps in wound suturing and suture removal.*

The care of the wound is largely controlled by the tactical situation, facilities available, and the length of time before proper medical care may be available. Normally, the advice to the Corpsman regarding the suturing of wounds is **DO NOT ATTEMPT IT**. However, if days are expected to elapse before the patient can be seen by a surgeon, the Corpsman should know how to use the various suture procedures and materials, and how to select the most appropriate of both.

Before discussing the methods of coaptation (bringing together), some of the contraindications to wound closing should be described.

- If there is reddening and edema of the wound margins, infection manifested by the discharge of pus, and persistent fever or toxemia, **DO NOT CLOSE THE WOUND**. If these signs are minimal, the wound should be allowed to “clean up.” The process may be hastened by warm, moist dressings, and irrigations with sterile saline. These aid in the liquefaction of necrotic wound materials and the removal of thick exudates and dead tissues.
- If the wound is a puncture wound, a large gaping wound of the soft tissue, or an animal bite, leave it unsutured. Even under the care of a surgeon, it is the rule **not** to close wounds of this nature until after the fourth day. This is called “delayed primary closure” and is performed upon the indication of a healthy appearance of the wound. Healthy muscle tissue that is viable is evident by its color, consistency, blood supply, and contractibility. Muscle that is dead or dying is comparatively dark and mushy; it does not

contract when pinched, nor does it bleed when cut. If this type of tissue is evident, do not close the wound.

- If the wound is deep, consider the support of the surrounding tissue; if there is not enough support to bring the deep fascia together, do not suture because dead (hollow) spaces will be created. In this generally gaping type of wound, muscles, tendons, and nerves are usually involved. Only a surgeon should attempt to close this type of wound.

NOTE: To a certain extent, firm pressure dressings and immobilization can obliterate hollow spaces. If tendons and nerves do not seem to be involved, absorbable sutures may be placed in the muscle. Be careful to suture muscle fibers end-to-end and to correctly appose them. Close the wound in layers. This is extremely delicate surgery, and the Corpsman should weigh carefully the advisability of attempting it—and then only if he has observed and assisted in numerous surgical operations.

If the wound is small, clean, and free from foreign bodies and signs of infection, steps should be taken to close it. All instruments should be checked, cleaned, and thoroughly sterilized. Use a good light and position the patient on the table so that access to the wound will be unhampered.

The area around the wound should be cleansed and then prepared with an antiseptic. The wound area should be draped, whenever possible, to maintain a sterile field in which the Corpsman will work. The Corpsman should wear a cap and mask, scrub his hands and forearms, and wear sterile gloves.

Suture Materials

In modern surgery, many kinds of ligature and suture materials are used. All can be grouped into two classes: nonabsorbable sutures and absorbable sutures.

NONABSORBABLE SUTURES.—These are sutures that cannot be absorbed by the body cells and fluids in which they are embedded during the healing process. When used as buried sutures, these sutures become surrounded or encapsulated in fibrous tissue and remain as innocuous foreign bodies. When used as skin sutures, they are removed after the skin has healed. The most commonly used sutures of this type

and the characteristics associated with each are listed below.

- **Silk**—frequently reacts with tissue and can be “spit” from the wound.
- **Cotton**—loses tensile strength with each autoclaving.
- **Linen**—is better than silk or cotton but is more expensive and not as readily available.
- **Synthetic materials** (e.g., nylon, dermalon)—are excellent, particularly for surface use. They cause very little tissue reaction. Their only problem seems to be the tendency for the knots to come untied. (Because of this tendency, most surgeons tie 3 to 4 square knots in each such suture.) Nylon is preferred over silk for face and lip areas because silk too often causes tissue reactions.
- **Rust-proof metal** (usually stainless steel wire)—has the least tissue reaction of all suture materials and is by far the strongest. The primary problems associated with it are that it is more difficult to use because it kinks and that it must be cut with wire cutters.

ABSORBABLE SUTURES.—These are sutures that are absorbed or digested during and after the healing processes by the body cells and tissue fluids in which they are embedded. It is this characteristic that enhances their use beneath the skin surfaces and on mucous membranes.

Surgical gut fulfills the requirements for the perfect suture—ease of manufacture, tensile strength, and variety available—more often than any other material.

- **Manufacture of catgut:** Though it is referred to as “catgut,” surgical gut is derived from the submucosal connective tissue of the first one-third (about 8 yards) of the small intestine of healthy government-inspected sheep. The intestine of the sheep has certain characteristics that make it especially adaptable for surgical use. Among these characteristics is its uniformly fine-grained tissue structure and its great tensile strength and elasticity.
- **Tensile strength of catgut:** This suture material is available in sizes of 6-0 to 0 and 1 to 4, with 6-0 being the smallest diameter and 4 being the largest. The tensile strength increases with the diameter of the suture.

- **Varieties of catgut:** Surgical gut varies from plain catgut (the raw gut that has been gauzed, polished, sterilized, and packaged) to chromic catgut (that has undergone various intensities of tanning with one of the salts of chromic acid to delay tissue absorption time). Some examples of these variations and their absorption times follow in table 4–3.

Suture Needles

Suture needles may be straight or curved, and they may have either a tapered round point or a cutting edge point. They vary in length, curvature, and diameter for various types of suturing. Specific characteristics of suture needles are listed below.

- **Size:** Suture needles are sized by diameter and are available in many sizes.
- **Taper point:** Most often used in deep tissues, this type **needle causes minimal amounts of tissue damage.**
- **Cutting edge point:** This type needle is preferred for suturing the skin because of the needle's ability to penetrate the skin's toughness.
- **Atraumatic (atraloc, wedged):** These needles may either have a cutting edge or a taper point. Additionally, the suture may be fixed on the end of the needle by the manufacturer to cause the least tissue trauma.

Preparation of Casualty

Before suturing the wound(s) of any victim, the following steps should be taken to prepare the casualty.

1. Examine the casualty carefully to determine what materials are needed to properly close the wound.
 - a. Select and prepare sterile instruments, needles, and suture materials.

Table 4-3.—Absorption Times of Various Types of Surgical Gut

Type Gut	Absorption Time
A: Plain	10 days
B: Mild chromic	20 days
C: Medium chromic	30 days
D: Extra chromic	40 days

- b. Position the patient securely so that access to the wound and suture tray is optimal. It is usually not necessary to restrain patients for suturing.
 - c. Make sure a good light is available.
2. Strictly observe aseptic wound preparation. Use mask, cap, and gloves. Thorough cleaning and proper draping are essential.
 3. Select an anesthetic with care. Consider the patient's tolerance to pain, time of injury, medications the patient is taking or has been given, and the possible distortion of the tissue when the anesthetic are infiltrated.

SELECTION OF ANESTHESIA.—The most common local anesthetic used is Xylocaine®, which comes in various strengths (0.5%, 1%, 2%) and with or without epinephrine. Injectables containing epinephrine must never be used on the fingers, toes, ears, nose—any appendage with small vessels—because of the vasoconstricting effect of the epinephrine. Epinephrine is also contraindicated in patients with hypertension, diabetes, or heart disease.

The three methods of anesthesia administration are topical, local infiltration, and nerve block. Topical anesthetics are generally reserved for ophthalmic or plastic surgery, and nerve blocks are generally accomplished by an anesthesiologist or anesthetist for the surgical patient. For a Corpsman, topical anesthesia is limited to the instillation of eye drops for mild corneal abrasions after all foreign bodies have been removed. **DO NOT** attempt to remove embedded foreign bodies. Nerve blocks are limited to digital blocks wherein the nerve trunks that enervate the fingers or toes are anesthetized. The most common method of anesthesia used by a Corpsman is the infiltration of the anesthetizing agent around a wound or minor surgical site.

ADMINISTRATION OF ANESTHESIA.—Performing a digital block is a fairly simple procedure, but it should not be attempted except under the supervision of a medical officer or after a great deal of practice. The first step is cleansing the injection site with an antiseptic solution. The anesthetizing agent is then infiltrated into the lateral and medial aspects at the base of the digit with a small bore needle (25- or 26-gauge), taking care not to inject into the veins or arteries. Proper placement of the anesthesia should result in a loss of sensitivity in a few minutes. This is tested by asking the patient if he can distinguish a sharp

sensation or pain when a sharp object is gently applied to the skin.

Administering local anesthesia is similar except you are anesthetizing nerves immediately adjacent to where you will be working instead of nerve trunks. There are two generally accepted methods of infiltrating the anesthesia. One is through the skin surrounding the margin of the wound and the other is through the wound into the surrounding tissue. In either case, sufficient quantities must be infiltrated to effect anesthesia approximately $\frac{1}{2}$ inch around the wound, taking care not to inject into a vein or artery.

CAUTION: The maximum recommended amount of Xylocaine to be used is 50 cc for a 1% solution or the equivalent.

General Principles of Wound Suturing

Wounds are closed either primarily or secondarily. A **primary closure** takes place within a short time of when the wound occurs, and it requires minimal cleaning and preparation. A **secondary closure**, on the other hand, occurs when there is a delay of the closure for up to several days after the wound's occurrence. A secondary closure requires a more complex procedure. Wounds 6 to 14 hours old may be closed primarily if they are not grossly contaminated and are meticulously cleaned. Wounds 14 to 24 hours old should not be closed primarily. When reddening and edema of the wound margins, discharge of pus, persistent fever, or toxemia are present, do not close the wound.

Do not use a primary closure for a large, gaping, soft-tissue wound. This type of wound will require warm dressings and irrigations, along with aseptic care for 3 to 7 days to clear up the wound. Then a secondary wound closure may be performed.

The steps to perform a delayed wound closure are outlined below.

1. Debride the wound area and convert circular wounds to elliptical ones before suturing. Circular wounds cannot be closed with satisfactory cosmetic results.
2. Try to convert a jagged laceration to one with smooth edges before suturing it. Make sure that not too much skin is trimmed off; that would make the wound difficult to approximate.
3. Use the correct technique for placing sutures. The needle holder is applied at approximately one-quarter of the distance from the blunt end of the needle. Suturing with a curved needle is

done toward the person doing the suturing. Insert the needle into the skin at a 90° angle, and sweep it through in an arclike motion, following the general arc of the needle.

4. Carefully avoid bruising the skin edges being sutured. Use Adson forceps and very lightly grasp the skin edges. It is improper to use dressing forceps while suturing. Since there are no teeth on the grasping edges of the dressing forceps, the force required to hold the skin firmly may be enough to cause necrosis.
5. Do not put sutures in too tightly. Gentle approximation of the skin is all that is necessary. Remember that postoperative edema will occur in and about the wound, making sutures tighter. Figure 4-33 illustrates proper wound-closure techniques.
6. If there is a significant chance that the sutured wound may become infected (e.g., bites, delayed closure, gross contamination), place an iodoform (anti-infective) in the wound. Or place a small rubber drain in the wound, and remove the drain in 48 hours.
7. When suturing, the best cosmetic effect is obtained by using numerous interrupted simple sutures placed $\frac{1}{8}$ inch apart. Where cosmetic result is not a consideration, sutures may be slightly farther apart. Generally, the distance of the needle bite from the wound edges should be equal to the distance between sutures.
8. When subcutaneous sutures are needed, it is proper to use 4-0 chromic catgut.
9. When deciding the type of material to use on skin, use the finest diameter that will satisfactorily hold the tissues. Table 4-4 provides guidance as to the best suture to use in selected circumstances.
10. When cutting sutures, subcutaneous catgut should have a $\frac{1}{16}$ -inch tail. Silk skin sutures should be cut as short as is practical for removal on the face and lip. Elsewhere, skin sutures may have longer tails for convenience. A tail over $\frac{1}{4}$ inch is unnecessary, however, and tends to collect exudate.
11. The following general rules can be used in deciding when to remove sutures:
 - a. **Face:** As a general rule, 4 or 5 days. Better cosmetic results are obtained by removing every other suture and any suture with

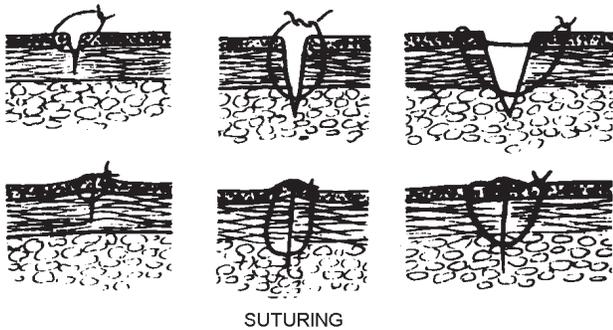
redness around it on the third day and the remainder on the fifth day.

- b. **Body and scalp:** 7 days.
- c. **Soles, palms, back, or over joints:** 10 days, unless excess tissue reaction is apparent around the suture, in which case they should come out sooner.
- d. Any suture with pus or infection around it should be removed immediately, since the suture's presence will make the infection worse.
- e. When wire is used, it may be left in safely for 10 to 14 days.

ORTHOPEDIC INJURIES

Many kinds of accidents cause injuries to bones, joints, or muscles. In giving first aid or emergency treatment to an injured person, you must always look for signs of fractures (broken bones), dislocations, sprains, strains, and contusions.

An essential part of the emergency treatment for fractures consists of immobilizing the injured part with splints so that the sharp ends of broken bones will not move around and cause further damage to nerves, blood vessels, or vital organs. Splints are also used to immobilize severely injured joints or muscles and to prevent the enlargement of extensive wounds. You must have a general understanding of the use of splints before going on to learn the detailed first aid treatment for injuries to bones, joints, and muscles.



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Figure 4-33.—Suturing.

Table 4-4.—Suture Guide

Wound	Suture Material/Size
Children under 3 years	6-0
All other faces	5-0
Body	4-0
Feet, elbows, knees	#34 or #36 wire, or 4-0
Child's scalp	4-0
Adult's scalp	3-0
Lip	6-0 or 5-0

SPLINTS

LEARNING OBJECTIVE: *Recognize the different types of splints that are available, and determine how and when they should be used.*

In an emergency, almost any firm object or material will serve as a splint. Thus, umbrellas, canes, rifles, tent pegs, sticks, oars, wire mesh, boards, corrugated cardboard, and folded newspapers can be used as splints. A fractured leg may sometimes be splinted by fastening it securely to the uninjured leg. Whenever available, use manufactured splints such as pneumatic splints or traction splints.

Requirements

Splints, whether manufactured or improvised, must fulfill certain requirements. They should be lightweight, strong, fairly rigid, and long enough to reach past the joints above and below the fracture. They should be wide enough so that the bandages used to hold them in place will not pinch the injured part. Splints must be well padded on the sides touching the body; if they are not properly padded, they will not fit well and will not adequately immobilize the injured part. If you have to improvise the padding for a splint, you may use clothing, bandages, cotton, blankets, or any other soft material. If the victim is wearing heavy clothes, you may be able to apply the splint on the outside, allowing the clothing to serve as at least part of the required padding. Fasten splints in place with

bandages, strips of adhesive tape, clothing, or other suitable materials. If possible, one person should hold the splints in position while another person fastens them.

Application

Although splints should be applied snugly, they should **never** be tight enough to interfere with the circulation of the blood. When you are applying splints to an arm or a leg, try to leave the fingers or toes exposed. If the tips of the fingers or toes become blue or cold, you will know that the splints or bandages are too tight. You should examine a splinted part approximately every half hour and loosen the fastenings if the circulation appears to be impaired. Remember that any injured part is likely to swell, and splints or bandages that are otherwise applied correctly may later become too tight.

MANAGEMENT OF BONE INJURIES

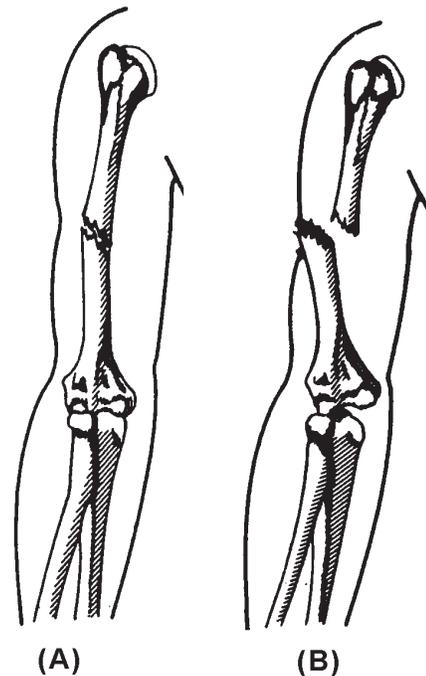
LEARNING OBJECTIVE: *Select the appropriate stabilization and treatment procedure for the management of bone injuries.*

A break in a bone is called a **fracture**. There are two main kinds of fractures. A **closed fracture** is one in which the injury is entirely internal; the bone is broken but there is no break in the skin. An **open fracture** is one in which there is an open wound in the tissues and the skin. Sometimes the open wound is made when a sharp end of the broken bone pushes out through the flesh; sometimes it is made by an object such as a bullet that penetrates from the outside.

Figure 4-34 shows closed and open fractures.

Open fractures are more serious than closed fractures. They usually involve extensive damage to the tissues and are quite likely to become infected. Closed fractures are sometimes turned into open fractures by rough or careless handling of the victim.

It is not always easy to recognize a fracture. All fractures, whether closed or open, are likely to cause severe pain and shock; but the other symptoms may vary considerably. A broken bone sometimes causes the injured part to be deformed or to assume an unnatural position. Pain, discoloration, and swelling may be localized at the fracture site, and there may be a



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Figure 4-34.—Fractures: A. Closed; B. Open.

wobbly movement if the bone is broken clear through. It may be difficult or impossible for the victim to move the injured part; if able to move it, there may be a grating sensation (crepitus) as the ends of the broken bone rub against each other. However, if a bone is cracked rather than broken through, the victim may be able to move the injured part without much difficulty. An open fracture is easy to recognize if an end of the broken bone protrudes through the flesh. If the bone does not protrude, however, you might see the external wound but fail to recognize the broken bone.

General Guidelines

If you are required to give first aid to a person who has suffered a fracture, you should follow these general guidelines:

- If there is any possibility that a fracture has been sustained, treat the injury as a fracture until an X-ray can be made.
- Get the victim to a definitive care facility at the first possible opportunity. All fractures require medical treatment.
- Do not move the victim until the injured part has been immobilized by splinting (unless the move is necessary to save life or to prevent further injury).

- Treat for shock.
- Do not attempt to locate a fracture by grating the ends of the bone together.
- Do not attempt to set a broken bone unless a medical officer will not be available for many days.
- When a long bone in the arm or leg is fractured, the limb should be carefully straightened so that splints can be applied, unless it appears that further damage will be caused by such a maneuver. Never attempt to straighten the limb by applying force or traction with any improvised device. Pulling gently with your hands along the long axis of the limb is permissible and may be all that is necessary to get the limb back into position.
- Apply splints. If the victim is to be transported only a short distance, or if treatment by a medical officer will not be delayed, it is probably best to leave the clothing on and place emergency splinting over it. However, if the victim must be transported for some distance, or if a considerable period of time will elapse before treatment by a medical officer, it may be better to remove enough clothing so that you can apply well padded splints directly to the injured part. If you decide to remove clothing over the injured part, cut the clothing or rip it along the seams. In any case, **be careful!** Rough handling of the victim may convert a closed fracture into an open fracture, increase the severity of shock, or cause extensive damage to the blood vessels, nerves, muscles, and other tissues around the broken bone.
- If the fracture is open, you must take care of the wound before you can deal with the fracture. Bleeding from the wound may be profuse, but most bleeding can be stopped by direct pressure on the wound. Other supplemental methods of hemorrhage control are discussed in the section on wounds of this chapter. Use a tourniquet as a last resort. After you have stopped the bleeding, treat the fracture.

Now that we have seen the general rules for treating fractures, we turn to the symptoms and emergency treatment of specific fracture sites.

Forearm Fracture

There are two long bones in the forearm, the radius and the ulna. When both are broken, the arm usually

appears to be deformed. When only one is broken, the other acts as a splint and the arm retains a more or less natural appearance. Any fracture of the forearm is likely to result in pain, tenderness, inability to use the forearm, and a kind of wobbly motion at the point of injury. If the fracture is open, a bone will show through.

If the fracture is open, stop the bleeding and treat the wound. Apply a sterile dressing over the wound. Carefully straighten the forearm. (Remember that rough handling of a closed fracture may turn it into an open fracture.) Apply a pneumatic splint if available; if not, apply two well-padded splints to the forearm, one on the top and one on the bottom. Be sure that the splints are long enough to extend from the elbow to the wrist. Use bandages to hold the splints in place. Put the forearm across the chest. The palm of the hand should be turned in, with the thumb pointing upward. Support the forearm in this position by means of a wide sling and a cravat bandage, as shown in figure 4-35. The hand should be raised about 4 inches above the level of the elbow. Treat the victim for shock and evacuate as soon as possible.

Upper Arm Fracture

The signs of fracture of the upper arm include pain, tenderness, swelling, and a wobbly motion at the point



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Figure 4-35.—First aid for a fractured forearm.

of fracture. If the fracture is near the elbow, the arm is likely to be straight with no bend at the elbow.

If the fracture is open, stop the bleeding and treat the wound before attempting to treat the fracture.

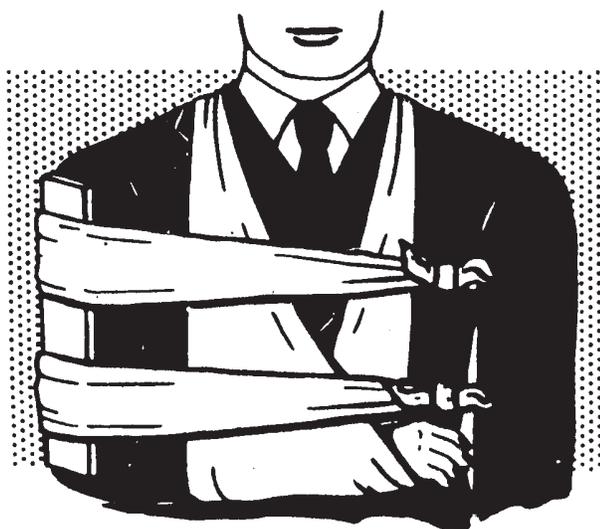
NOTE: Treatment of the fracture depends partly upon the location of the break.

If the fracture is in the upper part of the arm near the shoulder, place a pad or folded towel in the armpit, bandage the arm securely to the body, and support the forearm in a narrow sling.

If the fracture is in the middle of the upper arm, you can use one well-padded splint on the outside of the arm. The splint should extend from the shoulder to the elbow. Fasten the splinted arm firmly to the body and support the forearm in a narrow sling, as shown in figure 4-36.

Another way of treating a fracture in the middle of the upper arm is to fasten two wide splints (or four narrow ones) about the arm and then support the forearm in a narrow sling. If you use a splint between the arm and the body, be very careful that it does not extend too far up into the armpit; a splint in this position can cause a dangerous compression of the blood vessels and nerves and may be extremely painful to the victim.

If the fracture is at or near the elbow, the arm may be either bent or straight. No matter in what position you find the arm, **DO NOT ATTEMPT TO STRAIGHTEN IT OR MOVE IT IN ANY WAY.** Splint the arm as carefully as possible in the position in



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Figure 4-36.—Splint and sling for a fractured upper arm.

which you find it. This will prevent further nerve and blood vessel damage. The only exception to this is if there is no pulse distal to the fracture, in which case gentle traction is applied and then the arm is splinted. Treat the victim for shock and get him under the care of a medical officer as soon as possible.

Thigh Fracture

The femur is the long bone of the upper part of the leg between the kneecap and the pelvis. When the femur is fractured through, any attempt to move the limb results in a spasm of the muscles and causes excruciating pain. The leg has a wobbly motion, and there is complete loss of control below the fracture. The limb usually assumes an unnatural position, with the toes pointing outward. By actual measurement, the fractured leg is shorter than the uninjured one because of contraction of the powerful thigh muscles. Serious damage to blood vessels and nerves often results from a fracture of the femur, and shock is likely to be severe.

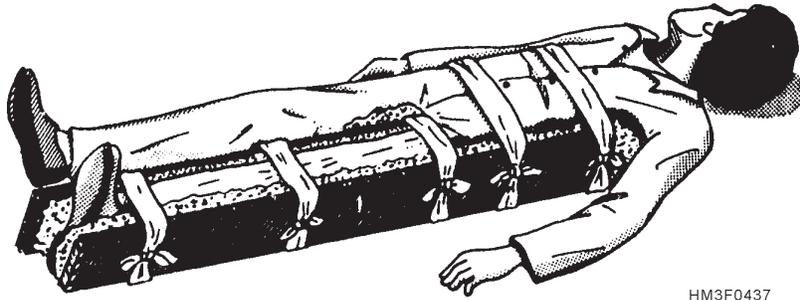
If the fracture is open, stop the bleeding and treat the wound before attempting to treat the fracture itself. Serious bleeding is a special danger in this type of injury, since the broken bone may tear or cut the large artery in the thigh.

Carefully straighten the leg. Apply two splints, one on the outside of the injured leg and one on the inside. The outside splint should reach from the armpit to the foot. The inside splint should reach from the crotch to the foot. The splints should be fastened in five places: (1) around the ankle; (2) over the knee; (3) just below the hip; (4) around the pelvis; and (5) just below the armpit (fig. 4-37). The legs can then be tied together to support the injured leg as firmly as possible.

It is essential that a fractured thigh be splinted before the victim is moved. Manufactured splints, such as the Hare or the Thomas half-ring traction splints, are best, but improvised splints may be used. Figure 4-37 shows how boards may be used as an emergency splint for a fractured thigh. Remember, **DO NOT MOVE THE VICTIM UNTIL THE INJURED LEG HAS BEEN IMMOBILIZED.** Treat the victim for shock, and evacuate at the earliest possible opportunity.

Lower Leg Fracture

When both bones of the lower leg are broken, the usual signs of fracture are likely to be present. When only one bone is broken, the other one acts as a splint and, to some extent, prevents deformity of the leg. However, tenderness, swelling, and pain at the point of



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Figure 4-37.—Splint for a fractured femur.

fracture are almost always present. A fracture just above the ankle is often mistaken for a sprain. If both bones of the lower leg are broken, an open fracture is very likely to result.

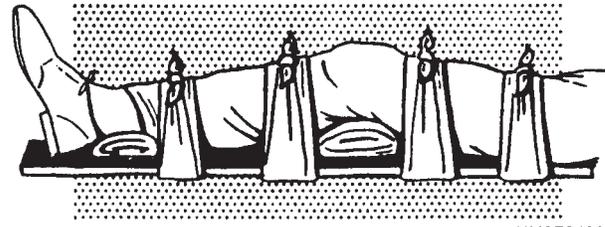
If the fracture is open, stop the bleeding and treat the wound. Carefully straighten the injured leg. Apply a pneumatic splint if available; if not, apply **three** splints, one on each side of the leg and one underneath. Be sure that the splints are well padded, particularly under the knee and at the bones on each side of the ankle.

A pillow and two side splints work very well for treatment of a fractured lower leg. Place the pillow beside the injured leg, then carefully lift the leg and place it in the middle of the pillow. Bring the edges of the pillow around to the front of the leg and pin them together. Then place one splint on each side of the leg (over the pillow), and fasten them in place with strips of bandage or adhesive tape. Treat the victim for shock and evacuate as soon as possible. When available, you may use the Hare or Thomas half-ring traction splints.

Kneecap Fracture

The following first aid treatment should be given for a fractured kneecap (patella):

Carefully straighten the injured limb. Immobilize the fracture by placing a padded board under the injured limb. The board should be at least 4 inches wide and should reach from the buttock to the heel. Place extra padding under the knee and just above the heel, as shown in figure 4-38. Use strips of bandage to fasten the leg to the board in four places: (1) just below the knee; (2) just above the knee; (3) at the ankle; and (4) at the thigh. **Do not cover the knee itself.** Swelling is likely to occur very rapidly, and any bandage or tie fastened over the knee would quickly become too tight. Treat the victim for shock and evacuate as soon as possible.



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Figure 4-38.—Immobilization of a fractured patella.

Clavicle Fracture

A person with a fractured clavicle usually shows definite symptoms. When the victim stands, the injured shoulder is lower than the uninjured one. The victim is usually unable to raise the arm above the level of the shoulder and may attempt to support the injured shoulder by holding the elbow of that side in the other hand. This is the characteristic position of a person with a broken clavicle. Since the clavicle lies immediately under the skin, you may be able to detect the point of fracture by the deformity and localized pain and tenderness.

If the fracture is open, stop the flow of blood and treat the wound before attempting to treat the fracture. Then apply a sling and swathe splint as described below (and illustrated in figure 4-39).

Bend the victim's arm on the injured side, and place the forearm across the chest. The palm of the hand should be turned in, with the thumb pointed up. The hand should be raised about 4 inches above the level of the elbow. Support the forearm in this position by means of a wide sling. A wide roller bandage (or any wide strip of cloth) may be used to secure the victim's arm to the body (see figure 4-35). A figure-eight bandage may also be used for a fractured clavicle. Treat the victim for shock and evacuate to a definitive care facility as soon as possible.

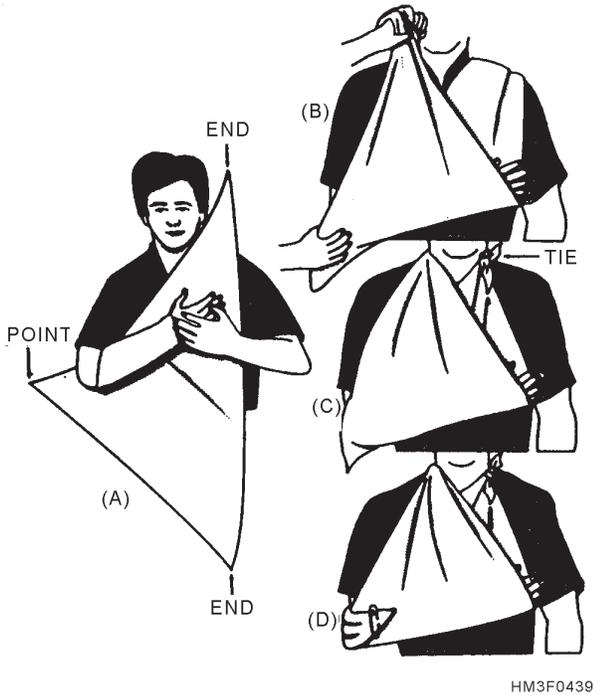


Figure 4-39.—Sling for immobilizing fractured clavicle.

Rib Fracture

If a rib is broken, make the victim comfortable and quiet so that the greatest danger—the possibility of further damage to the lungs, heart, or chest wall by the broken ends—is minimized.

The common finding in all victims with fractured ribs is pain localized at the site of the fracture. By asking the patient to point out the exact area of the pain, you can often determine the location of the injury. There may or may not be a rib deformity, chest wall contusion, or laceration of the area. Deep breathing, coughing, or movement is usually painful. The patient generally wishes to remain still and may often lean toward the injured side, with a hand over the fractured area to immobilize the chest and to ease the pain.

Ordinarily, rib fractures are **not** bound, strapped, or taped if the victim is reasonably comfortable. However, they may be splinted by the use of external support. If the patient is considerably more comfortable with the chest immobilized, the best method is to use a swathe (fig. 4-40) in which the arm on the injured side is strapped to the chest to limit motion. Place the arm on the injured side against the chest, with the palm flat, thumb up, and the forearm

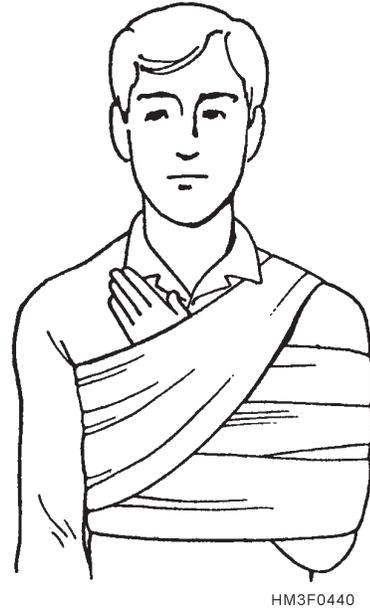


Figure 4-40.—Swathe bandage of fractured rib victim.

raised to a 45° angle. Immobilize the chest, using wide strips of bandage to secure the arm to the chest.

Do not use wide strips of adhesive plaster applied directly to the skin of the chest for immobilization since the adhesive tends to limit the ability of the chest to expand (interfering with proper breathing). Treat the victim for shock and evacuate as soon as possible.

Nose Fracture

A fracture of the nose usually causes localized pain and swelling, a noticeable deformity of the nose, and extensive nosebleed.

Stop the nosebleed. Have the victim sit quietly, with the head tipped slightly backward. Tell the victim to breathe through the mouth and not to blow the nose. If the bleeding does not stop within a few minutes, apply a cold compress or an ice bag over the nose.

Treat the victim for shock. Ensure the victim receives a medical officer's attention as soon as possible. Permanent deformity of the nose may result if the fracture is not treated promptly.

Jaw Fracture

A person who has a fractured jaw may suffer serious interference with breathing. There is likely to be great difficulty in talking, chewing, or swallowing. Any movement of the jaw causes pain. The teeth may be out of line, and there may be bleeding from the gums. Considerable swelling may develop.

One of the most important phases of emergency care is to clear the upper respiratory passage of any obstruction. If the fractured jaw interferes with breathing, pull the lower jaw and the tongue well **forward** and keep them in that position.

Apply a four-tailed bandage, as shown in figure 4-41. Be sure that the bandage pulls the lower jaw **forward**. Never apply a bandage that forces the jaw backward, since this might seriously interfere with breathing. The bandage must be firm so that it will support and immobilize the injured jaw, but it must not press against the victim's throat. Be sure that the victim has scissors or a knife to cut the bandage in case of vomiting. Treat the victim for shock and evacuate as soon as possible.

Skull Fracture

When a person suffers a head injury, the greatest danger is that the brain may be severely damaged; whether or not the skull is fractured is a matter of secondary importance. In some cases, injuries that fracture the skull do not cause serious brain damage; but brain damage can—and frequently does—result from apparently slight injuries that do not cause damage to the skull itself.

It is often difficult to determine whether an injury has affected the brain because the symptoms of brain damage vary greatly. A person suffering from a head injury must be handled very carefully and given immediate medical attention.

Some of the symptoms that may indicate brain damage are listed below. However, you must remember that all of these symptoms are not always

present in any one case and that the symptoms that do occur may be greatly delayed.

- Bruises or wounds of the scalp may indicate that the victim has sustained a blow to the head. Sometimes the skull is depressed (caved in) at the point of impact. If the fracture is open, you may find glass, shrapnel, or other objects penetrating the skull.
- The victim may be conscious or unconscious. If conscious, the victim may feel dizzy and weak, as though about to faint.
- Severe headache sometimes (but not always) accompanies head injuries.
- The pupils of the eyes may be unequal in size and may not react normally to light.
- There may be bleeding from the ears, nose, or mouth.
- The victim may vomit.
- The victim may be restless and perhaps confused and disoriented.
- The arms, legs, face, or other parts of the body may be partially paralyzed.
- The victim's face may be very pale, or it may be unusually flushed.
- The victim is likely to be suffering from shock, but the symptoms of shock may be disguised by other symptoms.

It is not necessary to determine if the skull is fractured when you are giving first aid to a person who has suffered a head injury. The treatment is the same in either case, and the primary intent is to prevent further damage to the brain.

Keep the victim lying down. If the face is flushed, raise the head and shoulders slightly. If the face is pale, have the victim lie so that the head is level with, or slightly lower than, the body. Watch carefully for vomiting. If the victim begins to vomit, position the head to prevent choking on the vomitus.

If there is serious bleeding from the wounds, try to control that bleeding by the application of direct pressure, using caution to avoid further injury to the skull or brain. Use a donut-shaped bandage to gently surround protruding objects. Never manipulate those objects.

- Be very careful about moving or handling the victim. Move the victim no more than is

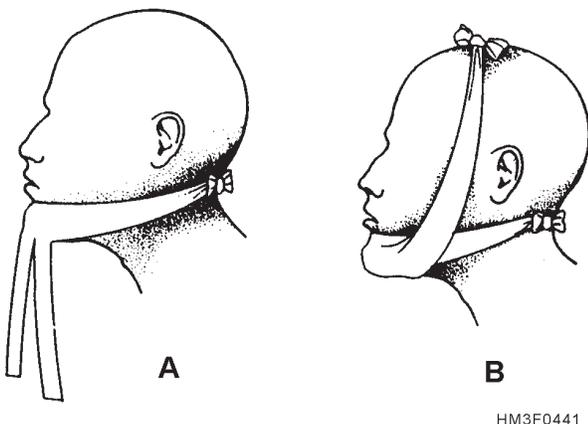


Figure 4-41.—Four-tailed bandage for the jaw.

necessary. If transportation is necessary, keep the victim lying down.

- In any significant head or facial injury, assume injury to the cervical spine. Immobilization of the cervical spine is indicated.
- Be sure that the victim is kept comfortably warm, but not too warm.
- **Do not** give the victim anything to drink. **DO NOT GIVE ANY MEDICATIONS.** See that the victim receives a medical officer's attention as soon as possible.

Spinal Fractures

If the spine is fractured at any point, the spinal cord may be crushed, cut, or otherwise damaged so severely that death or paralysis will result. However, if the fracture occurs in such a way that the spinal cord is not seriously damaged, there is a very good chance of complete recovery, **provided** that the victim is properly cared for. Any twisting or bending of the neck or back—whether due to the original injury or carelessness from handling later—is likely to cause irreparable damage to the spinal cord.

The primary symptoms of a fractured spine are pain, shock, and paralysis. **Pain** is likely to be acute at the point of fracture. It may radiate to other parts of the body. **Shock** is usually severe, but (as in all injuries) the symptoms may be delayed for some time. **Paralysis** occurs if the spinal cord is seriously damaged. If the victim cannot move the legs, feet, or toes, the fracture is probably in the back; if the fingers will not move, the neck is probably broken. Remember that a spinal fracture does not always injure the spinal cord, so the victim is not always paralyzed. Any person who has an acute pain in the back or the neck following an injury should be treated as though there is a fractured spine, even if there are no other symptoms.

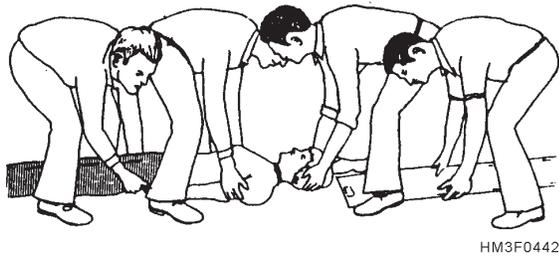
Emergency treatment for all spinal fractures, whether of the neck or of the back, has two primary purposes: (1) to minimize shock, and (2) to prevent further injury to the spinal cord. Keep the victim comfortably warm. Do not attempt to keep the victim in the position ordinarily used for the treatment of shock, because it might cause further damage to the spinal cord. Just keep the victim lying flat and do **NOT** attempt to lower the head.

To avoid further damage to the spinal cord, **DO NOT MOVE THE VICTIM UNLESS IT IS ABSOLUTELY ESSENTIAL!** If the victim's life is

threatened in the present location or transportation is necessary to receive medical attention, then, of course, you must move the victim. However, if movement is necessary, be sure that you do it in a way that will cause the least possible damage. **DO NOT BEND OR TWIST THE VICTIM'S BODY, DO NOT MOVE THE HEAD FORWARD, BACKWARD, OR SIDeways, AND DO NOT UNDER ANY CIRCUMSTANCES ALLOW THE VICTIM TO SIT UP.**

If it is necessary to transport a person who has suffered a fracture of the spine, follow these general rules:

- If the spine is broken at the **neck**, the victim must be transported lying on the back, **face up**. Place pillows or sandbags beside the head so that it cannot turn to either side. **DO NOT** put pillows or padding under the neck or head.
- If you suspect that the spine is fractured but do not know the location of the break, treat the victim as though the neck is broken (i.e., keep the victim supine). If both the neck and the back are broken, keep the victim supine.
- No matter where the spine is broken, **use a firm support in transporting the victim**. Use a rigid stretcher, or a door, shutter, wide board, etc. Pad the support carefully, and put blankets both under and over the victim. Use cravat bandages or strips of cloth to secure the victim firmly to the support.
- When placing the victim on a spineboard, one of two acceptable methods may be used. However, **DO NOT ATTEMPT TO LIFT THE VICTIM UNLESS YOU HAVE ADEQUATE ASSISTANCE.** Remember: Any bending or twisting of the body is almost sure to cause serious damage to the spinal cord. Figure 4-42 shows the straddle-slide method. One person lifts and supports the head while two other persons each lift at the shoulders and hips, respectively. A fourth person slides the spineboard under the patient. Figure 4-43 shows the proper procedure in performing the log-roll method. The victim is rolled as a single unit towards the rescuers, the spineboard is positioned, and the victim is rolled back onto the spineboard and secured in place. If there are at least four (preferably six) people present to help lift the victim, they can accomplish the job without too much movement of the victim's



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Figure 4-42.—Straddle-slide method of moving spinal cord injury victim onto a backboard.

body. **NEVER** attempt to lift the victim, however, with fewer than four people.

- Evacuate the victim very carefully.

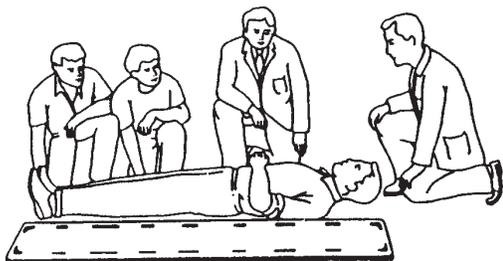
Pelvic Fracture

Fractures in the pelvic region often result from falls, heavy blows, and accidents that involve

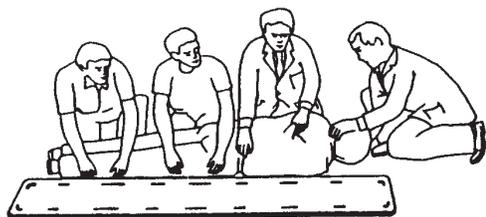
crushing. The great danger in a pelvic fracture is that the organs enclosed and protected by the pelvis may be seriously damaged when the bony structure is fractured. In particular, there is danger that the bladder will be ruptured. There is also danger of severe internal bleeding; the large blood vessels in the pelvic region may be torn or cut by fragments of the broken bone.

The primary symptoms of a fractured pelvis are severe pain, shock, and loss of ability to use the lower part of the body. The victim is unable to sit or stand. If the victim is conscious, there may be a sensation of “coming apart.” If the bladder is injured, the victim’s urine may be bloody.

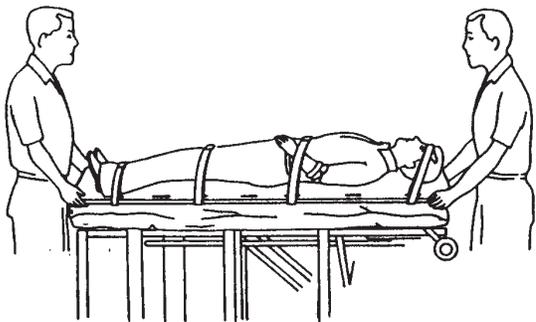
Do not move the victim unless ABSOLUTELY necessary. The victim should be treated for shock and



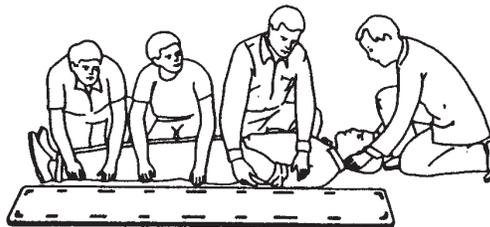
STEP 1



STEP 3



STEP 5



STEP 2



STEP 4

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Figure 4-43.—Log-roll method of moving spinal cord injury victim onto a backboard.

kept warm but should not be moved into the position ordinarily used for the treatment of shock.

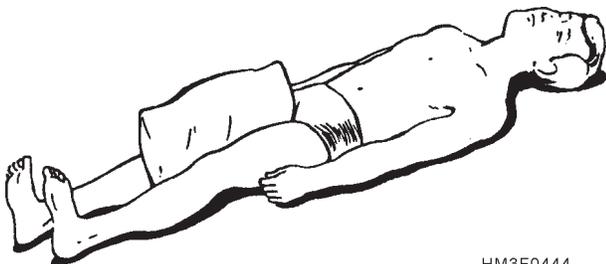
If you must transport the victim to another place, do it with the utmost care. Use a rigid stretcher, a padded door, or a wide board. Keep the victim supine. In some cases, the victim will be more comfortable if the legs are straight, while in other cases the victim will be more comfortable with the knees bent and the legs drawn up. When you have placed the victim in the most comfortable position, immobilization should be accomplished. Fractures of the hip are best treated with traction splints. Adequate immobilization can also be obtained by placing pillows or folded blankets between the legs as shown in figure 4-44 and using cravats, roller bandages, or straps to hold the legs together, or through the use of MAST garments. Fasten the victim securely to the stretcher or improvised support, and evacuate very carefully.

MANAGEMENT OF JOINT AND MUSCLE INJURIES

LEARNING OBJECTIVE: *Select the appropriate stabilization and treatment procedure for the management of joint and muscle injuries.*

Injuries to joints and muscles often occur together, and it is sometimes difficult to tell whether the primary injury is to a joint or to the muscles, tendons, blood vessels, or nerves near the joint. Sometimes it is difficult to distinguish joint or muscle injuries from fractures. In case of doubt, **always** treat any injury to a bone, joint, or muscle as though it were a fracture.

In general, joint and muscle injuries may be classified under four headings: (1) dislocations, (2) sprains, (3) strains, and (4) contusions (bruises).



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Figure 4-44.—Immobilizing a fractured pelvis.

Dislocations

When a bone is forcibly displaced from its joint, the injury is known as a **dislocation**. In some cases, the bone slips back quickly into its normal position, but at other times it becomes locked in the new position and remains dislocated until it is put back into place. Dislocations are usually caused by falls or blows but occasionally by violent muscular exertion. The most frequently dislocated joints are those of the shoulder, hip, fingers, and jaw.

A dislocation is likely to bruise or tear the muscles, ligaments, blood vessels, tendons, and nerves near a joint. Rapid swelling and discoloration, loss of ability to use the joint, severe pain and muscle spasms, possible numbness and loss of pulse below the joint, and shock are characteristic symptoms of dislocations. The fact that the injured part is usually stiff and immobile, with marked deformation at the joint, will help you distinguish a dislocation from a fracture. In a fracture, there is deformity **between** joints rather than **at** joints, and there is generally a wobbly motion of the broken bone at the point of fracture.

As a general rule, you should **not** attempt to reduce a dislocation—that is, put a dislocated bone back into place—unless you know that a medical officer cannot be reached within 8 hours. Unskilled attempts at reduction may cause great damage to nerves and blood vessels or actually fracture the bone. Therefore, except in great emergencies, you should leave this treatment to specially trained medical personnel and concentrate your efforts on making the victim as comfortable as possible under the circumstances.

The following emergency measures will be helpful:

1. Loosen the clothing around the injured part.
2. Place the victim in the most comfortable position possible.
3. Support the injured part by means of a sling, pillows, bandages, splints, or any other device that will make the victim comfortable.
4. Treat the victim for shock.
5. Get medical help as soon as possible.

You should **NEVER** attempt to reduce the more serious dislocations, such as those of the hip. However, if it is probable that the victim cannot be treated by a medical officer within a **reasonable time**, you should make a careful effort to reduce certain

dislocations (such as those of the jaw, finger, or shoulder) if there is no arterial or nerve involvement (pulse will be palpable and there will be no numbness below the joint). Treat all other dislocations as fractures, and evacuate the victim to a definitive care facility.

DISLOCATION OF THE JAW.—When the lower jaw is dislocated, the victim cannot speak or close the mouth. Dislocation of the jaw is usually caused by a blow to the mouth; sometimes it is caused by yawning or laughing. This type of dislocation is not always easy to reduce, and there is considerable danger that the operator's thumbs will be bitten in the process. For your own protection, wrap your thumbs with a handkerchief or bandage. While facing the victim, press your thumbs down just behind the last lower molars and, at the same time, lift the chin up with your fingers. The jaw should snap into place at once. You will have to remove your thumbs quickly to avoid being bitten. No further treatment is required, but you should warn the victim to keep the mouth closed as much as possible during the next few hours. Figure 4-45 shows the position you must assume to reduce a dislocated jaw.

DISLOCATION OF THE FINGER.—The joints of the finger are particularly susceptible to injury, and even minor injuries may result in prolonged loss of function. Great care must be used in treating any injury of the finger.

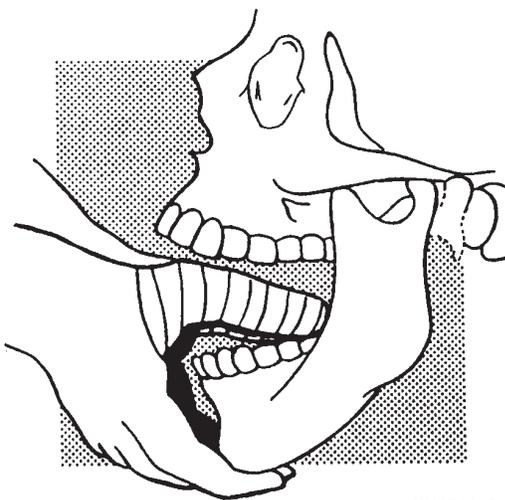
To reduce a dislocation of the finger, grasp the finger firmly and apply a steady pull in the same line as the deformity. If it does not slip into position, try it again, but if it does not go into position on the third attempt, **DO NOT TRY AGAIN**. In any case, and

whether or not the dislocation is reduced, the finger should be strapped, slightly flexed, with an aluminum splint or with a roller gauze bandage over a tongue blade. Figure 4-46 shows how a dislocated finger can be immobilized by strapping it to a flat, wooden stick, such as a tongue depressor.

DISLOCATION OF THE SHOULDER.—Before reduction, place the victim in a supine position. After putting the heel of your foot in the victim's armpit, grasp the wrist and apply steady traction by pulling gently and increasing resistance gradually. Pull the arm in the same line as it is found. After several minutes of steady pull, flex the victim's elbow slightly. Grasp the arm below the elbow, apply traction from the point of the elbow, and gently rotate the arm into the external or outward position. If three reduction attempts fail, carry the forearm across the chest and apply a sling and swathe. An alternate method involves having the patient lie face down on an examining table with the injured arm hanging over the side. Apply prolonged, firm, gentle traction at the wrist with gentle external rotation. A water bucket with a padded handle placed in the crook of the patient's elbow may be substituted. Gradually add sand or water to the bucket to increase traction. Grasping the wrist and using the elbow as a pivot point, gently rotate the arm into the external position.

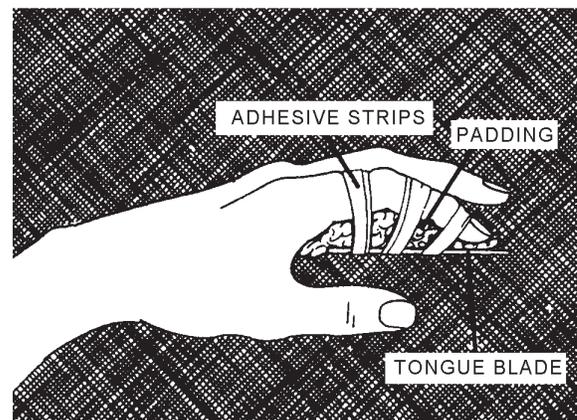
Sprains

Sprains are injuries to the ligaments and soft tissues that support a joint. A sprain is caused by the violent wrenching or twisting of the joint beyond its normal limits of movement and usually involves a momentary dislocation, with the bone slipping back into place of its own accord. Although any joint may



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Figure 4-45.—Position for reducing a dislocated jaw.



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Figure 4-46.—Immobilizing a dislocated finger.

be sprained, sprains of the ankle, wrist, knee, and finger are most common.

Symptoms of a sprain include pain or pressure at the joint, pain upon movement, swelling and tenderness, possible loss of movement, and discoloration. Treat all sprains as fractures until ruled out by X-rays.

Emergency care for a sprain includes application of cold packs for the first 24 to 48 hours to reduce swelling and to control internal hemorrhage; elevation and rest of the affected area; application of a snug, smooth, figure-eight bandage to control swelling and to provide immobilization (basket weave adhesive bandages can be used on the ankle); a follow-up examination by a medical officer; and X-rays to rule out the presence of a fracture.

NOTE: Check bandaged areas regularly for swelling that might cause circulation impairment and loosen bandages if necessary.

After the swelling stops (24 to 48 hours), moist heat can be applied for short periods (15 to 30 minutes) to promote healing and reduce swelling. Moist heat can be warm, wet compresses, warm whirlpool baths, etc.

CAUTION: Heat should not be applied until 24 hours after the last cold pack.

Strains

Injuries caused by the forcible overstretching or tearing of muscles or tendons are known as **strains**. Strains may be caused by lifting excessively heavy loads, sudden or violent movements, or any other action that pulls the muscles beyond their normal limits.

The chief symptoms of a strain are pain, lameness or stiffness (sometimes involving knotting of the muscles), moderate swelling at the place of injury, discoloration due to the escape of blood from injured blood vessels into the tissues, possible loss of power, and a distinct gap felt at the site.

Keep the affected area elevated and at rest. Apply cold packs for the first 24 to 48 hours to control hemorrhage and swelling. After the swelling stops, apply mild heat to increase circulation and aid in healing. As in sprains, heat should not be applied until 24 hours after the last cold pack. Muscle relaxants, adhesive straps, and complete immobilization of the area may be indicated. Evacuate the victim to a medical facility where X-rays can be taken to rule out the presence of a fracture.

Contusions

Contusions, commonly called bruises, are responsible for the discoloration that almost always accompanies injuries to bones, joints, and muscles. Contusions are caused by blows that damage bones, muscles, tendons, blood vessels, nerves, and other body tissues. They do not necessarily break the skin.

The symptoms of a contusion or bruise are familiar to everyone. There is immediate pain when the blow is received. Swelling occurs because blood from the broken vessels leaks into the soft tissue under the skin. At first the injured place is reddened due to local skin irritation from the blow. Later the characteristic “black and blue” marks appear. Perhaps several days later, the skin turns yellowish or greenish before normal coloration returns. The bruised area is usually very tender.

As a rule, slight bruises do not require treatment. However, if the victim has severe bruises, treat for shock. Immobilize the injured part, keep it at rest, and protect it from further injury. Sometimes the victim will be more comfortable if the bruised area is bandaged firmly with an elastic or gauze bandage. If possible, elevate the injured part. A sling may be used for a bruised arm or hand. Pillows or folded blankets may be used to elevate a bruised leg.

ENVIRONMENTAL INJURIES

LEARNING OBJECTIVE: *Recall the classification and evaluation process for burns, and determine the appropriate treatment for each type of burn.*

Under the broad category of environmental injuries, we will consider a number of emergency problems. Exposure to extremes of temperature, whether heat or cold, causes injury to skin, tissues, blood vessels, vital organs, and, in some cases, the whole body. In addition, contact with the sun’s rays, electrical current, or certain chemicals causes injuries similar in character to burns.

THERMAL BURNS

True burns are generated by exposure to extreme heat that overwhelms the body’s defensive mechanisms. Burns and scalds are essentially the same injury: Burns are caused by dry heat, and scalds are caused by moist heat. The seriousness of the injury can

be estimated by the depth, extent, and location of the burn, the age and health of the victim, and other medical complications.

Classification of Severity

Burns are classified according to their depth as first-, second-, and third-degree burns (as shown in figure 4-47).

FIRST-DEGREE BURN.—With a first-degree burn, the epidermal layer is irritated, reddened, and tingling. The skin is sensitive to touch and blanches with pressure. Pain is mild to severe, edema is minimal, and healing usually occurs naturally within a week.

SECOND-DEGREE BURN.—A second-degree burn is characterized by epidermal blisters, mottled appearance, and a red base. Damage extends into—but not through—the dermis. Recovery usually takes 2 to 3 weeks, with some scarring and depigmentation. This condition is painful. Body fluids may be drawn into the injured tissue, causing edema and possibly a “weeping” fluid (plasma) loss at the surface.

THIRD-DEGREE BURN.—A third-degree burn is a full-thickness injury penetrating into muscle and fatty connective tissues, or even down to the bone. Tissues and nerves are destroyed. Shock, with blood in the urine, is likely to be present. Pain will be absent at the burn site if all the area nerve endings are destroyed, and the surrounding tissue (which is less damaged)

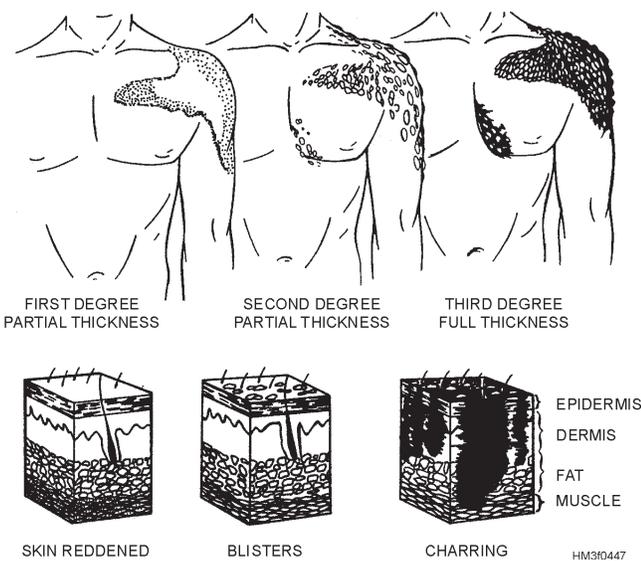


Figure 4-47.—Classification of burns.

will be painful. Tissue color will range from white (scalds) to black (charring burns). Although the wound is usually dry, body fluids will collect in the underlying tissue. If the area has not been completely cauterized, significant amounts of fluids will be lost by plasma “weeping” or by hemorrhage, thus reducing circulation volume. There is considerable scarring and possible loss of function. Skin grafts may be necessary.

Rule of Nines

Of greater importance than the depth of the burn in evaluating the seriousness of the condition is the extent of the burned area. A first-degree burn over 50 percent of the body surface area (BSA) may be more serious than a third-degree burn over 3 percent. The **Rule of Nines** is used to give a rough estimate of the surface area affected. Figure 4-48 shows how the rule is applied to adults.

Other Factors

A third factor in burn evaluation is the location of the burn. Serious burns of the head, hands, feet, or genitals will require hospitalization.

The fourth factor is the presence of any other complications, especially respiratory tract injuries or other major injuries or factors.

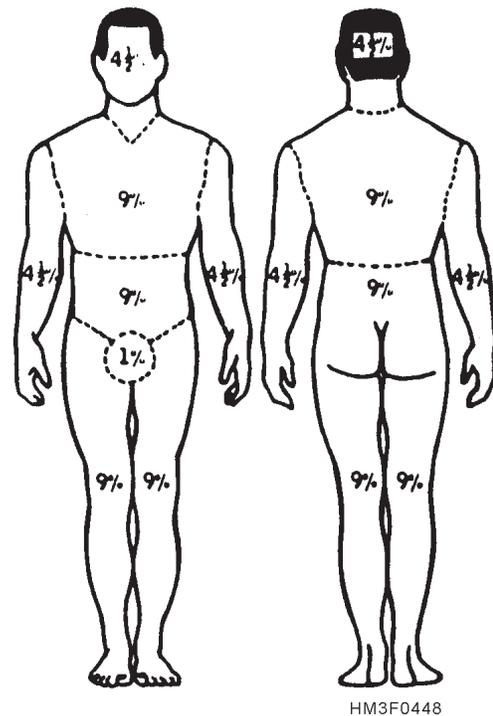


Figure 4-48.—Rule of Nines.

The Corpsman must take all these factors into consideration when evaluating the condition of the burn victim, especially in a triage situation.

First Aid

After the victim has been removed from the source of the thermal injury, first aid should be kept to a minimum.

- Maintain an open airway.
- Control hemorrhage, and treat for shock.
- Remove constricting jewelry and articles of clothing.
- Protect the burn area from contamination by covering it with clean sheets or dry dressings. **DO NOT** remove clothing adhering to a wound.
- Splint fractures.
- For all serious and extensive burns (over 20 percent BSA), and in the presence of shock, start intravenous therapy with an electrolyte solution (Ringer's lactate) in an unburned area.
- Maintain intravenous treatment during transportation.
- Relieve mild pain with aspirin. Relieve moderate pain with cool, wet compresses or ice water immersion (for burns of less than 20 percent BSA). Severe pain may be relieved with morphine or demerol injections. Pain resulting from small burns may be relieved with an anesthetic ointment if the skin is not broken.

Aid Station Care

Once the victim has arrived at the aid station, observe the following procedures.

- Continue to monitor for airway patency, hemorrhage, and shock.
- Continue intravenous therapy that is in place, or start a new one under a medical officer's supervision to control shock and replace fluid loss.
- Monitor urine output.
- Shave body hair well back from the burned area, and then cleanse the area gently with disinfectant soap and warm water. Remove dirt, grease, and nonviable tissue. Apply a sterile dressing of dry

gauze. Place bulky dressings around the burned parts to absorb serous exudate.

- All major burn victims should be given a booster dose of tetanus toxoid to guard against infection. Administration of antibiotics may be directed by a medical officer or an Independent Duty Corpsman.
- If evacuation to a definitive care facility will be delayed for 2 to 3 days, start topical antibiotic therapy after the patient stabilizes and following debridement and wound care. Gently spread a 1/16-inch thickness of Sulfamylon® or Silvadene® over the burn area. Repeat the application after 12 hours, and then after daily debridement. Treat minor skin reactions with antihistamines.

SUNBURN

Sunburn results from prolonged exposure to the ultraviolet rays of the sun. First- and second-degree burns similar to thermal burns result. Treatment is essentially the same as that outlined for thermal burns. Unless a major percentage of the body surface is affected, the victim will not require more than first aid attention. Commercially prepared sunburn lotions and ointments may be used. Prevention through education and the proper use of sun screens is the best way to avoid this condition.

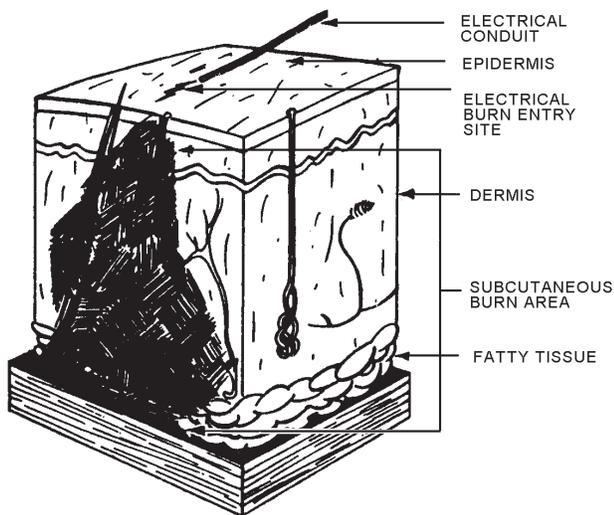
ELECTRICAL BURNS

Electrical burns may be far more serious than a preliminary examination may indicate. The entrance and exit wounds may be small, but as electricity penetrates the skin it burns a large area below the surface, as indicated in figure 4-49. A Corpsman can do little for these victims other than monitoring the basic life functions, delivering CPR, treating for shock if necessary, covering the entrance and exit wounds with a dry, sterile dressing, and transporting the victim to a medical treatment facility.

Before treatment is started, ensure that the victim is no longer in contact with a live electrical source. Shut the power off or use a nonconducting rope or stick to move the victim away from the line or the line away from the victim. See figure 3-26.

CHEMICAL BURNS

When acids, alkalies, or other chemicals come in contact with the skin or other body membranes, they



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Figure 4-49.—Electrical burns.

may cause injuries that are generally referred to as chemical burns. For the most part, these injuries are not caused by heat but by direct chemical destruction of body tissues. Areas most often affected are the extremities, mouth, and eyes. Alkali burns are usually more serious than acid burns because alkalis penetrate deeper and burn longer.

When such burns occur, the following emergency procedures must be carried out immediately:

1. Quickly flush the area with large amounts of water, using a shower or hose, if available. Do not apply water too forcefully. Flood the area while the clothing (including shoes and socks) is being removed and continue often removal.

NOTE: There are two exceptions to the above: (1) In alkali burns caused by dry lime, the mixing of water and lime creates a very corrosive substance. Dry lime should be **brushed** away from the skin and clothing, unless large amounts of water are available for rapid and complete flushing. (2) In acid burns caused by phenol (carbolic acid), wash the affected area with alcohol because phenol is not water soluble; then wash with water. If alcohol is not available, flushing with water is better than no treatment at all.

2. After thorough washing, neutralize any chemical remaining on the affected area.

WARNING: DO NOT attempt to neutralize a chemical unless you know exactly what it is and what substance will neutralize it. Further damage may be done by a neutralizing agent that is too strong or incorrect.

For acid burns, make a solution of 1 teaspoon of baking soda to a pint of water and flush it over the affected area. For alkali burns, mix 1 or 2 teaspoons of vinegar to a pint of water and flush it over the affected area.

3. Flush the area again with water and gently pat dry with a sterile gauze. Do not rub the area.
4. Transport the victim to a medical treatment facility.

When treating chemical burns to the eye, the one and only emergency treatment is to flush the eye(s) immediately with large amounts of water or a sterile saline solution. Irrigate acid burns to the eyes for at least 5 to 10 minutes with at least 2000 ml of water. Irrigate alkali burns to the eyes for at least 20 minutes. Because of the intense pain, the victim may be unable to open the eyes. If this occurs, hold the eyelids apart so that water can flow across the eye.

A drinking fountain or field “water buffalo” may be used to supply a steady stream of water. Hold the victim’s head in a position that allows water to flow from the inside corner of the eye toward the outside. Do not allow the water to fall directly on the eye, and do not use greater force than is necessary to keep the water flowing across the eye.

CAUTION: Never use any chemical antidotes such as baking soda or alcohol in treating burns of the eye, and do not try to neutralize chemical agents.

After thorough irrigation, loosely cover both eyes with a clean dressing. This prevents further damage by decreasing eye movement.

The aftercare for all chemical burns is similar to that for thermal burns: Cover the affected area and get the victim to a medical treatment facility as soon as possible.

WHITE PHOSPHORUS BURNS

A special category of burns that may affect military personnel in a wartime or training situation is that caused by exposure of white phosphorus (WP or Willy Peter). First aid for this type of burn is

complicated by the fact that white phosphorus particles ignite upon contact with air.

Superficial burns caused by simple skin contact or burning clothes should be flushed with water and treated like thermal burns. Partially embedded white phosphorus particles must be continuously flushed with water while the first aid provider removes them with whatever tools are available (i.e., tweezers, pliers, forceps). Do this quickly, but gently. Firmly or deeply embedded particles that cannot be removed by the first aid provider must be covered with a saline-soaked dressing, and this dressing must be kept wet until the victim reaches a medical treatment facility. The wounds containing embedded phosphorus particles may then be rinsed with a dilute, freshly mixed 1% solution of copper sulfate. This solution combines with phosphorus on the surface of the particles to form a blue-black cupric phosphite covering, which both impedes further oxidation and facilitates identification of retained particles. **Under no circumstances** should the copper sulfate solution be applied as a wet dressing. Wounds must be flushed thoroughly with a saline solution following the copper sulfate rinse to prevent absorption of excessive amounts of copper. (Copper has been associated with extensive intravascular hemolysis.) An adjunct to the management of phosphorus burn injuries is the identification of the retained phosphorescent particles in a darkened room during debridement.

NOTE: Combustion of white phosphorus results in the formation of a severe pulmonary irritant. The ignition of phosphorus in a closed space (such as the BAS tent or sickbay) may result in the development of irritant concentrations sufficient to cause acute inflammatory changes in the tracheobronchial tree. The effects of this gas, especially during debridement, can be minimized by placing a moist cloth over the nose and mouth to inactivate the gas and by ventilating the tent.

HEAT EXPOSURE INJURIES

LEARNING OBJECTIVE: *Identify the signs, symptoms, and emergency treatment of heat cramps, heat exhaustion, and heat stroke.*

Excessive heat affects the body in a variety of ways. When a person exercises or works in a hot environment, heat builds up inside the body. The body

automatically reacts to get rid of this heat through the sweating mechanism. This depletes water and electrolytes from the circulating volume. If they are not adequately replaced, body functions are affected, and, initially, heat cramps and heat exhaustion develop. If the body becomes too overheated or water or electrolytes too depleted, the sweat-control mechanism of the body malfunctions and shuts down. The result is heat stroke (sunstroke). Heat exposure injuries are a threat in any hot environment, but especially in desert or tropical areas and in the boiler rooms of ships. Under normal conditions, it is a preventable injury. Individual and command awareness of the causes of heat stress problems should help eliminate heat exposure injuries.

Heat Cramps

Excessive sweating may result in painful cramps in the muscles of the abdomen, legs, and arms. Heat cramps may also result from drinking ice water or other cold drinks either too quickly or in too large a quantity after exercise. Muscle cramps are often an early sign of approaching heat exhaustion.

To provide first aid treatment for heat cramps, move the victim to a cool place. Since heat cramps are caused by loss of salt and water, give the victim plenty of cool (not cold) water to drink, adding about one teaspoon of salt to a liter or quart of water. Apply manual pressure to the cramped muscle, or gently massage it to relieve the spasm. If there are indications of anything more serious, transport the victim immediately to a medical treatment facility.

Heat Exhaustion

Heat exhaustion (heat prostration or heat collapse) is the most common condition caused by working or exercising in hot environments. In heat exhaustion, there is a serious disturbance of blood flow to the brain, heart, and lungs. This causes the victim to experience weakness, dizziness, headache, nausea, and loss of appetite. The victim may faint but will probably regain consciousness as the head is lowered, which improves the blood supply to the brain. Signs and symptoms of heat exhaustion are similar to those of shock; the victim will appear ashen gray, the skin cool, moist, and clammy and the pupils may be dilated (fig. 4-50). The vital signs usually are normal; however, the victim may have a weak pulse, together with rapid and shallow breathing. Body temperature may be below normal.

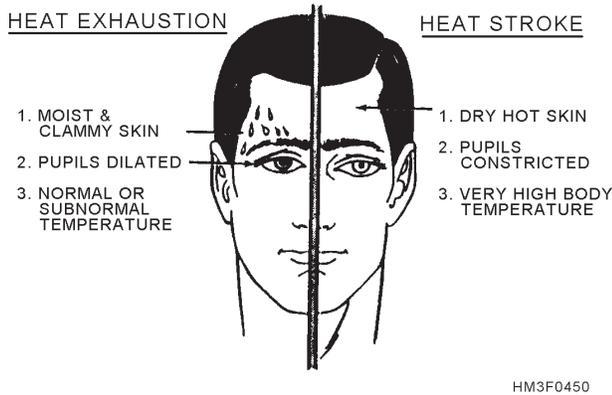


Figure 4-50.—Heat exhaustion and heat stroke.

Treat heat exhaustion as if the victim were in shock. Move the victim to a cool or air-conditioned area. Loosen the clothing, apply cool wet cloths to the head, axilla, groin, and ankles, and fan the victim. Do not allow the victim to become chilled. (If this does occur, cover with a light blanket and move into a warmer area.) If the victim is conscious, give a solution of 1 teaspoon of salt dissolved in a liter of cool water. If the victim vomits, do not give any more fluids. Transport the victim to a medical treatment facility as soon as possible. Intravenous fluid infusion may be necessary for effective fluid and electrolyte replacement to combat shock.

Heat Stroke

Sunstroke is more accurately called heat stroke since it is not necessary to be exposed to the sun for this condition to develop. It is a less common but far more serious condition than heat exhaustion, since it carries a 20 percent mortality rate. The most important feature of heat stroke is the extremely high body temperature (105°F, 41°C or higher) accompanying it. In heat stroke, the victim suffers a breakdown of the sweating mechanism and is unable to eliminate excessive body heat build up while exercising. If the body temperature rises too high, the brain, kidneys, and liver may be permanently damaged.

Sometimes the victim may have preliminary symptoms such as headache, nausea, dizziness, or weakness. Breathing will be deep and rapid at first, later shallow and almost absent. Usually the victim will be flushed, very dry, and very hot. The pupils will be constricted (pinpoint) and the pulse fast and strong (fig. 4-50). Compare these symptoms with those of heat exhaustion.

When providing first aid for heat stroke, remember that this is a true life-and-death emergency. The longer the victim remains overheated, the more likely irreversible brain damage or death will occur. First aid is designed to reduce body heat fast.

Reduce heat immediately by dousing the body with cold water or by applying wet, cold towels to the whole body. Move the victim to the coolest place available and remove as much clothing as possible. Maintain an open airway. Place the victim on his back, with the head and shoulders slightly raised. If cold packs are available, place them under the arms, around the neck, at the ankles, and in the groin. Expose the victim to a fan or air conditioner, since drafts will promote cooling. Immersing the victim in a cold water bath is also very effective. If the victim is conscious, give cool water to drink. **Do not give any hot drinks or stimulants.** Discontinue cooling when the rectal temperature reaches 102°F; watch for recurrence of temperature rise by checking every 10 minutes. Repeat cooling if temperature reaches 103°F rectally.

Get the victim to a medical facility as soon as possible. Cooling measures must be continued while the victim is being transported. Intravenous fluid infusion may be necessary for effective fluid and electrolyte replacement to combat shock.

Prevention of Heat Exposure Injuries

LEARNING OBJECTIVE: *Determine the steps needed to prevent heat exposure injuries.*

The prevention of heat exposure injuries is a command responsibility, but the medical department plays a role in it by educating all hands about the medical dangers, monitoring environmental health, and advising the commanding officer.

On the individual level, prevention centers on water and salt replacement. Sweat must be replaced ounce for ounce; in a hot environment, water consumption must be drastically increased. Salt should be replaced by eating well-balanced meals, three times a day, salted to taste. In the field, “C” rations contain enough salt to sustain a person in most situations. **DO NOT** use salt tablets unless specified by a physician. **DO NOT** consume alcoholic beverages.

At the command level, prevention centers on an awareness of the environment. The Wet Bulb Globe

Temperature (WBGT) must be monitored regularly, and the results interpreted with the Physiological Heat Exposure Limit (PHEL) chart before work assignments are made. In addition, unnecessary heat sources, especially steam leaks, must be eliminated, and vents and exhaust blowers must be checked for adequate circulation. The results will be a happier, healthier, and more productive crew.

COLD EXPOSURE INJURIES

LEARNING OBJECTIVE: *Identify the signs, symptoms, and emergency treatment of each type of cold exposure injury.*

When the body is subjected to extremely cold temperatures, blood vessels constrict, and body heat is gradually lost. As the body temperature drops, tissues are easily damaged or destroyed.

The cold injuries resulting from inadequate response to the cold in military situations have spelled disaster for many armies—those of Napoleon and Hitler in their Russian campaigns, for example. The weather (i.e., temperature, humidity, precipitation, and wind) is the predominant influence in the development of cold injuries. Falling temperature interacting with high humidity, a wet environment, and rising wind accelerates the loss of body heat.

Other factors that influence the development of cold injuries are the individual's level of dehydration, the presence of other injuries (especially those causing a reduction in circulatory flow), and a previous cold injury (which increases susceptibility by lowering resistance). In addition, the use of any drug (including alcohol) that modifies autonomic nervous system response or alters judgment ability can drastically reduce an individual's chance for survival in a cold environment.

Like heat exposure injuries, cold exposure injuries are preventable. Acclimatization, the availability of warm, layered clothing, and maintenance of good discipline and training standards are important factors. These are command—not medical—responsibilities, but the Corpsman plays a crucial role as a monitor of nutritional intake and personal hygiene (with emphasis on foot care) and as an advisor to the commanding officer. A Corpsman is also responsible for acquainting the troops with the dangers of cold exposure and with preventive measures.

Two major points must be stressed in the management of all cold injuries: Rapid rewarming is

of primary importance, and all unnecessary manipulations of affected areas must be avoided. More will be said about these points later.

In military operations the treatment of cold injuries is influenced by the tactical situation, the facilities available for the evacuation of casualties, and the fact that most cold injuries are encountered in large numbers during periods of intense combat when many other wounded casualties appear. Highly individualized treatment under these circumstances may be impossible because examination and treatment of more life-endangering wounds must be given priority. In a high-casualty situation, shelter cold-injury victims, and try to protect them from further injury until there is sufficient time to treat them.

All cold injuries are similar, varying only in the degree of tissue damage. Although the effects of cold can, in general, be divided into two types—general cooling of the entire body and local cooling of parts of the body—cold injuries are seldom strictly of one type or the other; rather, these injuries tend to be a combination of both types. Each type of cooling, however, will be discussed separately in the sections that follow.

General Cooling (Hypothermia)

General cooling of the whole body is caused by continued exposure to low or rapidly falling temperatures, cold moisture, snow, or ice. Those exposed to low temperatures for extended periods may suffer ill effects, even if they are well protected by clothing, because cold affects the body systems slowly, almost without notice. As the body cools, there are several stages of progressive discomfort and disability. The first symptom is shivering, which is an attempt to generate heat by repeated contractions of surface muscles. This is followed by a feeling of listlessness, indifference, and drowsiness. Unconsciousness can follow quickly. Shock becomes evident as the victim's eyes assume a glassy stare, respiration becomes slow and shallow, and the pulse is weak or absent. As the body temperature drops even lower, peripheral circulation decreases and the extremities become susceptible to freezing. Finally, death results as the core temperature of the body approaches 80°F.

The steps for treatment of hypothermia are as follows:

1. Carefully observe respiratory effort and heart beat; CPR may be required while the warming process is underway.

2. Rewarm the victim as soon as possible. It may be necessary to treat other injuries before the victim can be moved to a warmer place. Severe bleeding must be controlled and fractures splinted over clothing before the victim is moved.
3. Replace wet or frozen clothing and remove anything that constricts the victim's arms, legs, or fingers, interfering with circulation.
4. If the victim is inside a warm place and is conscious, the most effective method of warming is immersion in a tub of warm (100° to 105°F or 38° to 41°C) water. The water should be warm to the elbow—never hot. Observe closely for signs of respiratory failure and cardiac arrest (rewarming shock). Rewarming shock can be minimized by warming the body trunk before the limbs to prevent vasodilation in the extremities with subsequent shock due to blood volume shifts.
5. If a tub is not available, apply external heat to both sides of the victim. Natural body heat (skin to skin) from two rescuers is the best method. This is called “buddy warming.” If this is not practical, use hot water bottles or an electric rewarming blanket. Do not place the blanket or bottles next to bare skin, however, and be careful to monitor the temperature of the artificial heat source, since the victim is very susceptible to burn injury. Because the victim is unable to generate adequate body heat, placement under a blanket or in a sleeping bag is not sufficient treatment.
6. If the victim is conscious, give warm liquids to drink. Never give alcoholic beverages or allow the victim to smoke.
7. Dry the victim thoroughly if water is used for rewarming.
8. As soon as possible, transfer the victim to a definitive care facility. Be alert for the signs of respiratory and cardiac arrest during transfer, and keep the victim warm.

Local Cooling

Local cooling injuries, affecting individual parts of the body, fall into two categories: freezing and nonfreezing injuries. In the order of increasing seriousness, they include chilblain, immersion foot,

superficial frostbite, and deep frostbite. The areas most commonly affected are the face and extremities.

CHILBLAIN.—Chilblain is a mild cold injury caused by prolonged and repeated exposure for several hours to air temperatures from above freezing 32°F (0°C) to as high as 60°F (16°C). Chilblain is characterized by redness, swelling, tingling, and pain to the affected skin area. Injuries of this nature require no specific treatment except warming of the affected part (if possible use a water bath of 90°F to 105°F), keeping it dry, and preventing further exposure.

IMMERSION FOOT.—Immersion foot, which also may occur in the hands, results from prolonged exposure to wet cold at temperatures ranging from just above freezing to 50°F (10°C). Immersion foot is usually seen in connection with limited motion of the extremities and water-soaked protective clothing.

Signs and symptoms of immersion foot are tingling and numbness of the affected areas; swelling of the legs, feet, or hands; bluish discoloration of the skin; and painful blisters. Gangrene may occur. General treatment for immersion foot is as follows:

1. Get the victim off his feet as soon as possible.
2. Remove wet shoes, socks, and gloves to improve circulation.
3. Expose the affected area to warm, dry air.
4. Keep the victim warm.
5. **Do not** rupture blisters or apply salves and ointments.
6. If the skin is not broken or loose, the injured part may be left exposed; however, if it is necessary to transport the victim, cover the injured area with loosely wrapped fluff bandages of sterile gauze.
7. If the skin is broken, place a sterile sheet under the extremity and gently wrap it to protect the sensitive tissue from pressure and additional injury.
8. Transport the victim as soon as possible to a medical treatment facility as a litter patient.

FROSTBITE.—Frostbite occurs when ice crystals form in the skin or deeper tissues after exposure to a temperature of 32°F (0°C) or lower. Depending upon the temperature, altitude, and wind speed, the exposure time necessary to produce frostbite varies from a few minutes to several hours.

The areas most commonly affected are the face and extremities.

The symptoms of frostbite are progressive. Victims generally incur this injury without being acutely aware of it. Initially, the affected skin reddens and there is an uncomfortable coldness. With continued heat loss, there is a numbness of the affected area due to reduced circulation. As ice crystals form, the frozen extremity appears white, yellow-white, or mottled blue-white, and is cold, hard, and insensitive to touch or pressure. Frostbite is classified as superficial or deep, depending on the extent of tissue involvement.

Superficial Frostbite.—In superficial frostbite the surface of the skin will feel hard, but the underlying tissue will be soft, allowing it to move over bony ridges. This is evidence that only the skin and the region just below it are involved. General treatment for superficial frostbite is as follows:

1. Take the victim indoors.
2. Rewarm hands by placing them under the armpits, against the abdomen, or between the legs.
3. Rewarm feet by placing them in the armpit or against the abdomen of the buddy.
4. Gradually rewarm the affected area by warm water immersion, skin-to-skin contact, or hot water bottles.
5. Never rub a frostbite area.

Deep Frostbite.—In deep frostbite, the freezing reaches into the deep tissue layers. There are ice crystals in the entire thickness of the extremity. The skin will not move over bony ridges and will feel hard and solid.

The objectives of treatment are to protect the frozen areas from further injury, to rapidly thaw the affected area, and to be prepared to respond to circulatory or respiratory difficulties.

1. Carefully assess and treat any other injuries first. Constantly monitor the victim's pulse and breathing since respiratory and heart problems can develop rapidly. Be prepared to administer CPR if necessary.
2. Do not attempt to thaw the frostbitten area if there is a possibility of refreezing. It is better to

leave the part frozen until the victim arrives at a medical treatment facility equipped for long-term care. Refreezing of a thawed extremity causes severe and disabling damage.

3. Treat all victims with injuries to the feet or legs as litter patients. When this is not possible, the victim may walk on the frozen limb, since it has been proven that walking will not lessen the chances of successful treatment as long as the limb has not thawed out.
4. When adequate protection from further cold exposure is available, prepare the victim for rewarming by removing all constricting clothing such as gloves, boots, and socks. Boots and clothing frozen on the body should be thawed by warm-water immersion before removal.
5. Rapidly rewarm frozen areas by immersion in water at 100°F to 105°F (38°C to 41°C). Keep the water warm by adding fresh hot water, but do not pour the water directly on the injured area. Ensure that the frozen area is completely surrounded by water; do not let it rest on the side or bottom of the tub.
6. After rewarming has been completed, pat the area dry with a soft towel. Later it will swell, sting, and burn. Blisters may develop. These should be protected from breaking. Avoid pressure, rubbing, or constriction of the injured area. Keep the skin dry with sterile dressings and place cotton between the toes and fingers to prevent their sticking together.
7. Protect the tissue from additional injury and keep it as clean as possible (use sterile dressings and linen).
8. Try to improve the general morale and comfort of the victim by giving hot, stimulating fluids such as tea or coffee. Do not allow the victim to smoke or use alcoholic beverages while being treated.
9. Transfer to a medical treatment facility as soon as possible. During transportation, slightly elevate the frostbitten area and keep the victim and the injured area warm. Do not allow the injured area to be exposed to the cold.

Later Management of Cold Injuries

LEARNING OBJECTIVE: *Determine the steps needed for the later management of cold-exposure injuries.*

When the patient reaches a hospital or a facility for definitive care, the following treatment should be employed:

1. Maintain continued vigilance to avoid further damage to the injured tissue. In general, this is accomplished by keeping the patient at bed rest with the injured part elevated (on surgically clean sheets) and with sterile pieces of cotton separating the toes or fingers. Expose all lesions to the air at normal room temperature. Weight bearing on injured tissue must be avoided.
2. Whirlpool baths, twice daily at 98.6°F (37°C) with surgical soap added, assist in superficial debridement, reduce superficial bacterial contamination, and make range of motion exercises more tolerable.
3. Analgesics may be required in the early post-thaw days but will soon become unnecessary in uncomplicated cases.
4. Encourage the patient to take a nutritious diet with adequate fluid intake to maintain hydration.
5. Perform superficial debridement of ruptured blebs, and remove suppurative scabs and partially detached nails.

MORPHINE USE FOR PAIN RELIEF

LEARNING OBJECTIVE: *Recall morphine dosage, administration routes, indications, contraindications, and casualty marking procedures.*

As a Corpsman, you may be issued morphine for the control of shock through the relief of severe pain. You will be issued this controlled drug under very strict accountability procedures. Possession of this drug is a medical responsibility that must not be taken lightly. Policies pertaining to morphine administration are outlined in BUMEDINST 6570.2, *Morphia Dosage and Casualty Marking*.

MORPHINE ADMINISTRATION

Morphine is the most effective of all pain-relieving drugs. It is most commonly available in premeasured doses in syrettes or tubexes. Proper administration in selected patients relieves distressing pain and assists in preventing shock. The adult dose of morphine is 10 to 20 mg, which may be repeated, if necessary, in no less than 4 hours.

Morphine has several undesirable effects, however, and a Corpsman must thoroughly understand these effects. Morphine

- is a severe respiratory depressant and must not be given to patients in moderate or severe shock or in respiratory distress.
- increases intracranial pressure and may induce vomiting. These effects may be disastrous in head injury cases.
- causes constriction of the pupils (pinpoint pupils). This effect prevents the use of the pupillary reactions for diagnosis in head injuries.
- is cardiotoxic and a peripheral vasodilator. Small doses of morphine may cause profound hypotension in a patient in shock.
- poisoning is always a danger. There is a narrow safety margin between the amounts of morphine that may be given therapeutically and the amounts that produce death.
- causes considerable mental confusion and interferes with the proper exercise of judgment. Therefore, morphine should not be given to ambulatory patients.
- is a highly addictive drug. Morphine should not be given trivially and must be rigidly accounted for. Only under emergency circumstances should the Corpsman administer morphine.

Rigidly control morphine administration to patients in shock or with extensive burns. Because of the reduced peripheral circulation, morphine administration by subcutaneous or intramuscular routes may not be absorbed into the bloodstream, and pain may persist. When pain persists, the uninformed often give additional doses, hoping to bring about relief. When resuscitation occurs and the peripheral circulation improves, the stored quantities of morphine are released into the system, and an extremely serious condition (morphine poisoning) results.

When other pain-relieving drugs are not available and the patient in shock or with burns is in severe pain, 20 mg of morphine may be given intramuscularly (followed by massage of the injection site). Resist the temptation to give more, however. Unless otherwise ordered by a medical officer, doses should not be repeated more than twice, and then at least 4 hours apart.

If the pain from a wound is severe, morphine may be given when examination of the patient reveals no

- head injury;
- chest injury, including sucking and nonsucking wounds;
- wounds of the throat, nasal passages, oral cavity, or jaws wherein blood might obstruct the airway;
- massive hemorrhage;
- respiratory impairment, including chemical burns of the respiratory tract (any casualty having fewer than 16 respirations per minute should not be given morphine);
- evidence of severe or deepening shock; or
- loss of consciousness.

CASUALTY MARKING

Morphine overdose is always a danger. For this reason, plainly identify every casualty who has received morphine. Write the letter “M” and the hour of injection on the patient’s forehead (e.g., M0830) with a skin pencil or semi-permanent marking substitute. Attach the empty morphine syrette or tubex to the patient’s shirt collar or another conspicuous area of the clothing with a safety pin or by some other means. This action will alert others that the drug has been administered. If a Field Medical Card is prepared, record the dosage, time, date, and route of administration.

COMMON MEDICAL EMERGENCIES

LEARNING OBJECTIVE: *Choose the appropriate treatment and management techniques for the common medical emergencies.*

This section of the chapter deals with relatively common medical emergencies a Hospital Corpsman may face. Generally speaking, these particular

problems are the result of previously diagnosed medical conditions; so, at least for the victim, they do not come as a complete surprise. Many of these victims wear a medical identification device (necklace or bracelet), or carry a medical identification card that specifies the nature of the medical condition or the type of medications being taken. In all cases of sudden illness, search the victim for a medical identification device.

SYNCOPE

Uncomplicated syncope (fainting) is the result of blood pooling in dilated veins, which reduces the amount of blood being pumped to the brain. Causes of syncope include getting up too quickly, standing for long periods with little movement, and stressful situations. Signs and symptoms that may be present are dizziness; nausea; visual disturbance from pupillary dilation; sweating; pallor; and a weak, rapid pulse. As the body collapses, blood returns to the head, and consciousness is quickly regained. Revival can be promoted by carefully placing the victim in the shock position or in a sitting position with the head between the knees. Placing a cool, wet cloth on the patient’s face and loosening their clothing can also help.

Syncope may also result from an underlying medical problem such as diabetes, cerebrovascular accident (stroke), heart condition, or epilepsy.

DIABETIC CONDITIONS

Diabetes mellitus is an inherited condition in which the pancreas secretes an insufficient amount of the protein hormone insulin. Insulin regulates carbohydrate metabolism by enabling glucose to enter cells for use as an energy source. Diabetics almost always wear a medical identification device.

Diabetic Ketoacidosis

Diabetic ketoacidosis most often results either from forgetting to take insulin or from taking too little insulin to maintain a balanced condition. Diabetics may suffer from rising levels of glucose in the blood stream (hyperglycemia). The rising levels of glucose result in osmotic diuresis, an increased renal excretion of urine. Serious dehydration (hypovolemia) may result. Concurrently, the lack of glucose in the cells leads to an increase in metabolic acids in the blood (acidosis) as other substances, such as fats, are metabolized as energy sources. The result is gradual central nervous system depression, starting with symptoms of confusion and disorientation, and leading

to stupor and coma. Blood pressure falls, and the pulse rate becomes rapid and weak. Respirations are deep, and a sickly sweet acetone odor is present on the breath. The skin is warm and dry.

NOTE: Diabetic victims are often mistakenly treated as if intoxicated since the signs and symptoms presented are similar to those of alcohol intoxication.

The diabetic under treatment tries to balance the use of insulin against glucose intake to avoid the above problems. The victim or the victim's family may be able to answer two key questions:

1. Has the victim eaten today?
2. Has he taken the prescribed insulin?

If the answer is yes to the first and no to the second question, the victim is probably in a diabetic coma.

Emergency first aid centers around ABC support, administration of oral or intravenous fluids to counter shock, and rapid evacuation to a medical officer's supervision.

Insulin Shock

Insulin shock results from too little sugar in the blood (hypoglycemia). This type of shock develops when a diabetic exercises too much or eats too little after taking insulin. Insulin shock is a very serious condition because glucose is driven into the cells to be metabolized, leaving too little glucose in circulation to support the brain. Brain damage develops quickly. Signs and symptoms of insulin shock include

- pale, moist skin;
- dizziness and headache;
- strong, rapid pulse; and
- fainting, seizures, and coma.

Treatment is centered on getting glucose into the system quickly to prevent brain damage. Placing sugar cubes under the tongue or administering oral liquid glucose are the most beneficial treatments. Transport the victim to a medical treatment facility as soon as possible.

NOTE: If you are in doubt as to whether the victim is in insulin shock or a ketoacidotic state, give them sugar. Brain damage develops very quickly in insulin shock and must be reversed immediately. If the victim turns out to be ketoacidotic, a condition that progresses

slowly, the extra sugar will do no appreciable harm.

CEREBROVASCULAR ACCIDENT

A cerebrovascular accident, also known as **stroke** or **apoplexy**, is caused by an interruption of the arterial blood supply to a portion of the brain. This interruption may be caused by arteriosclerosis or by a clot forming in the brain. Tissue damage and loss of function result.

Onset of a cerebrovascular accident is sudden, with little or no warning. The first signs include weakness or paralysis on the side of the body opposite the side of the brain that has been injured. Muscles of the face on the affected side may be involved. The patient's level of consciousness varies from alert to unresponsive. Additionally, motor functions—including vision and speech—on the affected side are disturbed, and the throat may be paralyzed.

Emergency treatment for a cerebrovascular accident is mainly supportive. Special attention must be paid to the victim's airway, since he may not be able to keep it clear. Place the victim in a semi-reclining position or on the paralyzed side.

- Be prepared to use suction if the victim vomits.
- Act in a calm, reassuring manner, and keep any onlookers quiet since the victim may be able to hear what is going on.
- Administer oxygen to combat cerebral hypoxia.
- Carefully monitor the victim's vital signs and keep a log. Pay special attention to respirations, pulse strength and rate, and the presence or absence of the bilateral carotid pulse.
- Transport the victim to a medical treatment facility as soon as possible.

ANAPHYLACTIC REACTION

This condition, also called **anaphylaxis** or **anaphylactic shock**, is a severe allergic reaction to foreign material. The most frequent causes are probably penicillin and the toxin from bee stings, although foods, inhalants, and contact substances can also cause a reaction. Anaphylaxis can happen at any time, even to people who have taken penicillin many times before without experiencing any problems. This condition produces severe shock and cardiopulmonary failure of a very rapid onset. Because of the rapidity

and severity of the onset of symptoms, immediate intervention is necessary. The general treatment for severe anaphylaxis is the subcutaneous injection of 0.3 cc of epinephrine and supportive care.

The most characteristic and serious symptoms of an anaphylactic reaction are loss of voice and difficulty breathing. Other typical signs are giant hives, coughing, and wheezing. As the condition progresses, signs and symptoms of shock develop, followed by respiratory failure. Emergency management consists of maintaining vital life functions. Summon the medical officer immediately.

POISONS/DRUG ABUSE/HAZARDOUS MATERIALS

As a Hospital Corpsman, you could encounter special situations that include poisoning, suspected drug abuse, or exposure to hazardous materials. Knowledge of these conditions—along with the ability to assess and treat them—is essential. These situations are discussed in detail in chapter 5, “Poisoning, Drug Abuse, and Hazardous Material Exposure.”

HEART CONDITIONS

A number of heart conditions are commonly referred to as heart attacks. These conditions include **angina pectoris**, **acute myocardial infarction**, and **congestive heart failure**. Together these heart conditions are the cause of at least half a million deaths per year in our country. Heart conditions occur more commonly in men in the 50-to-60-year age group. Predisposing factors are the lack of physical conditioning, high blood pressure and blood cholesterol levels, smoking, diabetes, and a family history of heart disease.

Angina Pectoris

Angina pectoris, also known simply as **angina**, is caused by insufficient oxygen being circulated to the heart muscle. This condition results from a spasm of the coronary artery, which allows the heart to function adequately at rest but does not allow enough oxygen-enriched blood to pass through the heart to support sustained exercise. When the body exerts itself, the heart muscle becomes starved for oxygen. The result of this condition is a squeezing, substernal pain that may radiate to the left arm and to the jaw.

Angina is differentiated from other forms of heart problems because the pain results from exertion and

subsides with rest. Many people who suffer from angina pectoris carry nitroglycerin tablets. If the victim of a suspected angina attack is carrying a bottle of these pills, place one pill under the tongue. Relief will be almost instantaneous. Other first aid procedures include providing supplemental oxygen, reassurance, comfort, monitoring vital signs, and transporting the victim to a medical treatment facility.

Acute Myocardial Infarction

Acute myocardial infarction results when a coronary artery is severely occluded by arteriosclerosis or completely blocked by a clot. The pain associated with myocardial infarction is similar to that of angina pectoris but is longer in duration, not related to exertion or relieved by nitroglycerin, and leads to death of heart-muscle tissue. Other symptoms are sweating, weakness, and nausea. Additionally, although the patient’s respirations are usually normal, his pulse rate increases and may be irregular, and his blood pressure falls. The victim may have an overwhelming feeling of doom. Death may result.

First aid for an acute myocardial infarction includes

- reassurance and comfort while placing the victim in a semi-sitting position;
- loosening of all clothing;
- carefully maintaining a log of vital signs, and recording the history and general observations;
- continuously monitoring vital signs and being prepared to start CPR;
- starting a slow intravenous infusion of 5% dextrose solution in water;
- administering oxygen; and
- quickly transporting the victim to a medical treatment facility.

Congestive Heart Failure

A heart suffering from prolonged hypertension, valve disease, or heart disease will try to compensate for decreased function by increasing the size of the left ventricular pumping chamber and increasing the heart rate. This condition is known as congestive heart failure. As blood pressure increases, fluid is forced out of the blood vessels and into the lungs, causing pulmonary edema. Pulmonary edema leads to rapid shallow respirations, the appearance of pink frothy

bubbles at the nose and mouth and distinctive rattling sounds (known as **rales**) in the chest. Increased blood pressure may also cause body fluids to pool in the extremities.

Emergency treatment for congestive heart failure is essentially the same as that for acute myocardial infarction. Do not start CPR unless the patient's heart function ceases. If an intravenous line is started, it should be maintained at the slowest rate possible to keep the vein open since an increase in the circulatory volume will make the condition worse. Immediately transport the patient to a medical treatment facility.

CONVULSIONS

Convulsions, or seizures, are a startling and often frightening phenomenon. Convulsions are characterized by severe and uncontrolled muscle spasms or muscle rigidity. Convulsive episodes occur in one to two percent of the general population.

Although epilepsy is the most widely known form of seizure activity, there are numerous forms of convulsions that are classified as either central nervous system (CNS) or non-CNS in origin. It is especially important to determine the cause in patients who have no previous seizure history. This determination may require an extensive medical workup in the hospital. Since epilepsy is the most widely known form of seizure activity, this section will highlight epileptic seizure disorders.

Epilepsy, also known as seizures or fits, is a condition characterized by an abnormal focus of activity in the brain that produces severe motor responses or changes in consciousness. Epilepsy may result from head trauma, scarred brain tissue, brain tumors, cerebral arterial occlusion, fever, or a number of other factors. Fortunately, epilepsy can often be controlled by medications.

Grand mal seizure is the more serious type of epilepsy. Grand mal seizure may be—but is not always—preceded by an aura. The victim soon comes to recognize these auras, which allows him time to lie down and prepare for the seizure's onset. A burst of nerve impulses from the brain causes unconsciousness and generalized muscular contractions, often with loss of bladder and bowel control. The primary dangers in a grand mal seizure are tongue biting and injuries resulting from falls. A period of sleep or mental confusion follows this type of seizure. When full consciousness returns, the victim will have little or no recollection of the attack.

Petit mal seizure is of short duration and is characterized by an altered state of awareness or partial loss of consciousness, and localized muscular contractions. The patient has no warning of the seizure's onset and little or no memory of the attack after it is over.

First aid treatment for both types of epileptic seizure consists of protecting the victim from self-injury. Additional methods of seizure control may be employed under a medical officer's supervision. In all cases, be prepared to provide suction to the victim since the risk of aspiration is significant. Transport the patient to a medical treatment facility once the seizure has ended.

DROWNING

Drowning is a suffocating condition in a water environment. Water seldom enters the lungs in appreciable quantities because, upon contact with fluid, laryngeal spasms occur, and these spasms seal the airway from the mouth and nose passages. To avoid serious damage from the resulting hypoxia, quickly bring the victim to the surface and immediately—even before the victim is pulled to shore—start artificial ventilation. Do not interrupt artificial ventilation until the rescuer and the victim are ashore. Once on dry ground, quickly administer an abdominal thrust (Heimlich maneuver) to empty the lungs, and then immediately restart the ventilation until spontaneous breathing returns. Oxygen enrichment is desirable if a mask is available.

Remember that an apparently lifeless person who has been immersed in cold water for a long period of time may be revived if artificial ventilation is started immediately.

PSYCHIATRIC EMERGENCIES

A psychiatric emergency is defined as a sudden onset of behavioral or emotional responses that, if not responded to, will result in a life-threatening situation. Probably the most common psychiatric emergency is the suicide attempt. A suicide attempt may range from verbal threats and suicidal gestures to a successful suicide. Always assume that a suicide threat is real; do not leave the patient alone. In all cases, the prime consideration for a Hospital Corpsman is to keep patients from inflicting harm to themselves and to get them under the care of a trained psychiatric professional. When dealing with suicidal gestures or attempts, treat any self-inflicted wounds appropriately.

In the case of ingested substances, do not induce vomiting in a patient who is not awake and alert. For specific treatment of ingested substances, refer to the section on poisons in chapter 5.

There are numerous other psychiatric conditions that would require volumes to expound upon. In almost all cases, appropriate first aid treatment consists of a calm, professional, understanding demeanor that does not aggravate or agitate the patient. With an assaultive or hostile patient, a “show of force” may be all that is required. Almost all cases of psychiatric emergencies will present with a third party—]often the family or friend of the patient—who has recognized a distinct change in the behavior pattern of the patient and who is seeking help for them.

DERMATOLOGIC EMERGENCIES

Most dermatologic cases that present as emergencies are not real emergencies. The patient perceives them as such because of the sudden presentation and/or repulsive appearance or excessive discomfort. Treat most dermatologic conditions symptomatically. The major exception to symptomatic treatment is **toxic epidermal necrolysis (TEN)**.

Toxic epidermal necrolysis is a condition characterized by sudden onset, excessive skin irritation, painful erythema (redness of skin produced by congestion of the capillaries), **bullae** (large blisters), and exfoliation of the skin in sheets. TEN is also known as the **scalded skin syndrome** because of its appearance. TEN is thought to be caused by a staphylococcal infection in children and by a toxic reaction to medications in adults.

Since skin is the largest single organ of the body and serves as a barrier to infection, prevention of secondary skin infection is very important. Treatment of skin infections consists of isolation techniques, silver nitrate compresses, aggressive skin care, intravenous antibiotic therapy and, in drug-induced cases, systemic steroids.

EMERGENCY CHILDBIRTH

Every Hospital Corpsman must be prepared to handle the unexpected arrival of a new life into the world. If the Corpsman is fortunate, a prepackaged sterile delivery pack will be available. This pack will contain all the equipment needed for the normal delivery of a healthy baby. If the pack is not available,

a Hospital Corpsman will require imaginative improvisation of clean alternatives.

When faced with an imminent childbirth, the Hospital Corpsman must first determine whether there will be time to transport the expectant mother to a hospital. To help make this determination, the Corpsman should try to find out

- if this will be the woman’s first delivery (first deliveries usually take much longer than subsequent deliveries);
- the time between contractions (if less than 3 minutes, delivery is approaching);
- if the mother senses that she has to move her bowels (if so, then the baby’s head is well advanced down the birth canal);
- if there is crowning (bulging) of the orifice (crowning indicates that the baby is ready to present itself); and
- how long it will take to get to the hospital.

The Corpsman must weigh the answers to these questions and decide if it will be safe to transport the patient to the hospital.

Prior to childbirth, a Corpsman must quickly “set the stage.” The mother must not be allowed to go to the bathroom since straining may precipitate delivery. Do not try to inhibit the natural process of childbirth. The mother should lie back on a sturdy table, bed, or stretcher with a folded sheet or blanket placed under her buttocks for absorption and comfort. Remove all the patient’s clothing below the waist, bend the knees, move the thighs apart, and drape her lower extremities with clean towels or sheets. Don sterile gloves, or, if these are not available, rewash your hands.

In a normal delivery, your calm professional manner and sincere reassurance to the mother will reduce her anxiety and make the delivery easier for everyone. Help the woman rest and relax as much as possible between contractions. During a contraction, deep, open-mouth breathing will relieve some pain and straining. As the child’s head reaches the area of the rectum, the mother will feel an urgent need to defecate. Reassurance that this is a natural feeling and a sign that the baby will be born soon will help alleviate her apprehension.

Watch for the presentation of the top of the baby’s head. Once the head appears, take up your station at the foot of the bed and gently push against the head to keep it from emerging too quickly. Allow it to come

out slowly. As more of the head appears, check to be sure that the umbilical cord is not wrapped around the neck. If it is, either gently try to untangle the cord, or move one section over the baby's shoulder. If neither of these actions is possible, clamp the cord in two places, 2 inches apart, and cut it. Once the baby's chin emerges, support the head with one hand and use the bulb syringe from the pack to suction the nostrils and mouth. Before placing the bulb in the baby's mouth or nose, compress it; otherwise, a forceful aspiration into the lungs will result. The baby will now start a natural rotation to the left or right, away from the face-down position. As this rotation occurs, keep the baby's head in a natural relationship with the back. The shoulders appear next, usually one at a time.

NOTE: From this point on, it is essential to remember that the baby is **VERY** slippery, and great care must be taken so that you do not drop it. The surface beneath the mother should extend at least 2 feet out from her buttocks so that the baby will not be hurt if it does slip out of your hands. Keep one hand beneath the baby's head, and use the other hand to support its emerging body.

Once the baby has been born, suction the nose and mouth again if breathing has not started. Wipe the baby's face, nose, and mouth clean with sterile gauze. Your reward will be the baby's hearty cry.

Clamp the umbilical cord as the pulsations cease. Use two clamps from the prepackaged sterile delivery pack, 2 inches apart, with the first clamp 6 to 8 inches from the navel. Cut the cord between the clamps. For safety, use gauze tape to tie the cord 1 inch from the clamp toward the navel. Secure the tie with a square knot. Wrap the baby in a warm, sterile blanket, and log its time of arrival.

The **placenta** (afterbirth) will deliver itself in 10 to 20 minutes. Massaging the mother's lower abdomen can aid this delivery. Do not pull on the placenta. Log the time of the placenta's delivery, and wrap it up for hospital analysis.

Place a small strip of tape (1/2 -inch wide), folded and inscribed with the date, time of delivery, and mother's name, around the baby's wrist.

COMPLICATIONS IN CHILDBIRTH

Unfortunately, not all deliveries go smoothly. The following sections cover various complications in childbirth.

Breech Delivery

A breech delivery occurs when the baby's legs and buttocks emerge first. Follow the steps for a normal delivery, and support the lower extremities with one hand. If the head does not emerge within 3 minutes, try to maintain an airway by gently pushing fingers into the vagina. Push the vagina away from the baby's face and open its mouth with one finger. Get medical assistance immediately.

Prolapsed Cord

If the cord precedes the baby, protect it with moist, sterile wraps. If a physician cannot be reached quickly, place the mother in an extreme shock position. Give the mother oxygen, if available, and gently move your gloved hand into the vagina to keep its walls and the baby from compressing the cord. Get medical assistance immediately.

Excessive Bleeding

If the mother experiences severe bleeding, treat her for shock and give her oxygen, if available. Place sanitary napkins over the vaginal entrance and rush her to a hospital.

Limb Presentation

If a single limb presents itself first, immediately get the mother to a hospital.

SUMMARY

A medical emergency can occur at anytime. You must be prepared to act expeditiously and confidently, whether you are in a combat situation, on board a naval vessel, or at the Navy Exchange. This chapter covers the preliminary steps you should follow when managing sick or injured patients. The preliminary emergency steps include triage, patient assessment, and, when needed, basic life support. Other related topics covered in this chapter are breathing aids, shock, diagnosis and emergency treatment procedures for medical conditions and injuries, morphine use for pain relief, and other common emergencies. In the following chapters, diagnosis and emergency treatment procedures for medical conditions and injuries will be discussed.

CHAPTER 5

POISONING, DRUG ABUSE, AND HAZARDOUS MATERIAL EXPOSURE

As a Hospital Corpsman, you may encounter patients as the result of poisoning, drug overdose, or exposure to hazardous materials. Such patients may initially present with no symptoms or with varying degrees of overt intoxication. The asymptomatic patient may have been exposed to or ingested a lethal dose of a substance but not exhibit any manifestations of toxicity. A patient with mild symptoms may deteriorate rapidly, so observe them closely. Potentially significant exposures should be observed in an acute care facility whenever possible. Remember, though: We are not always in a hospital environment, and we must be prepared to deal with each situation when and wherever it should present itself.

In this chapter, we will discuss the assessment and treatment for ingested, inhaled, absorbed, and injected poisons. Drug abuse assessment and treatment procedures, patient handling techniques, and the recognition of hazardous material (HAZMAT) personal safety guidelines and information sources will also be covered. The last part of the chapter will cover rescue, patient care, and decontamination procedures for patients exposed to HAZMAT.

NOTE: Prior to deployments and operational commitments, commands are strongly recommended to contact the area **Environmental Preventive Medicine Unit (EPMU)** for current, specific, medical intelligence, and surveillance data. With this information at hand, the local preventive medicine authority can identify, prevent, and treat conditions not common to the homeport area. The cognizant EPMU will provide data through MEDIC, (*Medical, Environmental, Diagnosis, Intelligence and Countermeasure*). Formally called a *Disease Risk Assessment Profile (DISRAP)*, MEDIC is a comprehensive, constantly updated management tool. MEDIC is an invaluable aid for identifying at-risk communicable diseases, immunization requirements, and—as applies especially to this chapter—local pests and environmental dangers.

POISONING

LEARNING OBJECTIVE: *Recall assessment and treatment procedures for ingested, inhaled, absorbed, and injected poisons*

A **poison** is a substance that, when introduced into the body, produces a harmful effect on normal body structures or functions. Poisons come in solid, liquid, and gaseous forms, and they may be ingested, inhaled, absorbed, or injected into the system.

Every chemical in a sufficient dose can cause toxic effects in a human—or in any organism. The amount or concentration of a chemical and the duration of exposure to it are what determine the chemical's dose and toxicity. A 16th century quotation from Paracelsus states, "Dose alone makes a poison. . . . All substances are poisons, there is none which is not a poison. The right dose differentiates a poison and a remedy."

A **poisoning** is defined as the presence of signs or symptoms associated with exposure or contact with a substance. If there are no clinical manifestations or toxic effects, the incident is simply an "exposure" or a contact with a potentially poisonous substance. Just being exposed to a chemical does not mean that a poisoning has or will occur. It is a matter of dose and a few other variables (e.g., age, sex, individual resistance, or state of health) that determine if, or what, toxic effects will occur.

ASSESSMENT AND TREATMENT OF PATIENT

In most cases, ASSESSMENT AND TREATMENT OF THE PATIENT IS MORE IMPORTANT THAN EFFORT TO IDENTIFY AND TREAT A SPECIFIC POISON. Supportive therapy—managing the **ABCs (Airway, Breathing, and Circulation)** of basic life support and treating the signs and symptoms—is safe and effective in the vast majority of poisonings. Extraordinary means to enhance elimination of the poison (hemodialysis and hemoperfusion) are seldom needed. Except for agents with a delayed onset of

toxicity (such as acetaminophen), most ingested poisons produce signs and symptoms in less than 4 hours, and most efforts to decontaminate the gut (remove an ingested poison) have little value more than 1 hour after ingestion.

In acute poisonings, prompt treatment is indicated. After the patient has been evaluated and stabilized, general poison management can be initiated. There are six steps in the initial evaluation and follow-on poison management:

1. **Stabilization**, which consists of a brief evaluation and assessment directed toward identifying the measures required to maintain life and prevent further deterioration of the patient.
 - Observe the **ABC + D & E** (Drug-induced central nervous system (CNS) depression, and undressing/uncovering to Expose the patient for disabilities (injuries) to ensure areas of contact or exposure to a chemical can be seen.)
 - Check the pupils for size and reactivity to light, and do a basic neurologic exam.
 - Administer oxygen as needed, IV line for fluids.
 - Watch for signs and symptoms of anaphylaxis.
2. **Evaluation**, which must be performed once the patient is stabilized.
 - Include a full history, physical exam, and ordering of appropriate tests (i.e., labs, EKG, x-rays) directed toward identification of toxic agent, evaluating the severity of toxic effects, and searching for trauma and complications.
 - Periodically reassess the patient. Look for changes. Monitor vital signs, urine output, and cardiac rhythm.
 - Record your findings (including time), and respond to important changes appropriately.
3. **Prevention or limitation of absorption**, through skin decontamination, flushing of eyes, ventilation, stomach emptying, administration of charcoal and cathartics, and whole bowel irrigation.
4. **Elimination enhancement**, through serially administered activated charcoal, ion-trapping

(pH adjustment of the urine to promote excretion of certain poisons), hemodialysis, and hemoperfusion (similar to hemodialysis, but used for larger size molecules).

5. **Administration of specific antidotes**. Less than 5 percent of poisons have specific antidotes. All patients who present should receive glucose, thiamine, and naloxone. Consider supplemental oxygen.
6. **Continuing care and disposition**, including a period of observation and education (i.e., poison prevention) or psychiatric counseling. Establish follow-up.

THE DIAGNOSIS OF POISONING

In most situations, the treatment of a poisoning victim will be under the direction of a medical officer. However, in isolated situations, a Hospital Corpsman must be ready to treat the victim.

Poisoning should be suspected in all cases of sudden, severe, and unexpected illness. You should investigate such situations by ascertaining, as quickly and thoroughly as possible, the answers to the following questions:

- What are the signs and symptoms of the illness?
- What was happening before the illness occurred? (Remember, there may have been a chronic exposure over time with the signs and symptoms just becoming apparent.)
- What substances were in use? Could more than one substance have been involved?
- Is there a container of the suspected substance? If so, how much was there initially, and how much is there now? (If possible, bring the container to the treatment facility. The label will often identify the contents and the recommended precautions and treatment. The label may also list a contact number for emergency advice. Remember, though, that other people—including you—may become contaminated through contact with the container. Handle it carefully.)
- What was the duration of exposure? When did it happen?
- What is the location of the bite or injury (if applicable)?
- Has this happened before?

- Are there other people involved?
- Does the patient have a significant past medical history?
- Is the patient's condition improving/deteriorating?

The presence of a toxic syndrome or **toxidrome** can help establish that a poison has been involved by suggesting the class of poison(s) to which the patient may have been exposed. Table 5-1 provides a list of commonly encountered toxidromes, their sources and symptoms.

The “non-syndrome syndrome” is of special importance. The only method to recognize the potential for a delayed onset poisoning to occur is to suspect the possibility from the history or presentation of a person. In some cases, the individual's affect or behavior may provide a clue. In other cases, the examiner must rely on clinical experience or even a hunch.

GENERAL TREATMENT

Once poisoning has been established, the general rule is to quickly remove as much of the toxic

substance from the victim as possible. The method of removal of the poison varies depending upon how the poison was introduced:

- **Ingested poisons:** There is a choice between emetics and gastric lavage, followed by adsorbents and cathartics.
- **Inhaled poisons:** Oxygen ventilation is the method of choice.
- **Absorbed poisons:** Removal of the poison is primarily attained by cleansing the skin.
- **Injected poisons:** Antidotal medications are recommended.

INGESTED POISONS

Ingested poisons are those poisons which have been consumed, whether accidentally or intentionally, by the victim. Ingestion is the most common route of exposure to toxic materials in the home.

The local actions of an ingested poison can have irritant, acidic (corrosive), or basic (caustic) effects at the site of contact.

Table 5-1.—Commonly Encountered Toxidromes

Syndrome	Sources	Signs & Symptoms
narcotic	opiates, benzodiazepines, barbiturates	“beady eyes,” sunglasses, decreased blood pressure, CNS and respiratory depression
withdrawal	alcohol, barbiturates, benzodiazepines, narcotics, sedative-hypnotics	diarrhea, dilated pupils, goose bumps, increased heart rate, tearing, yawning, stomach cramps, hallucinations
sympathomimetic	theophylline, caffeine, LSD, PCP, amphetamine, cocaine, decongestants	CNS excitation (confusion, incoordination, agitation, hallucination, delirium, seizures), increased blood pressure and heart rate
anticholinergic	antihistamines, atropine, scopolamine, antidepressants, anti-Parkinson R, antipsychotics, antispasmodics, mushrooms, hallucinogens, antidepressants	dry skin, increased heart rate, dilated pupils, fever, urinary retention, decreased bowel sounds, CNS excitation
cholinergic	organophosphates, carbamates, physostigmine, neostigmine, endrophonium	“ SLUDGE ”: increased salivation, lacrimation, urination, defecation, GI cramping, emesis ; CNS (headache, restless, anxiety, confusion, coma, seizures); muscle weakness and fasciculations
non-syndrome syndrome	various chemicals with delayed onset due to biotransformation, depletion of natural detoxifying agent, accumulation of dose or effect	from “nothing” to minor complaints that initially appear to be trivial

NOTE

There are two important categories of substances which act locally on the skin, eyes, or mucous membranes and cause damage through direct contact. These are acids (**corrosives**) and bases (**caustics**). Although these two categories are distinct and there are significant differences in the physiological effects of contact with them, the term “corrosive” is recognized as a generic term for the action that occurs upon contact with either an acid or a base. The terms “corrosive” and “noncorrosive,” as used in this chapter, should be understood to represent the generic and not the specific. When specifically discussing acids or bases in this chapter, the terms “acid” or “base” (or “alkali”), respectively, will be used.

Ingested substances can be absorbed into the body and transported to a distant site with systemic action(s). In such situations, the poisonous substance may cause few effects—or even no effect—at the site of contact or absorption, but it may have severe systemic effects.

Ingestion of substances that do not produce local effects can be divided into two types:

- nontoxic substances (latex paint, dirt, silica gel, spider plant), and
- potentially toxic substances (poisonous fish, medications, heavy metals (lead, mercury), pesticides, and personal care products).

Episodes involving the ingestion of non-toxic substances do not require decontamination of the gut. (Swallowing a non-toxic foreign body, however, like a coin or button battery in a child, may result in choking and require prompt medical intervention.)

The toxicity range of absorbed poisons extends from essentially non-toxic to extremely toxic (remember Paracelsus’ “dose”). Ingestion of substances with a low order of toxicity may result in the production of only minor systemic effects (nausea, vomiting, diarrhea), effects that are mild, self-limiting, and do not require significant medical intervention.

NOTE: Do not induce unnecessary vomiting to discourage a patient from repeating a voluntary ingestion again.

Table 5-2.—Common Stomach Irritants and Possible Sources of Contact

Irritant	Sources of Contact
Arsenic	Dyes, insecticides, paint, printer’s ink, wood preservatives
Copper	Antifoulant paint, batteries, canvas preservative, copper plating, electroplating, fungicides, insecticides, soldering, wood preservatives
Iodine	Antiseptics
Mercury	Bactericides, batteries, dental supplies and appliances, disinfectants, dyes, fungicides, ink, insecticides, laboratories, photography, wood preservatives
Phosphorus	Incendiaries, matches, pesticides, rat poison
Silver nitrate	Batteries, cleaning solutions, ink, photographic film, silver polish, soldering
Zinc	Disinfectants, electroplating, fungicides, galvanizing, ink, insecticides, matches, metal plating and cutting, paint, soldering, wood preservatives

Noncorrosives

The many different noncorrosive substances have the common characteristic of irritating the stomach. They produce nausea, vomiting, convulsions, and severe abdominal pain. The victim may complain of a strange taste, and the lips, tongue, and mouth may look different than normal. Shock may also occur. Examples of noncorrosives are listed in table 5-2.

First aid for most forms of noncorrosive poisoning centers on quickly emptying the stomach of the irritating substance. The following steps are suggested:

1. Maintain an open airway. Be prepared to give artificial ventilation.
2. Dilute the poison by having the conscious victim drink one to two glasses of water or milk.
3. Empty the stomach using emetic, gastric lavage, adsorbent, and/or cathartic.
 - a. Giving an emetic is a preferred method for emptying the contents of the stomach. It is

quick and—except in cases of caustic or petroleum distillate poisoning, or when an antiemetic has been ingested—can be used in almost every situation when the victim is conscious. In most situations, a Hospital Corpsman will have access to syrup of Ipecac. This emetic acts locally by irritating the gastric mucosa and centrally by stimulating the medullary vomiting center in the brain. The usual adult dose is 15-30 cc, and the dose for a child (age 1 to 12 years) is 15 cc. The dosage should be followed immediately by a glass of water. Most people will vomit within 30 minutes. The amount of stomach contents (and poison) recovered will vary. In an emergency room, the medical officer can rapidly induce vomiting by the injection of various medications. If nothing else is available, tickle the back of the victim's throat with your finger or a blunt object. This procedure should induce vomiting.

- b. Trained personnel may use gastric lavage by itself or after two doses of Ipecac syrup has failed to induce vomiting. After passing a large—caliber nasogastric tube, aspirate the stomach contents. Next, instill 100 ml of normal saline into the stomach, then aspirate it out again. Continue this flushing cycle until the returning fluid is clear. Gastric lavage is preferred when the victim is unconscious or—as in the case of strychnine poisoning—is subject to seizures.
 - c. Activated charcoal (AC) adsorbs many substances in the gut and prevents absorption into the body. After the substance is adsorbed to the AC, the bound substance moves through the gut and is eliminated with the production of a charcoal-black bowel movement. AC may be administered after emesis or lavage, or it may be used alone.
 - d. A cathartic (magnesium sulfate or sorbitol) may be used to “speed” the movement of the bound substance and minimize absorption.
4. Collect the vomitus for laboratory analysis.
 5. Soothe the stomach with milk or milk of magnesia.
 6. Transport the victim to a definitive care facility if symptoms persist.

Corrosives

Acids and alkalis (bases) produce actual chemical burning and corrosion of the tissues of the lips, mouth, throat, and stomach. Acids do most of their damage in the acidic stomach environment, while alkalis primarily destroy tissues in the mouth, throat, and esophagus. Stains and burns around the mouth, and the presence of characteristic odors provide clues as to an acid or base ingestion. Swallowing and breathing may be difficult, especially if any corrosive was aspirated into the lungs. Stridor, a high-pitched sound coming from the upper airway, may be heard. The abdomen may be tender and swollen with gas, and perforation of the esophagus or stomach may occur. **NEVER ATTEMPT TO TREAT AN ACID OR BASE INGESTION BY ADMINISTERING A NEUTRALIZING SOLUTION BY MOUTH. GIVE WATER ONLY, UNLESS DIRECTED BY A POISON CONTROL CENTER (PCC) OR MEDICAL OFFICER.** Monitor the ABC+D&Es, and watch for signs of shock.

Examples of corrosive agents and sources of contact are listed in table 5-3.

When providing treatment for the above poisons, **DO NOT INDUCE VOMITING.** The damage to the mouth and esophagus will be compounded. In addition, the threat of aspiration during vomiting is too great. Gastric lavage could cause perforation of the esophagus or stomach. Therefore, use it only on a doctor's order. First aid consists of diluting the corrosive and keeping alert for airway potency and shock. If spontaneous vomiting occurs, administer an antiemetic.

Irritants

Substances such as automatic dishwasher detergent, diluted ammonia, and chlorine bleach can produce local irritation to the mucous membranes and potentially cause mild chemical burns. The pH of irritants may be slightly acidic or basic. If a person has ingested an irritant, direct the patient to spit the product out and rinse the mouth repeatedly with water. Spit the rinse water out also. Do **NOT** administer anything other than water unless directed by a PCC or medical officer.

Petroleum Distillates or Hydrocarbons

Volatile petroleum products (such as kerosene, gasoline, turpentine, and related petroleum products

Table 5-3.—Examples of Common Acids, Alkalies, and Phenols, with Possible Sources of Contact

Agent	Sources of Contact	
ACIDS	Hydrochloric	Electroplating, metal cleaners, photoengraving
	Nitric	Industrial cleaners, laboratories, photoengraving, rocket fuels
	Oxalic	Cleaning solutions, paint and rust removers, photo developer
	Sulfuric	Auto batteries, detergents, dyes, laboratories, metal cleaners
ALKALIES	Ammonia	Galvanizers, household cleaners, laboratories, pesticides, rocket fuels
	Lime	Brick masonry, cement, electroplating, insecticides, soap, water treatment
	Lye	Bleaches, degreasers, detergents, laboratories, paint and varnish removers
	Carbolic	Disinfectants, dry batteries, paint removers, photo materials, wood preservatives
PHENOLS	Creosol	Disinfectants, ink, paint and varnish removers, photo developer, stainers
	Creosote	Asbestos, carpentry, diesel engines, electrical shops, furnaces, lens grinders, painters, waterproofing, wood preservatives

like red furniture polish) usually cause severe chemical pneumonia as well as other toxic effects in the body. Symptoms include abdominal pain, choking, gasping, vomiting, and fever. Often these products may be identified by their characteristic odor. Mineral oil and motor oil are not as serious since they usually do nothing more than cause diarrhea.

When providing treatment for the ingestion of petroleum distillates, **DO NOT INDUCE VOMITING** unless told to do so by a physician or poison control center. Vomiting may cause additional poison to enter the lungs. However, the quantity of poison swallowed or special petroleum additives may make gastric lavage or the use of cathartics advisable. If a physician or poison control center cannot be reached, give the victim 30 to 60 ml of vegetable oil. Transport the victim immediately to a medical treatment facility.

Food Poisoning

Food poisoning can occur from ingesting animal or plant materials, or even from the chemicals that are used in raising, processing, or preserving crops and livestock. Although illness associated with a contaminated water supply could be considered a type of food poisoning, this issue will not be addressed.

Most bacterial and viral food poisonings appear within 8 hours of ingesting food. The signs and symptoms of poisoning include nausea, vomiting, diarrhea, muscle aches, and low-grade fever. The general treatment is supportive and directed at preventing dehydration through the administration of fluids. If diarrhea persists more than 24 hours, or if the patient is unable to keep fluids down, further definitive medical care is necessary. Food poisoning can also occur from ingestion of parasites.

Marine food-borne illnesses from ingesting fish and shellfish is a concern especially when traveling to new destinations. Wherever you are in the world, you should learn which local seafood is known to be safe and which present the potential for harm. Table 5-4 lists some of toxins found in fish and shellfish and their potential sources.

Mussels, clams, oysters, and other shellfish often become contaminated with bacteria during the warm months of March through November (in the northern hemisphere). Numerous varieties of shellfish should not be eaten at all. Therefore, wherever you are in the world, you should learn which local seafoods are known to be safe and which present the potential for harm.

Table 5-4.—Examples of Toxins from Fish Known to be Poisonous

Toxin	Source
Ciguatoxin (cholinergic effects)	tends to be found in fish from coral reefs, including barracuda, grouper, red snapper, parrot fish
Scombrototoxin (histamine-like reaction)	tuna, bonito, skipjack, mackerel, mahi mahi
Saxitoxin (neurologic effects)	bivalve shellfish (mussels, clams, scallops) accumulate toxin from dinoflagellate during red tides causing "paralytic shellfish poisoning"
*Tetrodotoxin (neurotoxin)	bacteria found in puffer fish, California newt, eastern salamander
*Neurotoxin	Moray eel

* toxic at all times

Most fish poisonings occur from eating fish that normally are considered to be safe to eat. However, fish can become poisonous at different times of the year because of their consumption of poisonous algae and plankton (red tide) that occur in certain locations. The signs and symptoms of red tide paralytic shellfish poisoning are tingling and numbness of the face and mouth, muscular weakness, nausea and vomiting, increased salivation, difficulty in swallowing, and respiratory failure. Primary treatment is directed at evacuating the stomach contents as soon as possible. If the patient has not vomited, select the appropriate method to remove the stomach contents by either syrup of Ipecac or gastric lavage. If respiratory failure develops, support ventilation and other life-sustaining systems as needed.

Examples of fish that are known to be poisonous **AT ALL TIMES** are shown in figure 5-1.

The symptoms of shellfish and fish poisoning are tingling and numbness of the face and mouth, muscular weakness, nausea and vomiting, increased salivation, difficulty in swallowing, and respiratory failure.

Primary treatment is directed toward evacuating the stomach contents. If the victim has not vomited, cause him to do so. Use syrup of Ipecac, gastric lavage, or manual stimulation; then administer a cathartic. If

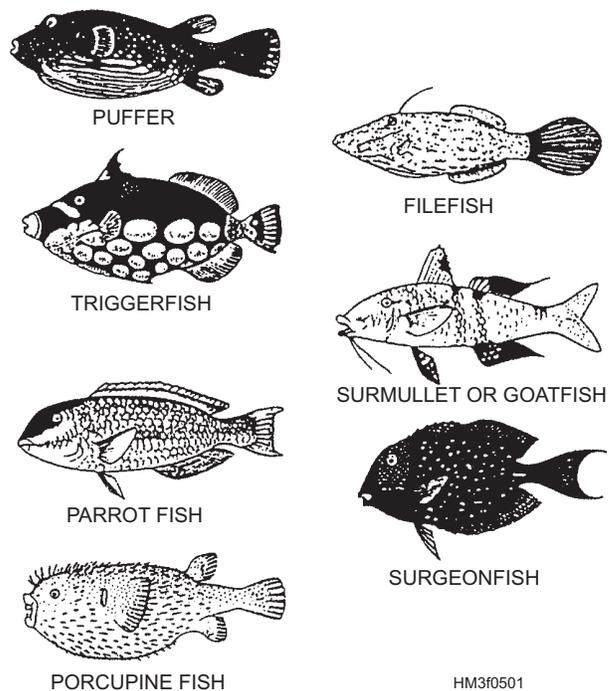


Figure 5-1.—Poisonous fish.

respiratory failure develops, give artificial ventilation and treat for shock.

INHALATION POISONS

In the Navy, and in other industrial settings in general, inhalation is the most common route of exposure to toxic substances. The irritants and corrosives mentioned in tables 5-2 and 5-3 are more often a source of poisoning by means of inhalation rather than by ingestion. An inhaled poison can act directly on the upper respiratory tract or lungs with immediate, delayed, or chronic effects, or the substance can use the pulmonary system to gain entry into the body, be absorbed into the blood, and cause toxic effects (systemic toxicity) at a distant site of action.

The handling of large quantities of petroleum products (fuel oil and gasoline, in particular) constitutes a special hazard, since all of these products give off hazardous vapors. Other poisonous gases are by-products of certain operations or processes: exhaust fumes from internal combustion engines; fumes or vapors from materials used in casting, molding, welding, or plating; gases associated with bacterial decomposition in closed spaces; and gases that accumulate in voids, double bottoms, empty fuel

tanks, and similar places. Some sources of inhalation chemical poisoning are listed in table 5-5.

NOTE: Inhaled substances can cause **olfactory fatigue**. After a few minutes of exposure, the smell is no longer detected, fooling the individual into believing the substance is no longer there and, thus, no longer a danger.

Table 5-5.—Sources of Inhalation Poisoning

Inhaled Substance	Source of Exposure
Acetone, isopropyl alcohol, amyl acetate	Nail polish remover
Aliphatic hydrocarbons	Fuels, Stoddard solvent, PD-680, mineral spirits, naphtha
Butane	“Throw-away” lighters
Carbon dioxide	Fire suppression/fighting, evaporation of dry ice, wells and sewers
Carbon monoxide	Fires, lightning, heating and fuel exhausts
Chlorinated hydrocarbons	Shoe polish
Chlorine	Water purification, sewage treatment
Chlorofluorocarbons (CFCs)	Refrigerants, degreasers, propellants (old)
Hydrogen sulfide	Sewer, decaying materials, CHT system
Methylethylketone	Paint
Methylene chloride	Paint stripper, solvent, dyes
N-hexane	Rubber cement
Nitrous oxide	Aerosol can propellant
Tetrachloroethylene (perchloroethylene)	Dry cleaning
Toluene	Plastic adhesive, acrylic paint, shoe polish
Trichloroethane (methylchloroform)	Solvent, degreaser

Carbon monoxide is the most common agent of gas poisoning. It is present in exhaust gases of internal combustion engines as well as in sewer gas, lanterns, charcoal grills, and in manufactured gas used for heating and cooking. It gives no warning of its presence since it is completely odorless and tasteless. The victim may lose consciousness and suffer respiratory distress with no warning other than slight dizziness, weakness, and headache. The lips and skin of a victim of carbon monoxide poisoning are characteristically cherry red. Death may occur within a few minutes.

Most inhalation poisoning causes shortness of breath and coughing. The victim’s skin will turn blue. If the respiratory problems are not corrected, cardiac arrest may follow.

Inhaling fine metal fumes can cause a special type of acute or delayed poisoning. These metal fumes are generated from heating metal to boiling and evaporation during hot metal work in such operations as metal cutting or welding. The resulting illness is called **metal fume fever (MFF)**. In the Navy, the most common cause of MFF is the inhalation of vaporized zinc found in the galvanized covering of iron/steel. Proper local and general ventilation and/or the use of respiratory protection are necessary to prevent this illness.

The first stage of treatment for an inhalation poisoning is to remove the victim from the toxic atmosphere immediately. **WARNING:** Never try to remove a victim from the toxic environment if you do not have the proper protective mask or breathing apparatus, or if you are not trained in its use. Too often, well-intentioned rescuers become victims. If help is not immediately available, and if you know you can reach and rescue the victim, take a deep breath, hold it, enter the area, and pull the victim out. Next,

1. start basic life support (the ABC+D&Es);
2. remove or decontaminate the clothing (if chemical warfare agents or volatile fuels were the cause);
3. keep the victim quiet, treat for shock, and administer oxygen; and
4. transport the victim to a medical treatment facility for further treatment.

ABSORBED POISONS

Some substances may cause tissue irritation or destruction by contact with the skin, eyes, and lining of

the nose, mouth, and throat. These substances include acids, alkalis, phenols, and some chemical warfare agents. Direct contact with these substances will cause inflammation or chemical burns in the affected areas. Consult the “Chemical Burns” section of chapter 4 and the “Chemical Agents” section of chapter 8 of this manual for treatment.

INJECTED POISONS AND ENVENOMATIONS

Injection of venom by stings and bites from various insects and arthropods, while not normally life-threatening, can cause acute allergic reaction that can be fatal. Poisons may also be injected by snakes and marine animals.

Bee, Wasp, and Fire Ant Stings

Stings from bees, wasps, and ants account for more poisonings than stings from any other insect group. Fortunately, they rarely result in death. The vast majority of stings cause a minor local reaction at the injection site, with pain, redness, itching, and swelling. These symptoms usually fade after a short time. A small percentage of these stings can cause an allergic victim severe anaphylactic reactions, presenting with itching, swelling, weakness, headache, difficulty breathing, and abdominal cramps. Shock may follow quickly, and death may occur.

The following first aid measures are recommended for all but minor, local reactions to bites or stings:

1. Closely monitor vital signs (and the whole patient), and remove all rings, bracelets, and watches.
2. Remove stingers without squeezing additional venom (remaining in poison sacs attached to stingers) into the victim. To do this, scrape along the skin with a **dull** knife (as if you were shaving the person). The dull blade will catch the stinger and pull it out.
3. Place an ice cube or analgesic-corticosteroid cream or lotion over the wound site to relieve pain. Do **NOT** use “tobacco juice,” saliva, or other concoctions.
4. For severe allergic reactions (generalized itching or swelling, breathing difficulty, feeling faint or clammy, unstable pulse or blood pressure), immediately give the victim a subcutaneous injection of 1:1000 aqueous

solution of epinephrine. Dosage is 0.5 cc for adults and ranges from 0.1 to 0.3 cc for children.

5. Patients with severe allergic reactions should be evacuated immediately to a medical facility.

Scorpion Stings

About 40 species of scorpions (fig. 5-2) exist in America. *Centruroides exilicauda* may cause severe effects. Most dangerous species are found from North Africa to India. Scorpion stings vary in severity, depending on the species of the scorpion and the amount of poison actually injected. They cause severe pain in the affected area.

Mild reactions may include local swelling, skin discoloration, swollen lymph nodes near the sting area, itching, paresthesias (“pins and needles,” numbness), and even nausea and vomiting. The duration of symptoms is less than 24 hours.

The following first aid treatment should be given for scorpion stings:

1. Place ice over the sting site (cool the area for up to 2 hours). Do **NOT** use tobacco juice, saliva, or other concoctions.
2. Elevate the affected limb to approximately heart level.
3. Give acetaminophen for minor pain.
4. Calcium gluconate, 10 ml of 10 percent solution, may be given intravenously to relieve muscle spasms.
5. Valium may be used to control excitability and convulsions.
6. An antivenom is available for severe bites by *Centruroides exilicauda* (also called “bark scorpion,” it is the scorpion found in Mexico and the American southwest). It is available from the Antivenom Production Laboratory, Arizona State University, Tempe, Arizona 85281, phone (602) 965-6443 or (602) 965-1457, and from Poison Control in Phoenix, phone (602) 253-3334.

CAUTION: Morphine and meperidine hydrochloride may worsen the respiratory depression from the venom of *Centruroides exilicauda*.

THE "BLACK WIDOW" SPIDER

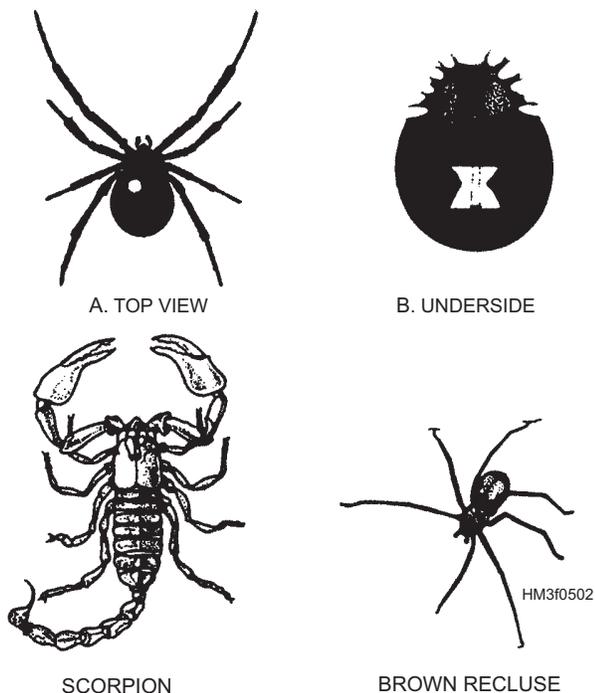


Figure 5-2.—Black widow and brown recluse spiders and scorpion.

Spider Bites

Spiders in the United States are generally harmless, with several exceptions. The most notable are the black widow (*Latrodectus mactans*) and brown recluse (*Loxosceles reclusa*, also found in South America) spiders. Their bites are serious but rarely fatal. Wandering spiders (*Phoneutria* species, found in South America), funnel web spiders (*Atrax* species, found in Australia), and more widely distributed spiders of the *Chiracanthium* species may also cause moderate to severe human reactions. Check current MEDIC CD-ROM for management of specific situations and venues.

The female black widow spider is usually identified by the red hourglass-shaped spot on its belly (fig. 5-2). Its bite causes a dull, numbing pain, which gradually spreads from the region of the bite to the muscles of the entire torso. The pain becomes severe, and a board-like rigidity of the abdominal muscles is common. Nausea, vomiting, headache, dizziness, difficulty in breathing, edema, rash, hypertension, and anxiety are frequently present. The bite site can be very hard to locate (there is little or no swelling at the site), and the victim may not be immediately aware of having been bitten. The buttocks and genitalia should be carefully examined for a bite site if the suspected

victim has recently used an outside latrine. The following first aid treatment steps are suggested:

1. Place ice over the bite to reduce pain.
2. Hospitalize victims who are under 16 or over 65 (for observation).
3. Be prepared to give antivenom in severe cases.

The brown recluse spider (fig. 5-2) is identified by its violin-shaped marking. Its bite may initially go unnoticed, but after several hours, a bleb develops over the site, and rings of erythema begin to surround the bleb. Other symptoms include skin rash, fever and chills, nausea and vomiting, and pain. A progressively enlarging necrotic (dead tissue) ulcerating lesion (with a crusty black scab) eventually develops. Intravascular hemolysis (breakdown of the blood) is most often seen in children and may be fatal. Antivenom is not currently available.

Treatment for brown recluse spider bites includes the following:

- Debridement of lesion, followed by peroxide cleansing and Burrow's solution soaks
- Application of polymyxin-bacitracin-neomycin ointment and sterile dressing
- Dapsone 50-100 mg twice a day is used to promote healing in some cases, **but only after screening for G6PD deficiency**. Other antibiotics may be used to treat infection, and steroids to reduce inflammation

NOTE: Glucose-6-phosphate dehydrogenase (G6PD) deficiency is a common human enzyme deficiency. A G6PD deficiency can cause a harmful reaction to a number of medications, including dapsone.

- Based upon medical consultation, excision of the lesion and optional commencement of corticosteroid therapy

Centipede Bites

Centipedes can attain sizes of over one foot in length! Their bite, though rare, leaves two tiny red marks and causes redness and swelling. Severe pain, swelling, and inflammation may follow, and there may be headache, dizziness, vomiting, irregular pulse, muscle spasm, and swollen lymph nodes. No long-term effects are usually seen. Treat discomfort with acetaminophen, cool packs, and elevation of the affected limb to heart level.

Snakebites

Poisonous snakes are found throughout the world, with the exception of certain islands and the Antarctic. There are five venomous families of snakes.

- **Viperidae**—includes rattlesnakes, moccasins, South American lance-headed vipers and bushmaster, Asian pit vipers, African and Asian vipers and adders, the European adder, and saw-scaled viper (Middle-eastern). Kills mainly by coagulopathy (a blood clotting disorder) and shock.
- **Elapidae**—Includes cobras, kraits, mambas, and coral snakes. Kills from neurotoxic venom that can cause respiratory failure, paralysis, and cardiac failure.
- **Hydrophidae**—Includes sea snakes and venomous snakes from the islands of the southern Pacific Ocean, including Australia, New Zealand, and New Guinea. Also kills from neurotoxic venom.
- **Colubridae**—Includes most of the common nonvenomous species, as well as the boomslang, and vine/twig/bird snake (Africa); Japanese yamakagashi; Southeast Asian red-necked callback. Venom's method of toxic action varies according to type of snake.
- **Atractaspididae**—Includes the burrowing asps/mole vipers, stiletto snakes, and adders. Venom's method of toxic action varies according to type of snake.

Within the United States, poisonous snakes are Crotalids (rattlesnakes, copperheads, and moccasins) and the Elapids (coral snakes).

CROTALIDS.—Crotalids are of the *Viperidae* (viper) family and are called “pit vipers” because of the small, deep pits between the nostrils and the eyes (fig. 5-3). They have two long, hollow fangs. These fangs are normally folded against the roof of the mouth, but they can be extended when the snake strikes. Other identifying features of the Crotalids include thick bodies; slit-like pupils of the eyes; and flat, triangular heads. The most identifying feature of a pit viper is the relative width of the snake's head compared to the thickness of the body. The head will be much wider than the body, giving the appearance of an arrowhead. The difference in size is so obvious that identification of a snake as a pit viper can usually be made from a safe distance.

Further identification can be made by examining the wound for signs of fang entry in the bite pattern. Pit viper bites leave two puncture marks (sometimes only one, and sometimes more). Nonvenomous snakes (for example, garter snakes) leave a series, often in a curve or semi-circle, of tiny scratches or punctures. Individual identifying characteristics include rattles on the tails of most rattlesnakes, and the cotton-white interior of the mouths of moccasins.

ELAPIDS.—Coral snakes are of the family *Elipidae* and related to the cobra, kraits, and mamba snakes in other parts of the world (fig. 5-4). Corals, which are found in the Southeastern United States, are comparatively thin snakes with small bands of red, black, and yellow (or almost white). Some

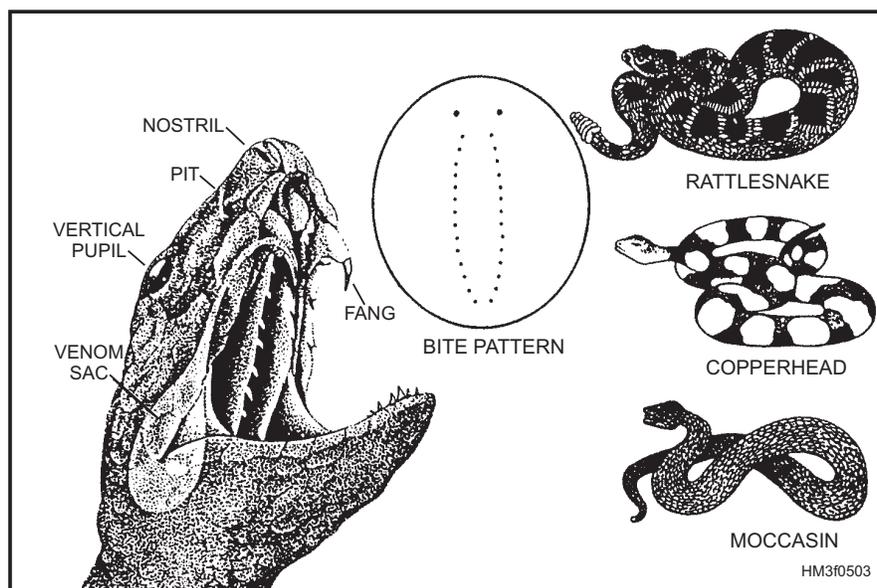


Figure 5-3.—American pit vipers.

nonpoisonous snakes have similar coloring, but in the North American coral snake, the red band always touches the yellow band, and the bands go all the way around the body. (In some of the nonvenomous, similarly colored varieties, the bands are only on the back and sides, not the belly.) There is an old saying that only applies to **NORTH** American coral snakes: “Red on yellow, kill a fellow; red on black, venom lack.” The coral snake has short, hollow fangs that chew into its victim and introduce the poison. Coral snake venom is dangerous, so **if the skin is broken, give antivenom before envenomation is evidenced by symptoms or findings.**

Venom, which is stored in sacs in the snake’s head, is introduced into a victim through hollow or grooved fangs. An important point to remember, however, is that a bitten patient has not necessarily received a dose of venom. The snake can control whether or not it will release the poison and how much it will inject. As a result, while symptoms in a poisonous snakebite incident may be severe, they may also be mild or not develop at all.

SIGNS AND SYMPTOMS OF SNAKE-BITE.— In a snakebite situation, every reasonable effort should be made to positively identify the culprit, since treatment of a nonpoisonous bite is far simpler and less dangerous to the victim than treatment of a poisonous bite. However, unless the snake can be

POSITIVELY identified as nonpoisonous, **CONSIDER ALL SNAKEBITES AS POISONOUS! SEEK CONSULTATION FROM EXPERT SOURCE.**

Signs and symptoms of venomous snakebite may include

- a visible bite on the skin (possibly no more than a local discoloration);
- pain and swelling in the bite area (may develop slowly, from 30 minutes to several hours);
- continued bleeding from site of bite (often seen with viper bites);
- rapid pulse;
- labored breathing;
- progressive weakness;
- dim or blurred vision;
- nausea and vomiting;
- seizures; or
- drowsiness (or loss of consciousness).

Usually enough symptoms present themselves within an hour of a poisonous snakebite to erase any doubt as to the victim’s having been envenomated or

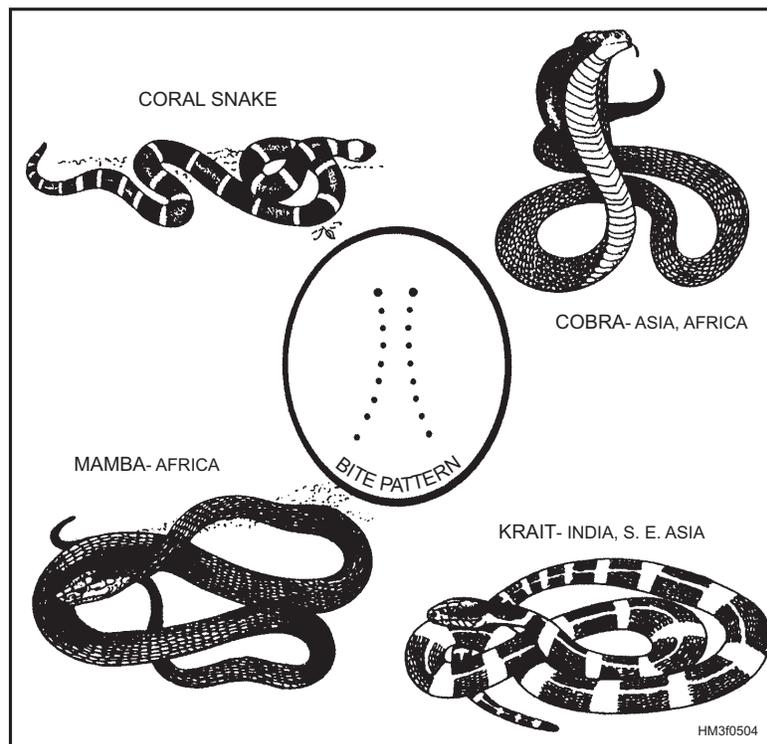


Figure 5-4.—Corals, cobras, kraits, and mambas.

not. The victim's condition provides the best information as to the seriousness of the situation.

The aims of first aid for envenomated snakebites are to reduce—**not stop**—the circulation of blood through the bite area, delay absorption of venom, prevent aggravation of the local wound, maintain vital signs, and transport the victim as soon as possible to an MTF with minimum movement.

TREATMENT OF SNAKEBITES.—The proper steps in the treatment of snakebites are listed below.

1. Try to identify the snake. Positive identification is important to selecting the correct antivenom for the treatment of the patient.

NOTE: Do not risk further injury by trying to kill the snake.

2. Certain suction extractors have benefit (for example, the Sawyer extractor), especially if used within the first 3 minutes. If available immediately, use the extractor and leave it on for 30 minutes. The cups may fill up. Empty and re-use them as necessary.
3. GENTLY wash the wound with soap and water (it may remove some of the venom). Do **NOT** rub vigorously, as it may cause the venom to be absorbed more rapidly.
4. Place the victim in a comfortable position.
5. Tell the patient to remove any jewelry (especially rings and bracelets, as these may impede blood flow if there is swelling of the extremities). Assist, if necessary.
6. Start an IV line.
7. Monitor vital signs (including ABC+D&Es) closely, responding appropriately as necessary.
8. Until evacuation or treatment is possible, ensure the victim lies quietly and does not move any more than necessary.
9. Do not allow the victim to smoke, eat, or drink any fluids. (Water is permissible if you anticipate more than several hours will pass before arriving at a hospital and being able to establish an IV line.)
10. Transport the victim to a hospital or other appropriate facility.
11. Place a **lymphatic** (light) constriction on the extremity (if the bite is on an extremity). The

goal is to obstruct lymphatic—not blood-flow. (See instructions below.) **DO NOT USE A TOURNIQUET!**

LYMPHATIC CONSTRICTION INSTRUCTIONS

An appropriate lymphatic constriction device is a blood pressure cuff, inflated to the diastolic blood pressure (so the blood can be felt flowing past the cuff). Other devices may be used, but **IT IS IMPORTANT THAT BLOOD CIRCULATION TO THE BITE AREA BE MAINTAINED.**

Constriction should be fully released every 30 minutes for 15 seconds. If the constriction pressure cannot be carefully controlled, **THE MAXIMUM TOTAL TIME OF USE OF THE CONSTRICTION DEVICE IS 2 HOURS.** (Thus, three 15-second breaks, and the fourth time the cuff, belt, or band remains **OFF**.)

NOTE: If you use a blood pressure cuff (or device that you **KNOW** is not constricting more than an Ace® bandage on a sprain), you may continue to apply constriction until the patient reaches a hospital.

12. Splint the extremity at the level of the body (heart). **DO NOT ELEVATE THE EXTREMITY!**
13. Hospitalize and observe all snakebites for at least 24 hours.

In the case of spitting cobras (found in Africa, Thailand, Malaysia, Indonesia, and the Philippines), which attempt to spray venom into victims' eyes, rinse the eyes with large volumes of water (neither a blast nor a trickle, and not with hot water). Apply antibacterial (tetracycline or chloramphenicol) eye ointment, and apply a patch with just enough pressure to keep the eyelid from blinking.)

Other aid will be mainly supportive:

- Check pulse and respiration frequently. Give artificial ventilation, if necessary.
- Treat for shock, including IV fluids (normal saline or lactated Ringer's solution).
- When possible, clean the area of the bite with soap and water, and cover the wound to prevent further contamination.

- Give acetaminophen for pain if delay in hospital treatment is anticipated.

Antivenom.—Antivenom (also called antivenin) is available for many snakes, and is indicated for severe envenomations by *Viperidae* family snakes and most envenomations by snakes of the other poisonous families. Antivenom is best given as soon as possible after an envenomation, but may be of value up to a few days after a bite.

If possible, antivenom specific to the snake should be used. Otherwise, a “polyspecific” antivenom may be used. READ THE PACKAGE INSERT OF THE ANTIVENOM FOR VALUABLE INFORMATION. Epinephrine and diphenhydramine must be available, as allergic reactions (including anaphylaxis) to antivenom have occurred (they are often prepared from horse serum, which some people are allergic to).

Antivenom is diluted (for example, 1:10) and given at 5 ml/minute IV, and the dose is based on stopping the progression of signs and symptoms, not the victim’s body weight (the children’s dose is the same as the adult dose). For neurotoxic snakebites, if there is no improvement in 30 minutes, the dose should be repeated. For *Viperidae* (which can cause bleeding disorders), spontaneous bleeding should stop after sufficient antivenom is given; continue giving antivenom until bleeding stops and progression of swelling is retarded. Because you may need to administer antivenom a number of times, one vial may not be enough to treat a patient.

Antivenom is available via PCCs and hospitals. It may also be available at zoos and embassies.

The “Don’ts” of Snakebite Treatment.—The following are the “don’ts” when it comes to treatment of snakebite.

- **DO NOT** use any ice or cooling on the bite.
- **DO NOT** use a tourniquet. Obstructing blood flow can make local tissue injury much worse.
- **DO NOT** use electric shock.
- **DO NOT** make any cuts or incisions in the wound. Cuts at the bite site may impede circulation and promote infection and make local tissue injury much worse.
- **DO NOT** give victim alcohol or narcotics.

Further information may be obtained on an emergent basis from a PCC or from Arizona Poison Control, (520) 626-6016.

Bites, Stings, and Punctures from Sea Animals

A number of sea animals are capable of inflicting painful wounds by biting, stinging, or puncturing. Except under rare circumstances, these stings and puncture wounds are not fatal. Major wounds from sharks, barracuda, moray eels, and alligators can be treated by controlling the bleeding, preventing shock, giving basic life support, splinting the injury, and transporting the victim to a medical treatment facility. Minor injuries inflicted by turtles and stinging corals require only that the wound be thoroughly cleansed and the injury splinted.

JELLYFISH INJURIES.—Other sea animals inflict injury by means of stinging cells located in tentacles. This group includes the jellyfish and the Portuguese man-of-war (fig. 5-5). The tentacles (which may be impossible to see, even in relatively clear water) release poison or tiny stingers through which poison is injected into the victim. Jellyfish stings may cause symptoms ranging from minor irritation (pain and itching) to death. Contact with the tentacles produces burning pain, a rash with small hemorrhage in the skin, and, on occasion, shock, muscular cramping, nausea, vomiting, and respiratory and cardiac distress. Treatment for minor jellyfish injuries consists of pouring sea water over the injured area and then removing the tentacles with a towel or gloves. Next, pour rubbing alcohol, formalin, vinegar, meat tenderizer, or diluted ammonia over the affected area to neutralize any remaining nematocysts (minute stinging structures). Finally, cover the area with any dry powder (to which the last nematocysts will

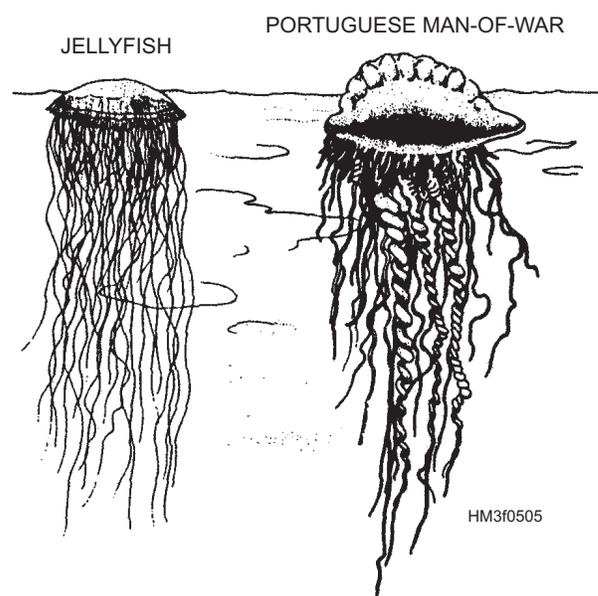


Figure 5-5.—Jellyfish and Portuguese Man-of-war.

adhere), and then scrape off with a dull knife. Apply cool packs and hydrocortisone cream.

Some jellyfish (notably, the Portuguese man-of-war, the box jellyfish, and certain jellyfish from northeastern Australia) may cause serious injuries and even have the potential to be lethal. In cases where the kind of jellyfish that caused the sting is either unknown or is known to have been from a box jellyfish or Portuguese man-of-war, the injury should be treated as a serious one, regardless of initial symptoms. The following steps should be taken in the case of serious jellyfish stings.

1. Retrieve the victim from the water if necessary.
2. Send others for an ambulance and antivenom. (Antivenom is available for box jellyfish stings. It is from sheep, and should be given in all serious stings.)
3. Pour vinegar liberally (2 liters) over the sting area for at least 30 seconds to inactivate stinging cells that may remain.
4. Remove any remaining tentacles carefully. (Excessive manipulation may cause rupture of nematocysts and further poison release.) Carefully (and gently) use a towel if necessary, or use a dull knife edge (as described above to remove arthropod stingers).
5. Apply a compression bandage to stings covering more than half of one limb or causing altered consciousness.
6. Start an IV.
7. Remain with the victim, and monitor vital signs (the ABCs and consciousness, responding appropriately (possibly including CPR) and as necessary).
8. Transport the patient to a hospital as quickly as possible.
9. Opiate analgesics (morphine or meperidine) may be necessary for pain relief.

“SPINE” INJURIES.—Spiny fish, stingrays, urchins, and cone shells inject their venom by puncturing with spines (fig. 5-6). General signs and symptoms include swelling, nausea, vomiting, generalized cramps, diarrhea, muscular paralysis, and shock. General emergency care consists of prompt flushing with cold sea water to remove the venom and to constrict hemorrhaging blood vessels. Next, debride the wound of any remaining pieces of the spine’s venom-containing integumentary sheath. Soak

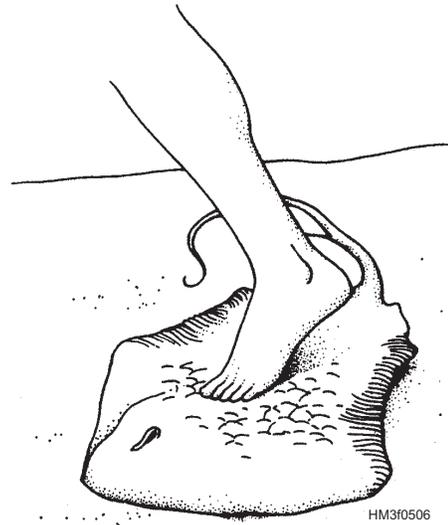


Figure 5-6.—Stingray sting.

the wound area in very hot water (110°F/43° C) for 30 to 60 minutes to neutralize the venom. Finally, completely debride the wound, control hemorrhage, suture, provide tetanus prophylaxis and a broad-spectrum antibiotic, and elevate the extremity. For minor injuries, a steroid cream to the wound area may relieve discomfort. For serious injuries—wounds that are deep, very painful, or causing the patient distress—stabilize the patient and transport immediately to a hospital.

In the case of contact with stonefish, scorpionfish, zebra, or lionfish, immerse the wound in very hot water for a **minimum** of 30 minutes until the pain is decreased. Inject emetine hydrochloride directly into the wound within 30 minutes, and provide meperidine (or other opiate) for pain. Monitor the victim’s vital signs closely. Obtain antivenom (from local zoos or aquariums) for all serious cases.

SEA SNAKE INJURIES.—Sea snakes are found in the warm water areas of the Pacific and Indian Oceans. Their venom is **VERY** poisonous, but their fangs are only 1/4 inch long. The first aid outlined for land snakes also applies to sea snakes.

DRUG ABUSE

LEARNING OBJECTIVE: *Recall drug abuse assessment and treatment procedures and patient handling techniques.*

Drug abuse is the use of drugs for purposes or in quantities for which they were not intended. Drugs of

abuse may be swallowed, inhaled, snorted (or by nose drops), injected, or even absorbed through the skin, rectum, or vagina. When abused, therapeutic drugs become a source of “poison” to the body. Drug abuse can lead to serious illness, dependency, and death. Death is usually because of acute intoxication or overdoses.

Drugs of abuse can be classified in many different ways. This chapter will classify drugs of abuse based on the symptoms they produce: CNS depression, CNS stimulation, and hallucinations. The CNS depressants include narcotics, ethanol, barbiturates, non-barbiturate sedative-hypnotics (including benzodiazepines). The CNS stimulants include caffeine, nicotine, amphetamines, and cocaine. The hallucinogens include LSD, PCP, and marijuana.

Table 5-6 lists many of the most frequently abused drugs with their recognizable trade names, some commonly used street names, and observable symptoms of abuse.

The following sections contain specific information about commonly abused drugs, as classified in table 5-6, including availability and methods of administration.

NARCOTIC INTOXICATION

Unfortunately, narcotic abuse is common, although it is rare among military personnel. This group of drugs includes the most effective and widely used pain killers in existence. Prolonged use of narcotic drugs, even under medical supervision, inevitably leads to physical and psychological dependence. The more commonly known drugs within this group are opium, morphine, heroin, codeine, and methadone (a synthetic narcotic). In addition, Darvon 7 and Talwin7 are included in this group because of their narcotic-like action. Next to cocaine (discussed later), heroin is the most popular narcotic drug because of its intense euphoria and long-lasting effect. It is far more potent than morphine but has no legitimate use in the United States. Heroin appears as a white, gray, or tan fluffy powder. The most common method of using heroin is by injection directly into the vein, although it can be sniffed. Codeine, although milder than heroin and morphine, is sometimes abused as an ingredient in cough syrup preparations. Symptoms of narcotic drug abuse include slow, shallow breathing; possible unconsciousness; constriction (narrowing) of the pupils of the eyes to pinpoint size; drowsiness; confusion; and slurred speech.

The narcotic user, suddenly withdrawn from drugs, may appear as a wildly disturbed person who is agitated, restless, and possibly hallucinating. Initial symptoms start within 2 to 48 hours and peak at about 72 hours. Although these signs and symptoms are not life-threatening, most users will state that they feel so bad they wish they were dead. The signs and symptoms of withdrawal immediately stop upon re-administering a narcotic and withdrawing the drug by tapering the dose over several days.

ALCOHOL INTOXICATION

Alcohol is the most widely abused drug today. Alcohol intoxication is so common that it often fails to receive the attention and respect it deserves. Although there are many other chemicals that are in the chemical grouping of “alcohols,” the type consumed by people as a beverage (in wines, beers, and distilled liquors) is known as ethyl alcohol, ethanol, grain alcohol, or just “alcohol.” It is a colorless, flammable, intoxicating liquid, classed as a drug because it depresses the central nervous system, affecting physical and mental activities.

Alcohol affects the body of the abuser in stages. Initially, there is a feeling of relaxation and well-being, followed by confusion with a gradual disruption of coordination, resulting in inability to accurately and efficiently perform normal activities and skills. Continued alcohol consumption leads to a stuporous state of inebriation that results in vomiting, an inability to walk or stand, and impaired consciousness (sleep or stupor). Excessive consumption can cause loss of consciousness, coma, and even—in extreme cases — death from alcohol poisoning.

The potential for physical and psychological addiction is very high when alcohol is abused. The severely intoxicated individual must be closely monitored to avoid inhalation of vomit (aspiration) and adverse behavioral acts to the patient or others. Withdrawal from alcohol is considered to be life-threatening and should be appropriately treated in a healthcare facility. Individuals withdrawing from alcohol are at a greater risk of serious complications or death than those withdrawing from narcotics. The effects of alcohol withdrawal include severe agitation, anxiety, confusion, restlessness, sleep disturbances, sweating, profound depression, delirium tremens (“DTs,” a particular type of confusion and shaking), hallucinations, and seizures.

Table 5-6.—Classification of Abused Drugs

A. NARCOTICS			
Agent	Trade Name	Some Street Names	Symptoms of Abuse
Morphine	“H”, Miss Emma, smack	<ul style="list-style-type: none"> •Lethargy •Drowsiness •Confusion •Euphoria •Slurred speech •Flushing of the skin on face, neck, and chest •Nausea and vomiting •Pupils constricted to pinpoint size
Diacetylmorphine	Heroin	“H”, horse, junk, smack, stuff, whack	
Codeine		
Meperidine	Demerol		
Methadone	Dolphine	Dolly	
Propoxyphene	Darvon		
Pentazocine	Talwin		
B. ALCOHOL (Ethyl)			
Agent	Trade Name	Some Street Names	Symptoms of Abuse
Alcohol (ethyl)	Ethanol	Liquors, beer, wines	<ul style="list-style-type: none"> •Slurred speech •Incoordination •Confusion •Tremors •Drowsiness •Agitation •Nausea and vomiting •Respiratory depression •Hallucinations •Possible coma
C. STIMULANTS (Uppers)			
Agent	Trade Name	Some Street Names	Symptoms of Abuse
Amphetamine	Benzedrine	Bennies, pep pills, ups, cartwheels	<ul style="list-style-type: none"> •Excitability •Rapid and unclear speech •Restlessness •Tremors •Sweating •Dry lips and mouth •Dilated pupils •Loss of consciousness •Coma •Hallucinations
Cocaine	Crack, coke, snow, gold dust, rock, freebase, snort, hubba hubba, flake	
Dextroamphetamine	Dexadrine	Dexies	
Methamphetamine	Methadrine	Speed, meth, crystal, diet pills, crank	
Methylphenidate	Ritalin		
D. BARBITURATES (Downers, dolls, barbs, rainbows)			
Agent	Trade Name	Some Street Names	Symptoms of Abuse
Phenobarbital	Goofballs, phennies	Same as those noted in alcohol intoxication, plus pupils may be dilated.
Amobarbital	Amytal	Blues, blue birds, blue devils, downers	
Pentobarbital	Nembutal	Yellows, yellow jackets	
Secobarbital	Seconal	Reds, red devils, seggy	

Table 5-6.—Classification of Abused Drugs—Continued

E. OTHER SEDATIVES & HYPNOTICS (Downers)			
Agent	Trade Name	Some Street Names	Symptoms of Abuse
Glutethimide	Doriden	Goofers	Same as those noted in alcohol and barbiturate intoxication.
Chlordiazepoxide	Librium		
Meprobamate	Miltown, Equanil		
Methaqualone	Quaalude, Sopor	Ludes, sopors	
F. HALLUCINOGENS			
Agent	Trade Name	Some Street Names	Symptoms of Abuse
Lysergic acid diethylamide	LSD, acid, sunshine Peyote, mesc	<ul style="list-style-type: none"> •Trance-like state •Anxiety •Confusion •Tremors •Euphoria •Depression •Hallucinations •Psychotic manifestations •Suicidal or homicidal tendencies
Mescaline		
Phencyclidine (PCP)		Angel dust, hog, peace pills	
Psilocin, psilocybin	Peyote	Buttons, mesc, magic mushrooms	
G. CANNABIS			
Agent	Trade Name	Some Street Names	Symptoms of Abuse
Cannabis	Marijuana	Pot, grass, weed, joint, tea, reefer, rope, Jane, hay, dope	<ul style="list-style-type: none"> •Euphoria •Excitability •Increased appetite •Dryness of mouth •Odor of burned rope on breath •Intoxication •Laughter •Mood swings •Increase in heart rate •Reddening of eyes •Loss of memory •Distortion of time and spatial perception
H. INHALANTS			
Agent	Trade Name	Some Street Names	Symptoms of Abuse
Amyl nitrate		Snappers, poppers	<ul style="list-style-type: none"> •Dazed, temporary loss of contact with reality •Possible coma •Swollen membranes in mouth and nose •“Funny numb feeling” •“Tingling” inside the head •Changes in heart rhythm •Possible death
Butyl nitrate		Locker room, rush	
Other volatile chemicals: Cleaning fluid, furniture polish, gasoline, glue, hair spray, nail polish remover, paint thinner, correction fluid			

BARBITURATE INTOXICATION

Benzodiazepines have largely replaced barbiturates, or “downers,” as sedatives, hypnotics (sleeping pills), or anxiolytic (anti-anxiety) agents. Barbiturates are still used to treat various seizure disorders. They are classified based on their duration of action: ultra-short acting, short acting, intermediate acting, and long acting. Barbiturate use classically causes various degrees of CNS depression with nystagmus (eyes moving up and down, or side-to-side involuntarily), vertigo (sensation of the room spinning), slurred speech, lethargy, confusion, ataxia (difficulty walking) and respiratory depression. Severe overdose may result in coma, shock, apnea (stopped breathing), and hypothermia. In combination with ethanol or other CNS depressants, there are additive CNS and respiratory depression effects.

Prolonged use of barbiturates can lead to a state of physical and psychological dependence. Upon discontinued use, the dependant person may go into withdrawal. Unlike narcotic (opiate) withdrawal, barbiturate withdrawal is **LIFE THREATENING!** Depending on type of barbiturate, signs and symptoms start within 24 hours. The withdrawal syndrome includes nausea, vomiting, sweating, tremors (trembling or shaking), weakness, insomnia, and restlessness. These clinical findings progress to apprehension, acute anxiety, fever, increased blood pressure, and increased heart rate. If untreated, severe and life-threatening effects include delirium, hallucinations, and seizures. The signs and symptoms will stop upon re-administration of the barbiturate and by tapering the dose slowly over several days.

NONBARBITURATE SEDATIVE-HYPNOTIC INTOXICATION

Nonbarbiturate sedative-hypnotics (a “hypnotic” is a sleeping pill) have actions very similar to the barbiturates. However, they have a higher margin of safety; overdose and addiction require larger doses and addiction requires a longer time period to occur. Like the barbiturates, when combined with ethanol or other depressants, there are addictive CNS- and respiratory-depression effects. Most of the traditional, nonbarbiturate sedative-hypnotics are either no longer available (Methaqualone, Ethchlorovynol, Glutethimide) or rarely used today (chloral hydrate) because of their profound “hangover effect.” Newer sedative-hypnotics are emerging for the temporary

treatment of insomnia. Benzodiazepines are widely used to treat seizure disorders, anxiety, muscle spasms, and insomnia.

STIMULANT INTOXICATION

The stimulants (“uppers”) directly affect the central nervous system by increasing mental alertness and combating drowsiness and fatigue. One group of stimulants, called amphetamines, is legitimately used in the treatment of conditions such as mild depression, obesity, and narcolepsy (sleeping sickness).

Amphetamines are also commonly abused. Usually referred to as stimulants, speed, or uppers, amphetamines can be taken orally, intravenously, or smoked as “ice.” Amphetamines directly affect the central nervous system by increasing mental alertness and combating drowsiness and fatigue. They are abused for their stimulant effect, which lasts longer than cocaine.

Amphetamines cause central nervous system stimulation with euphoria, increased alertness, intensified emotions, aggressiveness, altered self-esteem, and increased sexuality. In higher doses, unpleasant CNS effects of agitation, anxiety, hallucinations, delirium, psychosis, and seizures can occur. When stimulants are combined with alcohol ingestion, patients have increased psychological and cardiac effects.

Signs and symptoms associated with amphetamine use include mydriasis (dilated pupils), sweating, increased temperature, tachycardia (rapid pulse), and hypertension. Patients seeking medical attention usually complain of chest pain, palpitations, and shortness of breath.

“Heavy use” (involving large quantities) of amphetamines is physically addicting, and even “light use” (involving small amounts) can cause psychological dependence. Tolerance to increasingly higher doses develops and withdrawal can occur from these levels. Abruptly stopping chronic amphetamine use does not cause seizures or present a life-threatening situation. The withdrawal is typically characterized by apathy, lethargy, muscle aches, stomachaches, increased appetite, anxiety, sleep disturbances, and depression with suicidal tendencies.

Cocaine, although classified as a narcotic, acts as a stimulant and is commonly abused. It is relatively ineffective when taken orally; therefore, the abuser either injects it into the vein or “snorts” it through the

nose. Its effect is much shorter than that of amphetamines, and occasionally the abuser may inject or snort cocaine every few minutes in an attempt to maintain a constant stimulation and prevent depression experienced during withdrawal (come-down). Overdose is very possible, often resulting in convulsion and death.

The physical symptoms observed in the cocaine abuser will be the same as those observed in the amphetamine abuser.

HALLUCINOGEN INTOXICATION

The group of drugs that affect the central nervous system by altering the user's perception of self and environment are commonly known as hallucinogens. Included within this group are lysergic acid diethylamide (LSD), mescaline, dimethoxymethylamphetamine (STP), phencyclidine (PCP), and psilocybin. They appear in several forms: crystals, powders, and liquids.

The symptoms of hallucinogenic drugs include dilated pupils, flushed face, increased heartbeat, and a chilled feeling. In addition, the person may display a distorted sense of time and self, show emotions ranging from ecstasy to horror, and experience changes in visual depth perception.

Although no deaths have resulted from the drugs directly, hallucinogen-intoxicated persons have been known to jump from windows, walk in front of automobiles, or injure themselves in other ways because of the vivid but unreal perception of their environment.

Even though no longer under the direct influence of a hallucinogenic drug, a person who has formerly used one of the drugs may experience a spontaneous recurrence (flashback) of some aspect of the drug experience. The most common type of flashback is the recurrence of perceptual distortion; however, victims of flashback may also experience panic or disturbing emotion. Flashback may be experienced by heavy or occasional users of hallucinogenic drugs, and its frequency is unpredictable and its cause unknown.

CANNABIS INTOXICATION

Cannabis sativa, commonly known as marijuana, is widely abused and may be classified as a mild hallucinogen. The most common physical appearance

of marijuana is as ground, dried leaves, and the most common method of consumption is smoking, but it can be taken orally. A commercially prepared product of the active ingredient in marijuana, tetrahydrocannabinol (THC), is dronabinol (Marinol R) available in the U.S. as a controlled Schedule II drug. Dronabinol is used for the treatment of nausea and vomiting in chemotherapy patients. It may also be useful in the treatment of acute glaucoma, asthma, and nausea and vomiting from other chronic illnesses. The individual response to the recreational use of marijuana varies and depends on the dose, the personality and expectation of the user, and the setting. Unexpected ingestion, emotional stress, or underlying psychiatric disorders can increase the possibility of an unfavorable reaction.

After a single inhaled dose of marijuana, a subjective "high" begins in several minutes and is gone within four hours. Marijuana causes decreased pupil size and conjunctivitis (reddening of the white of the eye). Smoking marijuana can increase the heart rate (tachycardia) for about two hours. It can slightly increase systolic blood pressure in low doses and can lower blood pressure in high doses. An increased appetite and dry mouth are common complaints after marijuana use.

Social setting influences the psychological effects associated with "usual doses" of marijuana smoking. Smoking in a solitary setting may produce euphoria, relaxation, and sleep. In a group setting, increased social interaction, friendliness, and laughter or giddiness may be produced. Subjectively, time moves slower, images appear more vivid, and hearing seems keener. High doses can cause lethargy, depersonalization, pressured speech, paranoia, hallucinations, and manic psychosis (imagining everything is wonderful in a way that is out of reality).

INHALANT INTOXICATION

Inhalants are potentially dangerous, volatile chemicals that are not meant for human consumption. They are found in consumer, commercial, and industrial products intended for use in well-ventilated areas. The vapors they produce can be extremely dangerous when inhaled inadvertently or by design.

Substances in this category include adhesives (synthetic "glues"), paint, wet markers, lighter fluids, solvents, and propellants in aerosol spray cans, and air fresheners. Inhalants can be abused by "sniffing"

(inhaling through the nose directly over an open container), “bagging” (holding an open bag or container over the head), or “huffing” (pouring or spraying material on a cloth that is held over the mouth and inhaling through the mouth). These methods usually use a bag or other container to concentrate and retain the propellant thereby producing a quick “high” for the abuser.

Persons who regularly abuse inhalants risk permanent and severe brain damage and even sudden death. The vapors from these volatile chemicals can react with the fatty tissues in the brain and literally dissolve them. Additionally, inhalants can reduce the availability and use of oxygen. Acute and chronic damage may also occur to the heart, kidneys, liver, peripheral nervous system, bone marrow, and other organs. Sudden death can occur from respiratory arrest or irregular heart rhythms that are often difficult to treat even if medical care is quickly available.

Signs and symptoms of inhalant abuse closely resemble a combination of alcohol and marijuana intoxication. Acute symptoms are very short-lived and are completely gone within two hours. Physical symptoms of withdrawal from inhalants include hallucinations, nausea, excessive sweating, hand tremors, muscle cramps, headaches, chills and delirium tremens. Thirty to forty days of detoxification is required, and relapse is frequent.

HANDLING DRUG-INTOXICATED PERSONS

As in any emergency medical situation, priorities of care must be established. Conditions involving respiratory or cardiac failure must receive immediate attention before specific action is directed to the drug abuse symptom. General priorities of care are outlined below:

- The **ABCs + D & E**: check for adequacy of airway, breathing, and circulation, signs of drug/chemical (“**D**”) induced altered mental status, and hidden injuries or contact with a poison revealed by exposing (“**E**”) parts of the body covered with clothing or other articles. Watch for shock! Give appropriate treatment.
- If the victim cannot be aroused, place him on his side so secretions and vomitus can drain from the mouth and not be aspirated into the lungs.

- All adult patients with an altered mental status should receive dextrose after blood sugar testing, thiamine, naloxone, and oxygen.
- If recommended by the PCC or medical officer, place the patient on a cardiac monitor and/or obtain specimens for comprehensive laboratory work-up (blood and urine).
- If recommended by the PCC or medical officer, decontaminate the gut. (This decontamination should be accomplished **ONLY** if the victim is conscious and the drug was **RECENTLY TAKEN ORALLY**.)
- Prevent the victim from self-injury while highly excited or lacking coordination. Use physical restraints only if absolutely necessary (i.e., upon failure of chemical restraints).
- Calm and reassure the excited patient by “talking them down” in a quiet, relaxed, and sympathetic manner.
- Gather materials and information to assist in identifying and treating the suspected drug problem. Spoons, paper sacks, eyedroppers, hypodermic needles, and vials are excellent identification clues.
- The presence of capsules, pills, drug containers, needle marks (tracks) on the patient’s body, or paint or other substance around the mouth and nose, are also important findings of substance abuse.
- A personal history of drug use from the patient or those accompanying the patient is very important and may reveal how long the victim has been abusing drugs, approximate amounts taken, and time between doses. Knowledge of past medical problems, including history of convulsions (with or without drugs) is also important.
- Transport the patient and the materials collected to a medical treatment facility.
- Inform MTF personnel and present the materials collected at the scene upon arrival at the facility.

HAZARDOUS MATERIAL EXPOSURE

LEARNING OBJECTIVE: *Recognize hazardous material personal safety guidelines and hazardous material information sources.*

Hazardous materials are substances with the potential of harming people or the environment. Hazardous materials can be gaseous, liquid, or solid, and can include chemical or radioactive materials. (Radiological exposure will be covered in depth in chapter 8 of this manual. Radioactive materials are regulated by specific instructions/directives.) The most common substances involved in incidents of hazardous material (HAZMAT) exposure are volatile organic compounds, pesticides, ammonia, chlorine, petroleum products, and acids.

Your initial action at the scene of a hazardous materials incident must be to assess the situation, since your safety—as well as that of the public and any patients—is of primary concern. You must first determine the nature of the HAZMAT, then establish a safety zone. Only after these things have been accomplished can a victim who has been exposed to hazardous materials be rescued, transported to an appropriate facility, and properly decontaminated.

The Department of Transportation (DOT) publication, *Emergency Response Guidebook* (ERG series, published every four years), RSPA P5800.8, is a useful tool for first responders during the initial phase of a hazardous materials/dangerous goods incident. ERG series addresses labeling, identification, toxicity, safety/contamination zones, and decontamination procedures. **IT IS IMPERATIVE THAT ALL PERSONNEL INVOLVED WITH HAZMAT INCIDENT RESPONSE BE FAMILIAR WITH THIS PUBLICATION.** It is also available on the Internet at <http://hazmat.dot.gov/gydebook.htm>.

DETERMINING THE NATURE OF THE HAZARDOUS MATERIAL

When an incident involving the exposure of hazardous material occurs, it is of prime importance to any rescue operation to determine the nature of the substance(s) involved. All facilities that produce HAZMAT are required by law to prominently display this information, as is any vehicle transporting it. Any carton or box containing such material must also be

properly labeled. The name of the substance may also be displayed, along with a required four-digit identification number (sometimes preceded by the letters UN or NA).

The various kinds of hazardous materials usually have different labels to assist in their identification. These are generally diamond-shaped signs that have specific colors to identify the type of HAZMAT involved. Table 5-7 provides a list of the Department of Transportation (DOT)-mandated classifications of hazardous materials.

The ERG series provides a list of hazardous materials and appropriate emergency response actions. The Guidebook is primarily a tool to enable first responders to quickly identify the specific or generic classification of the material(s) involved in the incident, and to protect themselves and the general public during the initial phase of the incident.

SAFETY GUIDELINES

Your first objective should be to try to read the labels and identification numbers **FROM A DISTANCE**. If necessary, use binoculars. **DO NOT** go into the area unless you are absolutely certain that has been no hazardous spill. Relay any and all information available to your dispatch center where it can be used to identify the HAZMAT.

Once the HAZMAT has been identified, it can be classified as to the danger it presents (i.e., toxicity level). Based on this classification, the appropriate specialized equipment (known as personal protective equipment, or PPE) can be determined to provide adequate protection (i.e., protection level) from

Table 5-7.—Hazardous Materials Warning Labels

HAZMAT Type	Label Description
Explosives	solid orange color
Nonflammable gases	solid green color
Flammable liquids	solid red color
Flammable solids	white and red stripes
Oxidizers & peroxides	solid yellow color
Poisons & biohazards	solid white color
Radioactive materials	half white/half yellow with black radiation symbol
Corrosives	half white/half black
Other	usually white

secondary contamination to rescue personnel and healthcare providers.

Toxicity Levels

The National Fire Protection Association (NFPA) has developed a system for indicating the health, flammability, and reactivity hazards of chemicals. It is called the **NFPA 704 Labeling System** and is made up of symbols arranged in squares to comprise a diamond-shaped label (fig. 5-7). Each of the four hazards is indicated by a different colored square:

- **Red** indicates the flammability.
- **Yellow** indicates the reactivity.
- **White** indicates any special hazards.
- **Blue** indicates health hazards.
- The health hazard levels are
 - 4 - deadly,
 - 3 - extreme danger,
 - 2 - hazardous,
 - 1 - slightly hazardous, and
 - 0 - normal material.

Protection Levels

The protection levels, B, C, and D—indicate the type and amount of protective equipment required in a given hazardous circumstance, with level A being the most hazardous.

- **Level A** - positive pressure-demand, full-face piece self-contained breathing apparatus (SCBA) or positive pressure-demand supplied air respirator with escape SCBA; fully encapsulating, chemical-resistant suit; inner chemical-resistant gloves; chemical-resistant safety boots/shoes; and two-way radio communication.
- **Level B** - positive pressure-demand, full-face piece SCBA or positive pressure-demand supplied air respirator with escape SCBA; chemical-resistant clothing (overalls and long-sleeved jacket with hooded one- or two-piece chemical splash suit or disposable chemical-resistant one-piece suit); chemical-resistant safety boots/shoes; hard hat; and two-way communication.
- **Level C** - full-face piece, air-purifying canister-equipped respirator; chemical-resistant clothing (overalls and long-sleeved jacket with hooded one- or two-piece chemical splash suit or disposable chemical-resistant one-piece suit); inner and outer chemical-resistant gloves; chemical-resistant safety boots/shoes; hard hat; and two-way communication.
- **Level D** - Coveralls, safety boots/shoes, safety glasses or chemical splash goggles, and hard hat.

You are required to wear gloves at all four protection levels. If the correct type of glove to be used is not known, use neoprene or rubber, and avoid using latex or vinyl. In any instance, contact with HAZMAT should be avoided or minimized, and proper

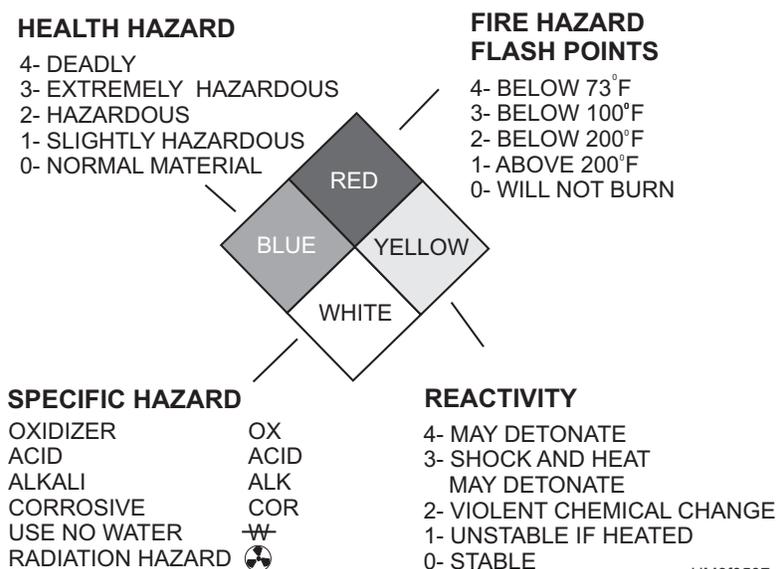


Figure 5-7.—NFPA 704 labeling system.

decontamination should be performed promptly. Protect feet from contact with chemical by using a disposable boot/shoe cover made from appropriate material.

Site Control

For management purposes, site control is divided up into three sections.

- **Exclusion Zone (Hot Zone):** The area where the contamination has occurred. The outer boundary of the exclusion zone should be marked either by lines, placards, hazard tape and/or signs, or enclosed by physical barriers. Access control points should be established at the periphery of the exclusion zone to regulate the flow of personnel and equipment. Remember also to remain **upwind** of the danger area, and avoid low areas where toxic gases/vapors may tend to settle.
- **Contamination-Reduction Zone (Warm Zone):** The transition area between the contaminated area and the clean area. This zone is designed to prevent the clean support zone from becoming contaminated or affected by other site hazards. Decontamination of personnel/equipment takes place in a designated area within the contamination-reduction zone called the “contamination-reduction corridor.”
- **Support Zone:** The location of the administrative and other support functions

needed to keep the operations in the exclusion and contamination- reduction zones running smoothly. The command post supervisor should be present in the support zone. Personnel may wear normal work clothes within this zone.

Figure 5-8 shows the three management sections of a hazard zone.

RESCUE AND PATIENT CARE PROCEDURES

LEARNING OBJECTIVE: *Recall rescue, patient care, and decontamination procedures for patients exposed to hazardous material.*

After a safety zone has been established—and regardless of your level of training—you should follow the procedures outlined below:

- Help isolate the incident site and keep the area clear of unauthorized and unprotected personnel.
- Establish and maintain communications with your dispatcher.
- Stay upwind and upgrade from the site, and monitor wind and weather changes.
- Don’t breathe any smoke, vapors, or fumes.

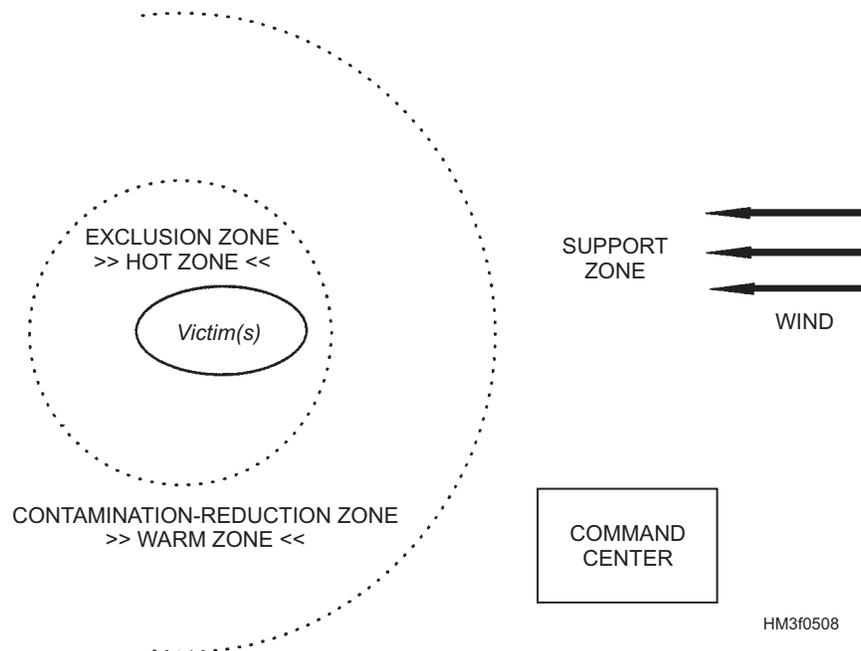


Figure 5-8.—Hazard zone management sections

- Don't touch, walk, or drive through the spilled materials, since these will increase the area of the spill.
- Don't eat, drink, or smoke at the site; don't touch your face, nose, mouth, or eyes. (These are all direct routes of entry into your body.)
- Eliminate any possible source of ignition (e.g., flares, flames, sparks, smoking, flashes, flashlights, engines, portable radios).
- Notify your dispatcher and give your location. Request the assistance of the HAZMAT response team.
- If possible, identify the hazardous material and report it to the dispatcher.
- Observe all safety precautions and directions given by the on-site HAZMAT expert. **All orders should be given and received face to face.**
- Stay clear of restricted areas until the on-site HAZMAT expert declares them to be safe.

Rescue from Exclusion Zone (Hot Zone)

The most dangerous element of any HAZMAT incident—both to the exposed victims and the rescuers—is the rescue from the hot zone. Rescue operations should always be performed using appropriate protective equipment (PPE). **You must never enter the area unless you have been appropriately trained to do so.** Let the experts handle this aspect of the rescue, but be prepared to provide supportive care once the victim is clear of the contaminated area.

As soon as the patient has been removed to safety, you should follow normal primary and secondary survey procedures, including interviews of the patient and bystanders. Observe the patient and provide basic life support. Give the patient supplemental oxygen, and monitor vital signs closely.

Patient Decontamination Procedures

Decontamination is the process of removing or neutralizing and properly disposing of contaminants that have accumulated on personnel and equipment. Decontamination protects site personnel by minimizing the transfer of contaminants, helps to prevent the mixing of incompatible chemicals, and protects the community by preventing uncontrolled

transportation of contaminants from the site. All personnel, clothing, and equipment that leave the contamination area (exclusion zone) must be decontaminated to remove any harmful chemicals that may have adhered to them. Some decontamination methods include those listed below.

- **Dilution:** the flushing of the contaminated person or equipment with water.
- **Absorption:** the use of special filters and chemicals to absorb the hazardous material.
- **Chemical washes:** specific chemicals used to neutralize the hazardous material.
- **Disposal and isolation:** the proper disposal of contaminated materials instead of attempting to decontaminate them.

Dilution is the most frequently appropriate method of decontamination.

Decontamination requires the use of PPE, although the level of protection required may be less once the victim is out of the hot zone. A victim who is exposed to a gas may not require actual “decontamination” after rescue and only require cessation of exposure and an opportunity to breathe fresh air. However, if a victim is soaked with a liquid, the HAZMAT may pose an ongoing risk to the victim and to the rescuers or medical personnel. **IT IS IMPORTANT TO ALWAYS ASSUME THAT THE VICTIM HAS BEEN CONTAMINATED WITH SOMETHING THAT COULD HARM YOU AND OTHERS UNTIL DETERMINED OTHERWISE.** Do not be foolish or bold and presume that you or others will not be exposed and harmed!

Once the victim is medically evaluated, carefully remove any solid material that remains on the patient's clothing. Be alert not to get any on yourself. If the material is dry, immediately remove the victim's clothing while avoiding or minimizing contact with the HAZMAT or loss of the HAZMAT from the clothing. Unless specifically contraindicated by the hazardous nature of the HAZMAT and directed by the incident commander or the supporting medical advisor, flush the patient's skin, clothing, and eyes with water. To the maximum extent possible, control or retain the runoff (which is contaminated) which will be containerized for proper disposal. Remove all of the victim's clothing, shoes, and jewelry. Place everything that may have contacted the HAZMAT in a special container. Mark the container as contaminated. Continue flushing the skin with water for at least 20

minutes. Again, try to retain the runoff. Using available items like towels or clean rags, mechanically remove the HAZMAT by wiping; avoid rubbing the skin too vigorously. Dry the skin and provide uncontaminated dry clothing or coverings.

The nature of the HAZMAT involved and the threat to the health of others (rescue team, other victims, medical personnel, transport crew) determines the degree of decontamination necessary before treatment or transporting the patient. Generally, it is preferred that decontamination be accomplished before treatment or transport. However, the patient's immediate medical condition may be more serious than the contamination itself. For example, ingested HAZMAT may pose little immediate threat to nearby personnel, but be an imminent threat to the victim's life. Therefore, the consequences of delaying the emergency care of the patient's injuries to accomplish gut decontamination must be carefully evaluated. In some cases, decontamination and emergency medical care can be carried out simultaneously. In rare instances of great urgency, the victim may require transportation to the hospital before decontamination. In these unusual cases, notify both the hospital and transportation crew of the patient's medical condition and contamination. Depending on the situation, the transportation crew will have to appropriately prepare to carry and care for the contaminated victim; otherwise, the crew themselves could be contaminated and/or be affected by the contamination. For example, the transport crew may need to wear level A or B suits and/or respirators. Remember, if the victim is contaminated and the transport requires personal protective devices, it is likely that the vehicle will be contaminated and require appropriate decontamination. There is also a potential to contaminate the receiving medical facility and its staff.

Diagnosis, Treatment, and Transport

As soon as the victim has been removed to safety, follow normal primary and secondary survey procedures, including interviews of the patient and bystanders. Observe the patient and provide the ABCs of basic life support (airway, breathing, circulation) and add "D" and "E" for disability and exposure. Look for signs of trauma and provide proper exposure (i.e., remove clothing) to fully assess the victim. Monitor vital signs and the victim closely! As a guideline, give the patient supplemental oxygen (4 to 6 liters per minute), and start an IV at an area of skin not exposed to the hazardous material (or at least that has been thoroughly decontaminated).

If the HAZMAT victim has swallowed a known or identified toxic material, treat the victim as a poisoned patient using the information provided above. Dress wounds and prepare the patient for transport to a medical treatment facility.

Finally, transport the victim to a medical treatment facility for complete medical evaluation and treatment. Care should be taken during transport to stabilize the victim by maintaining normal body temperature, administering oxygen, and treating shock.

SUMMARY

In this chapter, we discussed the assessment and treatment for poisoning, drug abuse, and hazardous material exposure, along with the rescue and decontamination procedures for patients exposed to HAZMAT. In our rapidly changing environment, we must be up to date on the latest changes in assessment and treatment for these conditions. You may stay informed through contact with the local Poison Control Center, MEDIC releases, or via the World Wide Web on the Internet.

CHAPTER 6

PHARMACY AND TOXICOLOGY

As you advance in rate, you will become more and more involved in the administration of medicines. Although drugs and their dosages are prescribed by medical officers and other authorized prescribers, you, as the Hospital Corpsman, are involved in their administration. It is necessary for you to learn drug sources, composition, methods of preparation and administration, and physiologic and toxicologic action. This chapter covers pharmacology, toxicology, medication calculations, pharmaceutical preparations, and prescriptions.

PHARMACOLOGY

LEARNING OBJECTIVE: *Recall the subsiences of pharmacology, drug standards, medication administration methods, and factors that affect dosage.*

Pharmacology is the science that deals with the origin, nature, chemistry, effects, and uses of drugs. The subsiences of pharmacology and their specific areas of concentration are as follows:

- **PHARMACOGNOSY**—the branch of pharmacology that deals with biological, biochemical, and economic features of natural drugs and their constituents.
- **PHARMACY**—the branch of pharmacology that deals with the preparation, dispensing, and proper use of drugs.
- **POSOLOGY**—the science of dosages.
- **PHARMACODYNAMICS**—the study of drug action on living organisms.
- **PHARMACOTHERAPEUTICS**—the study of the uses of drugs in the treatment of disease.
- **TOXICOLOGY**—the study of poisons, their actions, their detection, and the treatment of the conditions produced by them.

The science of treating disease by any method that will relieve pain, cure disease, or prolong life is called **therapeutics**. Therapeutics does not deal solely with

giving or taking medicine. This field also includes many other methods, such as radiological treatment, diathermy, and hydrotherapy.

DRUG STANDARDS

The texts dealing with pharmaceutical preparations include the *United States Pharmacopeia and National Formulary (USP-NF)*, which provides standards for drugs of therapeutic usefulness and pharmaceutical necessity. Inclusion of drugs into this compendium is based on therapeutic effectiveness and popularity. The USP-NF provides tests for drug identity, quality, strength, and purity.

Drug Facts and Comparisons and the *Physicians' Desk Reference (PDR)* have multiple indexes of commercially available drugs. Both are used as advertising outlets for various drug manufacturers. A comprehensive description of each pharmaceutical preparation (including composition, action and use, administration and dosage, precautions and side effects, dosage forms available, and the common (generic) drug names) is provided in both publications. These two publications are used as references for in-depth information on pharmaceutical products by healthcare providers and pharmacy personnel.

Remington: The Science and Practice of Pharmacy is probably the most widely used text/reference in American pharmacies. It contains all areas relevant to the art/science of pharmacy. The *Pharmacological Basis of Therapeutics* (Goodman and Gilman) is a textbook of pharmacology, toxicology, and therapeutics. This work is known as the "blue bible" of pharmacology.

MEDICATION ADMINISTRATION

The quantity and frequency of a drug's administration to a patient depend on several factors, as does the method of that medication's administration. This section will cover some of the factors affecting dosage calculations and methods of administration.

Dosage

The amount of medication to be administered is referred to as the **dose**. The study of dosage and the criteria that influence it is called **posology**. The doses given in the *United States Pharmacopeia and National Formulary (USP-NF)* are average therapeutic doses and are known as “usual adult doses.” The following terms are used in connection with doses.

THERAPEUTIC DOSE.—Therapeutic dose is also referred to as the normal adult dose, the usual dose or average dose. It is the amount needed to produce the desired therapeutic effect. This therapeutic dose is calculated on an average adult of 24 years who weighs approximately 150 pounds.

DOSAGE RANGE.—Dosage range is a term that applies to the range between the minimum and maximum amounts of a given drug required to produce the desired effect. Many drugs (such as penicillin) require large initial doses that are later reduced to smaller amounts. Closely associated with “dosage range” are the terms **minimum dose** (the least amount of drug required to produce a therapeutic effect), **maximum dose** (the largest amount of drug that can be given without reaching the toxic effect), and **toxic dose** (the least amount of drug that will produce symptoms of poisoning).

MINIMUM LETHAL DOSE.—Minimum lethal dose is the least amount of drug that can produce death.

Factors Affecting Dosage

The two primary factors that determine or influence the dosage of a medication are the age and weight of the patient.

AGE.—Age is the most common factor that influences the amount of drug to be given. An infant requires a lower dose than an adult. Elderly patients may require a higher or lower dose than the average dose, depending upon the action of the drug and the condition of the patient.

The rule governing calculation of pediatric (child’s) doses, **Young’s Rule**, is expressed as follows:

$$\frac{\text{age in years}}{\text{age in years} + 12} \times \text{adult dose} = \text{child's dose}$$

The age in years of the child is the numerator, and the age plus 12 is the denominator. This fraction is multiplied by the normal adult dose.

Example: The adult dose of aspirin is 650 mg. What is the dose for a 3-year-old child?

$$\frac{3}{3 + 12} \times \frac{650 \text{ mg}}{15} = 130 \text{ mg}$$

WEIGHT.—In the calculation of dosages, weight has a more direct bearing on the dose than any other factor, especially in the calculation of pediatric doses. The rule governing calculation of pediatric doses based on weight is **Clark’s Rule**, expressed as follows:

$$\frac{\text{weight in pounds}}{150} \times \text{adult dose} = \text{child's dose}$$

The child’s weight in pounds is the numerator, and the average adult weight (150 pounds) is the denominator. This fraction is multiplied by the adult dose.

Example: The adult dose of aspirin is 650 mg. What is the dose for a child weighing 60 pounds?

$$\frac{60 \text{ lbs}}{150 \text{ lbs}} \times 650 \text{ mg} = 260 \text{ mg}$$

OTHER FACTORS THAT INFLUENCE DOSAGE.—Other factors that influence dosage include the following:

- **Sex**—Females usually require smaller doses than males.
- **Race**—Black individuals usually require larger doses, and Asians require smaller doses than Caucasians.
- **Occupation**—Persons working in strenuous jobs may require larger doses than those who sit at a desk all day.
- **Habitual use**—Some patients must take medications continuously, causing their bodies to build up tolerance to the drug. This tolerance may require larger doses than their initial doses to obtain the same therapeutic effect.
- **Time of administration**—Therapeutic effect may be altered depending upon time of administration (e.g., before or after meals).

- **Frequency of administration**—Drugs given frequently may need a smaller dose than if administered at longer intervals.
- **Mode of administration**—Injections may require smaller doses than oral medications.

Methods of Administering Drugs

Drugs may be introduced into the body in several ways, each method serving a specific purpose.

ORAL.—Oral administration of medications is the most common method. Among the advantages of administering medication orally (as opposed to other methods) are the following:

- Oral medications are convenient.
- Oral medications are cheaper.
- Oral medications do not have to be pure or sterile.
- A wide variety of oral dosage forms is available.

Oral medication administration may be disadvantageous for the following reasons:

- Some patients may have difficulty swallowing tablets or capsules.
- Oral medications are often absorbed too slowly.
- Oral medications may be partially or completely destroyed by the digestive system.

Other methods of administration closely associated with oral administration are **sublingual** and **buccal**. Sublingual drugs are administered by placing the medication under the tongue. The medication is then rapidly absorbed directly into the blood stream. An example of a sublingual drug is nitroglycerin sublingual tablets (for relief of angina pectoris).

Buccal drugs are administered by placing the medication between the cheek and gum. Buccal drugs, like sublingual drugs, are quickly absorbed directly into the blood stream. An example of a drug that may be given buccally is the anesthetic benzocaine.

PARENTERAL.—Parenteral medications are introduced by injection. All drugs used by this route must be pure, sterile, pyrogen-free (pyrogens are products of the growth of microorganisms), and in a liquid state. There are several methods of parenteral administration, including subcutaneous, intradermal, intramuscular, intravenous, and intrathecal or intraspinal.

Subcutaneous.—The drug is injected just below the skin's cutaneous layers. **Example:** Insulin.

Intradermal.—The drug is injected within the dermis layer of the skin. **Example:** Purified protein derivative (PPD).

Intramuscular.—The drug is injected into the muscle. **Example:** Procaine penicillin G.

Intravenous.—The drug is introduced directly into the vein. **Example:** Intravenous fluids.

Intrathecal or Intraspinal.—The drug is introduced into the subarachnoid space of the spinal column. **Example:** Procaine hydrochloride.

INHALATION.—Inhalation is a means of introducing medications through the respiratory system in the form of a gas, vapor, or powder. Inhalation is divided into three major types: vaporization, gas inhalation, and nebulization.

Vaporization.—Vaporization is the process by which a drug is changed from a liquid or solid to a gas or vapor by the use of heat (such as in steam inhalation).

Gas Inhalation.—Gas inhalation is almost entirely restricted to anesthesia.

Nebulization.—Nebulization is the process by which a drug is converted into a fine spray by the use of compressed gas.

TOPICAL.—Topical drugs are applied to a surface area of the body. Topically applied drugs serve two purposes:

- **Local effect:** The drug is intended to relieve itching, burning, or other skin conditions without being absorbed into the bloodstream.
- **Systemic effect:** The drug is absorbed through the skin into the bloodstream.

Examples of topical preparations are ointments, creams, lotions, and shampoos.

RECTAL.—Drugs are administered rectally by inserting them into the rectum. The rectal method is preferred to the oral route when there is danger of vomiting or when the patient is unconscious, uncooperative, or mentally incapable. Examples of rectal preparations are suppositories and enemas.

VAGINAL.—Drugs are inserted into the vagina to produce a local effect. Examples of vaginal preparations are suppositories, creams, and douches.

DRUG CLASSIFICATIONS

LEARNING OBJECTIVE: *Recall drug groups, the generic and trade names of drugs listed in each drug group, and recognize each drug's use.*

The definition of a drug is any chemical substance that has an effect on living tissue but is not used as a food. Drugs are administered to humans or animals as an aid in the diagnosis, treatment, or prevention of disease or other abnormal condition; for the relief of pain or suffering; and to control or improve any physiologic or pathologic condition. Drugs are classified according to set criteria and fall into three specific areas: general, chemical, and therapeutic.

- **General**—Drugs are grouped according to their source, whether animal, vegetable, or mineral in origin.
- **Chemical**—Drugs are grouped by their chemical characteristics.
- **Therapeutic (Pharmacological)**—Drugs are grouped according to their action on the body.

NOTE: Some drugs may have more than one action.

Drug Nomenclature

Drugs normally have three names: chemical, generic, and trade (brand).

- **Chemical name** relates to the chemical and molecular structure. An example is 2,4,7-triamino-6-phenylpteridine.
- **Generic name** is often derived from the chemical name. Generic name is the common name of the drug. An example is triamterene. (Note the underlining of the chemical name above.)
- **Trade name** is the proprietary name given by the manufacturer. Trade name is referred to as the brand name. An example is Dyrenium®, a brand of triamterene made by SmithKline Beecham.

Drug Groups

The types of drugs discussed in this chapter and the correlating drugs in common use described in

appendix IV are grouped according to pharmacological classes. Only a brief summary is possible here, and the Corpsman who desires a more complete description of each drug should refer to the *USP-NF*, *Drug Facts and Comparisons*, the *Physicians' Desk Reference*, or other drug reference books.

ASTRINGENTS.—Astringents are drugs that cause shrinkage of the skin and mucous membranes. Astringents are mainly used to stop seepage, weeping, or discharge from mucous membranes. (See appendix IV, page 1.)

EMOLLIENTS.—Emollients are bland or fatty substances that may be applied to the skin to make it more pliable and soft. They may also serve as vehicles for application of other medicinal substances. Emollients are available as ointments, creams, or lotions. (See appendix IV, page 1.)

EXPECTORANTS AND ANTITUSSIVES.—Expectorants and antitussives are commonly used in the symptomatic treatment of the common cold or bronchitis. (See appendix IV, page 1.) **Expectorants** are more accurately known as bronchomucotropic agents. These agents assist in the removal of secretions or exudate from the trachea, bronchi, or lungs. They act by liquefying viscid mucous or mucopurulent exudates. Therefore, they are used in the treatment of coughs to help expel these exudates and secretions. **Antitussives** are agents that inhibit or suppress the act of coughing. Other cold and allergy relief preparations are discussed later in this chapter.

NASAL DECONGESTANTS.—Nasal decongestants reduce congestion and the swelling of mucous membranes. They are used for the temporary relief of nasal congestion due to the common cold, nasal congestion associated with sinusitis, and to promote nasal or sinus drainage. Nasal decongestants are also used to relieve eustachian tube congestion. Nasal decongestants are often combined with antihistamines, antitussives, and expectorants to relieve the symptoms of colds, allergies, and sinusitis. Some of the more frequently used drug combinations are covered in appendix IV, page 2.

ANTI-HISTAMINES.—Antihistamines are used to counteract the physical symptoms that histamines cause. Histamine, a substance released by mast cells distributed in connective tissues usually near blood vessels, promotes some of the reactions associated with inflammation and allergies, such as asthma and hay fever. Antihistamines may cause drowsiness, so

patients should be warned against driving or operating machinery while taking this type of medication. (See appendix IV, page 2.)

HISTAMINE H₂ RECEPTOR ANTAGONISTS.—Histamine H₂ receptor antagonists block histamines that cause an increase of gastric acid secretion in the stomach. Histamine H₂ receptor antagonists are effective in preventing complications of peptic ulcer disease and alleviating symptoms of this disease. (See appendix IV, page 2.)

ANTACIDS.—Antacids are drugs used to counteract hyperacidity in the stomach. Normally, there is a certain degree of acidity in the stomach. An excess of acid can irritate the mucous membranes and is commonly known as indigestion, heartburn, or dyspepsia. In some disease states, the gastrointestinal tract may become excessively acidic (very low pH), causing diarrhea or leading to peptic ulcer formation. Antacids may interfere with the body's ability to use many drugs. For this reason, oral drugs normally should not be taken within 2 hours of taking an antacid. (See appendix IV, page 3.)

NOTE: It is important for you to be aware of the significance of the sodium content of most antacids, particularly for cardiac patients or patients on a low-sodium diet.

ANTISEPTICS, DISINFECTANTS, AND GERMICIDES.—These agents are primarily intended for the prevention of infections by destroying bacteria or preventing their growth. The differences among them are based primarily on degree of activity and how they are used. **Antiseptics** suppress the growth of microorganisms. **Germicides** kill susceptible organisms. **Disinfectants** are agents used to disinfect inanimate objects and are primarily germicidal in their action. All of these agents are for external use only, unless otherwise indicated. (See appendix IV, pages 3 and 4.)

SULFONAMIDES.—Sulfonamides were the first effective chemotherapeutic agents to be available in safe therapeutic dosage ranges. They were the mainstay of therapy of bacterial infections in humans before the introduction of the penicillins in 1941. Sulfonamides are synthetically produced and are effective against both gram-positive and gram-negative organisms. (See appendix IV, page 5.)

PENICILLINS.—Penicillin is one of the most important antibiotics. It is derived from a number of *Penicillium* molds commonly found on breads and fruits. The mechanisms of action for the penicillins is

the inhibition of cell wall synthesis during the reproductive phase of bacterial growth. It is one of the most effective and least toxic of the antimicrobial agents. (See appendix IV, page 5.)

CEPHALOSPORINS.—The cephalosporins are a group of semisynthetic derivatives of *cephalosporin C*, an antimicrobial agent of fungal origin. They are structurally and pharmacologically related to the penicillins. Because the cephalosporins are structurally similar to the penicillins, some patients allergic to penicillin may also be allergic to cephalosporin drugs. The incidence of cross-sensitivity is estimated to be 5 to 16 percent.

This family of antibiotics is generally divided into generations:

- First generation — cefazolin sodium (Ancef®), Kefzol®)
- Second generation — cefoxitin sodium (Mefoxin®)
- Third generation — cefotaxime sodium (Claforan®)

The main differences among the groups is the change in the antibacterial spectrum. The third generation agents have a much broader gram-negative spectrum than the earlier generations.

Examples of various cephalosporins are listed in appendix IV, page 6.

TETRACYCLINES.—Tetracyclines, introduced in 1948, were the first truly broad-spectrum antibiotics. They include a large group of drugs with a common basic structure and chemical activity. The most important mechanism of action of the tetracyclines is the blocking of the formation of polypeptides used in protein synthesis. Because of their broad spectrum of activity, tetracyclines are most valuable to treat mixed infection, such as chronic bronchitis and peritonitis; however, they are drugs of choice for only a few bacterial infections. Tetracycline is also used as a topical preparation to treat acne.

The tetracyclines are relatively nontoxic, the most common side effects being mild gastrointestinal disturbances. Allergic reactions and anaphylaxis are rare. Administration to children and pregnant women is not indicated because it may produce discoloration of the teeth and depress bone marrow growth. The major hazard of tetracycline therapy is the overgrowth of resistant organisms, especially *Candida* and staphylococci.

Tetracyclines should not be administered with milk, milk products, antacids or iron preparations; they combine with metal ions to form nonabsorbable compounds.

Examples of tetracyclines in common use are listed in appendix IV, page 6.

AMINOGLYCOSIDES.—Aminoglycosides are a group of drugs that share chemical, antimicrobial, pharmacologic, and toxic characteristics, and that are effective against most gram-positive and gram-negative organisms. Their method of action is by inhibiting protein synthesis. Aminoglycosides can cause varying degrees of ototoxicity and nephrotoxicity, depending on the particular agent and the dose. Toxicity is more prevalent in the very young or old, in the presence of renal impairment or dehydration, or with the use of diuretics. Because of their high toxicity, aminoglycosides are not recommended when the infective organism is susceptible to less toxic preparations.

Examples of several aminoglycosides are listed in appendix IV, page 7.

MACROLIDES.—Macrolide antibiotics constitute a large group of bacteriostatic agents that inhibit protein synthesis. They are effective against gram-positive cocci, *Neisseria*, *Hemophilus*, and mycobacteria. All are similar to penicillin in their antibacterial spectra, and are often used in patients who are sensitive to penicillin. (See appendix IV, pages 7 and 8.)

ANTIFUNGALS.—Antifungal agents inhibit or suppress the growth systems of fungi, dermatophytes, or *Candida*. Antifungals have not been developed to the same degree as antibacterial agents. Most fungi are completely resistant to the action of chemicals at concentrations that can be tolerated by the human cell. Since there are only a few available for internal use, most antifungal agents are topical. The antifungal agents that are available for systemic use generally produce hepatic or renal dysfunction or other serious side effects. Because of these side effects, systemic antifungals should be limited to serious or potentially fatal conditions. Therapy that includes topical preparations may be provided in conjunction with oral or parenteral antifungal agents.

Examples of several antifungal agents are listed in appendix IV, page 8.

ANTIPARASITICS.—Antiparasitics are agents that are destructive to parasites. Parasitic infections or infestations account for the largest number of chronic

disabling diseases known. They are especially prevalent in the tropics or subtropics and in lesser-developed countries where overcrowding and poor sanitation exist. Parasitic infections include protozoal infections (malaria, amebiasis, and to a lesser extent, trichomoniasis), helminthic infections (intestinal worms), and **ectoparasites**. Ectoparasites, such as head lice and crab lice, although not disabling, are considered a nuisance and can transmit disease.

Examples of antiparasitics in common use are listed in appendix IV, page 9.

LAXATIVES.—Laxatives are drugs that facilitate the passage and elimination of feces from the colon and rectum. They are indicated to treat simple constipation and to clean the intestine of any irritant or toxic substances (catharsis). Laxatives may also be used to soften painfully hard stools and to lessen straining of certain cardiac patients when defecating. They are contraindicated in certain inflammatory conditions of the bowel, bowel obstruction, and abdominal pain of unknown origin, and should not be used in the presence of nausea and vomiting. Laxatives are classified as irritant, bulk, emollient, or stool softeners. Frequent or prolonged use of any laxative may result in dependence. (See appendix IV, pages 9 and 10.)

ANTIDIARRHEALS.—Antidiarrheals are drugs that are effective in combating diarrhea. Diarrhea is defined as an abnormal frequency and liquidity of fecal discharge. This condition may result from food poisoning, parasitic infestation of the bowel, and gastrointestinal diseases. (See appendix IV, page 10.)

DIURETICS.—The kidney is the primary organ that excretes water-soluble substances (urine) from the body. Diuretics are agents that increase the rate of urine formation. These agents are useful in treating hypertension and edematous conditions, such as congestive heart failure and acute pulmonary edema. However, loss body fluids due to use of diuretics can seriously deplete electrolytes from the system, and care should be taken to monitor and replenish lost sodium and potassium through diet and supplement therapy. (See appendix IV, page 10 and 11)

NON-NARCOTIC ANALGESICS, ANTI-PYRETICS, AND ANTI-INFLAMMATORY AGENTS.—**Non-narcotic analgesics** are drugs that relieve pain without producing unconsciousness or impairing mental capacities. **Antipyretics** relieve or reduce fevers. **Anti-inflammatory agents** counteract or suppress inflammation or the inflammatory process. Many of the drugs discussed in appendix IV, page 11, were developed with two or more of these properties.

CENTRAL NERVOUS SYSTEM STIMULANTS.—Certain drugs stimulate the activity of various portions of the central nervous system (CNS). The *Manual of the Medical Department* (MANMED) is explicit as to the usage of these drugs in the Navy. Primary indications for this class of drugs are narcolepsy, hyperkinesia, and attention deficit disorders in children. Central nervous system stimulants are generally contraindicated in patients with hypertension, arteriosclerosis, symptomatic cardiovascular disorders, agitated states, glaucoma, or history of drug abuse. (See appendix IV, page 12.)

CENTRAL NERVOUS SYSTEM DEPRESSANTS.—Central nervous system (CNS) depressants range in depressive action from mild sedation to deep coma, differing mainly in rapidity, degree, and duration of action. Any of these CNS depressants may, in sufficient doses, cause respiratory depression. Alcohol use while taking CNS depressants should be avoided. Many of the central nervous system depressants are controlled medications. Refer to the MANMED for control, custody, and accountability guidelines for controlled substances.

Barbiturates comprise a widely used group of CNS depressants. They are used mainly as sedative-hypnotics, anticonvulsants, anesthetics for short anesthesia, and may be used in combination with analgesics to enhance their analgesic effect.

NOTE: Barbiturates may be habit forming.

See appendix IV, page 12, for examples of central nervous system depressants.

OPIUM AND OPIUM ALKALOIDS.—The activity of opium is primarily due to its morphine content. The major medical use of opium has been for its antiperistaltic activity, particularly in diarrhea. Opium alkaloids, e.g., morphine and codeine, have replaced opium in medical use. Members of this drug group are used as analgesics, cough sedatives, and for certain types of diarrhea. (See appendix IV, pages 12 and 13.)

NOTE: Warn patients taking opium or opium alkaloids that drowsiness, dizziness, and blurring of vision may occur. For this reason, they should not drive or perform other tasks that require alertness. Also, caution patients against consuming alcohol and other CNS depressants. Patients should notify their physician immediately if shortness of breath or difficulty in breathing occurs.

PSYCHOTHERAPEUTIC AGENTS.—Tranquilizers and mood modifiers are the two primary groups of psychotherapeutic agents. Psychotherapeutic agents are classified as **major tranquilizers**, **minor tranquilizers**, and **mood modifiers**. The mood modifiers have replaced amphetamines as treatment of choice for depressive states. (See appendix IV, pages 13 and 14.)

SKELETAL MUSCLE RELAXANTS.—Skeletal muscle relaxants are used in connection with the treatment of muscle spasm due to various conditions. They may also be used to produce muscular relaxation during surgical anesthesia. Skeletal muscle relaxants may cause drowsiness and impair performance of tasks that require alertness. (See appendix IV, page 14.)

CARDIOVASCULAR AGENTS.—Cardiovascular agents affect the action of the circulatory system. Most of these agents are highly specialized. (See appendix IV, pages 14 and 15.)

VASOCONSTRICTORS.—Vasoconstrictors produce constriction of the blood vessels with consequent rise in blood pressure. (See appendix IV, page 15.)

ANTICOAGULANTS.—Anticoagulants delay or prevent blood coagulation. Before an anticoagulant agent is prescribed and its dosage determined, laboratory testing of the patient's blood-clotting capabilities should be performed.

Examples of commonly used anticoagulants are listed in appendix IV, page 15.

VITAMINS.—Vitamins are unrelated organic substances that occur in many foods and are necessary for the normal metabolic functioning of the body. Vitamins may be **water-soluble** or **fat-soluble**. The majority of vitamins are water-soluble. Water-soluble vitamins are excreted in the urine and are not stored in the body in appreciable quantities. The fat-soluble vitamins (A, D, E, and K) are soluble in fat solvents and are absorbed along with dietary fats. Fat-soluble vitamins are not normally excreted in the urine and tend to be stored in the body in moderate amounts.

See appendix IV, page 16, for a listing of several of the major vitamins and their respective properties.

GENERAL AND LOCAL ANESTHETICS.—Generally speaking, anesthesia means “without feeling.” Consequently, we apply the word to drugs that produce insensibility to pain. The field of anesthesia is a highly specialized one.

General anesthetics are usually gas or vapor and are administered by inhalation. Anesthesiology is a highly specialized field, and the administration of a general anesthetic should never be undertaken without the supervision of a medical officer. There may be times, however, when you, as a Hospital Corpsman, are called upon to assist by administering general anesthesia. You should, therefore, acquaint yourself with the most commonly used general anesthetics and their respective properties.

Local anesthetics produce loss of sensation to pain in a specific area or locality of the body, without loss of consciousness or mental capacity. The majority of these drugs are administered parenterally or topically.

See appendix IV, pages 17 and 18, for a listing of several of the most commonly used anesthetics.

OXYTOCICS.—Oxytocics are drugs that produce a rhythmic contraction of the uterus. Their action is selective for the uterus, although other smooth muscles are affected. (See appendix IV, page 18.)

Biological Agents

Biological agents are prepared from living organisms or their products. The chief purpose served by these preparations in the Navy is the immunization of personnel against infectious disease. They may, however, be used in the treatment of disease or act in a diagnostic capacity. Dosage and routes of administration are described in BUMEDINST 6320.1.

Biologicals include serums, viruses, toxins, antitoxins, antigens, and bacterial vaccines.

Manufacturers of these products must be licensed by the Secretary of the Treasury. Their products are monitored by the U.S. Public Health Service.

The label that must be placed on each package will bear the name, address, and license number of the manufacturer. It will also list the name of the product, lot number, date of manufacture (or expiration), period of potency, and the minimum potency (or the fact that there is no standard of potency).

FACTORS TO BE REMEMBERED CONCERNING BIOLOGICALS.—Most immunizing agents that are used in routine procedures may be obtained through normal supply channels. (Yellow fever vaccine must be ordered from activities that have been designated as supply points for this biological.) Biologicals must be stored in a cool, dry, and

preferably dark place. (Yellow fever vaccine must be maintained in a frozen state until prepared for use.) All biological products should be examined periodically, and a thorough examination for deterioration will be held immediately preceding their use.

EXAMINATIONS OF PARENTERAL SOLUTIONS.—Solutions are examined at least three times at the activity at which they are ultimately used:

1. Upon receiving the solution.
2. Periodically while in storage.
3. Immediately preceding use. Parenteral solutions, unless the label states otherwise, must be free of turbidity or undissolved material. All solutions should be inverted and gently swirled to bring any sediment or particulate matter into view. A well-illuminated black or white background will facilitate this examination.

Parenteral solutions may be unfit for use because of

- deterioration from prolonged storage,
- accidental contamination occurring upon original packaging, or
- defects that may develop in containers or seals.

There is no set rule that can be applicable in regards to any of these factors. Therefore, to ensure suitability for use, a regimented program of inspection is necessary.

IMMUNIZING AGENTS.—Following is a descriptive list of the most common immunizing agents used by the U.S. armed forces to inoculate military personnel against disease.

Diphtheria Antitoxin.—Diphtheria antitoxin is a transparent or slightly opalescent liquid, nearly colorless, and has a very slight odor due to its preservative. It is a sterile solution of antitoxic substances obtained from the blood serum or plasma of a healthy horse immunized against diphtheria toxin.

Tetanus Antitoxin.—Tetanus antitoxin is a sterile solution of antitoxic substances that are usually obtained from the blood serum or plasma of a healthy horse that has been immunized against tetanus toxin or toxoid. Tetanus antitoxin contains not more than 0.4 percent cresol or 0.5 percent phenol as a preservative. It is slightly opalescent with a yellow, brown, or greenish color, depending upon the manufacturer. There will be a slight odor of the preservative used.

Tetanus Toxoid.—Tetanus toxoid is a sterile solution of the growth of the tetanus bacillus,

Clostridium tetani, which has been treated with formaldehyde. It is a brownish yellow or slightly turbid liquid, usually having the distinctive odor of formaldehyde.

Alum Precipitated Diphtheria and Tetanus Toxoids and Pertussis Vaccines Combined (DPT).— This is a markedly turbid, whitish liquid. It is nearly odorless or may have a slight odor of the preservative. It is a sterile suspension of the precipitate obtained by treating the mixture of diphtheria toxoid, tetanus toxoid, and pertussis vaccine with alum and combining in such proportions as to ensure an immunizing dose of each in the total dosage as listed on the label.

Cholera Vaccine.—Cholera vaccine is a suspension of killed cholera, *Vibrio comma*, in a suitable diluent, usually normal saline. The vaccine presents a turbid appearance, and there may be a slight odor due to the preservative. On storage, autolysis may occur so that the vaccine may become almost as clear as water.

Poliovirus Vaccine.—There are two kinds of polio vaccine: Inactivated poliovirus vaccine (IPV), which is the shot recommended in the United States today, and a live, oral polio vaccine (OPV), which consists of drops that are swallowed. Until recently, OPV was recommended for most children in the United States. OPV helped us rid the country of polio, and it is still used in many parts of the world.

Both vaccines give immunity to polio, but OPV is better at keeping the disease from spreading to other people. However, for a few people (about one in 2.4 million), OPV actually causes polio. Since the risk of getting polio in the United States is now extremely low, experts believe that using oral polio vaccine is no longer worth the slight risk, except in limited circumstances.

Inactivated poliovirus vaccine (IPV) must be stored between 2°C and 8°C (24°F and 46°F). The vaccine is clear and colorless, and it should be administered intramuscularly or subcutaneously.

ORAL POLIOVIRUS VACCINE MUST NEVER BE ADMINISTERED PARENTERALLY. To maintain potency, OPV must be stored in the freezer compartment of the refrigerator. It should be noted that certain forms of this vaccine will remain fluid at temperatures above -14°C. If frozen, after thawing, agitate the vaccine to ensure homogeneity of its contents before use. Once the temperature rises above 0°C, the vaccine **MUST BE USED WITHIN 7 DAYS**. During this period, it must be stored below 10°C.

Yellow Fever Vaccine.—This vaccine is a dull, light orange, flaky or crust-like desiccated mass that requires rehydration immediately before use. It must be stored at or below 0°C until rehydration is effected with sterile sodium chloride injection USP.

Plague Vaccine.—The vaccine for plague is a sterile suspension of killed plague bacilli in an isotonic solution. The strain of bacilli used has been selected for its high antigenic efficiency. The vaccine is a turbid, whitish liquid with little or no odor. The presence of any precipitate is reason to suspect contamination.

Influenza Virus Vaccine.—The influenza virus vaccine is prepared from the allantoic fluid of incubated fertile hen eggs. It is a slightly hazy fluid, the result of minute amounts of egg protein. Its color varies from gray to very faint red, depending upon the method of manufacture.

The duration of immunity is probably no longer than a few months, which necessitates repeating the inoculation before the expected seasonal occurrence.

Do not inoculate individuals who are known to be sensitive to eggs or egg products, or personnel suffering from upper respiratory infections.

Dried Smallpox Vaccine.—This vaccine is prepared directly from calf lymph, purified, concentrated, stabilized, and dried by lyophilization. Dried smallpox vaccine is much more stable than the conventional liquid. When stored at or below 25°C, it retains its full potency for 18 months. When reconstituted and stored below 4°C (preferably 0°C), it retains its full potency for 3 months.

Smallpox is no longer considered to be a threat to world health, and immunizations against it are no longer required. However, a general knowledge of the disease and its prevention is important.

Anthrax Vaccine.—The anthrax vaccine for humans licensed for use in the United States is a cell-free filtrate vaccine (using dead as opposed to live bacteria). Inspect the vaccine visually for particulate matter and discoloration before administration. Anthrax vaccine should be stored between 2°C and 8°C (refrigerator temperature); it must not be frozen. Do not use the vaccine if the expiration date listed on the package has expired.

The vaccine should be administered only to healthy men and women from 18 to 65 years of age. It should **NOT** be administered to pregnant women.

The immunization consists of three subcutaneous injections given 2 weeks apart, followed by three additional subcutaneous injections given at 6, 12, and 18 months. Annual booster injections of the vaccine are required to maintain immunity.

TOXICOLOGY

LEARNING OBJECTIVE: *Identify how poisons are introduced into the body and the factors that affect their toxicity.*

Toxicology is the science of poisons, their actions, their detection, and the treatment of the conditions produced by them. A **poison** is a substance that, when inhaled, swallowed, absorbed, applied to the skin, or injected into the body in relatively small amounts, may cause damage to structures or disturbances of function. Poisons act by changing the normal metabolism of cells or by actually destroying them.

The effects of poisons may be local or remote, and in some instances, poisons can produce both effects. A **local effect** is produced when a poison only affects the area in which it is applied. A **remote effect** is produced when a poison affects parts of the body that are remote to the site of application or point of introduction. Poisons sometimes show no effect—or only a slight effect—until several doses have been taken. Then, suddenly, an effect is produced that nearly equals that produced by taking the whole amount at one time. This is known as a **cumulative effect**.

The toxicity of poisons depends upon their method of introduction into the body and how fast they are absorbed by the body. For example, snake venom taken into the mouth or into the stomach during first aid treatment of snakebite is not ordinarily harmful, but snake venom injected parenterally is extremely poisonous.

Various conditions affect an individual's reaction and susceptibility to poisons. For instance, some individuals by nature are unusually sensitive to certain poisons (such as venom from bee stings), while others possess a natural tolerance. Additionally, the age of the victim can affect the severity of the poisoning. Young children, for example, are normally more susceptible to poisons than adults. Habitual use of certain poisons, such as narcotics, may cause individuals to become accustomed to a poison's effects, even though the amount taken by these

individuals would ordinarily be considered lethal. This habitual use of poisons, however, may result in a sudden hypersensitivity that could be deadly. The actions of poisons may also be considerably modified by disease, some diseases increasing and others lessening the action of poisons.

Poisons are eliminated from the body by way of the kidneys, liver, gastrointestinal tract, and skin. Poisons are eliminated either unchanged or in the form of other compounds. These compounds are the result of chemical changes made in various body organs and tissues.

For a more in-depth understanding of the various types of poisoning and their emergency treatment procedures, see chapter 5, "Poisoning, Drug Abuse, and Hazardous Material Exposure."

PHARMACY

LEARNING OBJECTIVE: *Recall the various pharmaceutical weight and measurement systems, and determine medication dosage by using the conversion process or the percentage and ratio calculations.*

As you progress in your career as a Hospital Corpsman, you will be assigned duties in specialized departments throughout the hospital and especially aboard ship. Not only will your responsibilities increase, but your training will become more and more diversified.

One of the departments to which you may be assigned is the pharmacy, where you will assist in preparing and dispensing medicines. This section will give you a basic introduction to the field of pharmacy and help prepare you for these responsibilities.

METROLOGY AND CALCULATION

Metrology, called the arithmetic of pharmacy, is the science of weights and measures and its application to drugs, their dosage, preparation, compounding, and dispensing.

It is absolutely vital for Hospital Corpsmen to thoroughly understand the principles and applications of metrology in pharmacy. Errors in this area endanger the health—even the life—of the patient.

The Metric System

The metric system is the official system of weights and measures used by Navy Pharmacy Departments for weighing and calculating pharmaceutical preparations. The metric system is becoming the accepted system throughout the world. Hospital Corpsmen need to be concerned primarily with the divisions of weight, volume, and linear measurement of the metric system. Each of these divisions has a primary or basic unit and is listed below:

- Basic unit of weight is the **gram**, abbreviated “g”
- Basic unit of volume is the **liter**, abbreviated “l”
- Basic linear unit is the **meter**, abbreviated “m”

By using the prefixes **deka**, **hecto**, and **kilo** for multiples of, respectively, ten, one hundred, and one thousand basic units, and the prefixes **micro**, **milli**, **centi**, and **deci** for one-ten thousandth, one- thousandth, one-hundredth, and one-tenth, respectively, you have the basic structure of the metric system. By applying the appropriate basic unit to the scale of figure 6-1, you can readily determine its proper terms. For example, using the gram as the basic unit of weight, we can readily see that 10 g equals 1 dekagram, 100 g equals 1 hectogram, and 1000 g is referred to as a kilogram. Conversely, going down the scale, 0.1 g is referred to as a decigram, 0.01 g is called a centigram, and 0.001 g is a milligram.

The Apothecary System

Although fast becoming obsolete, the apothecary system for weighing and calculating pharmaceutical

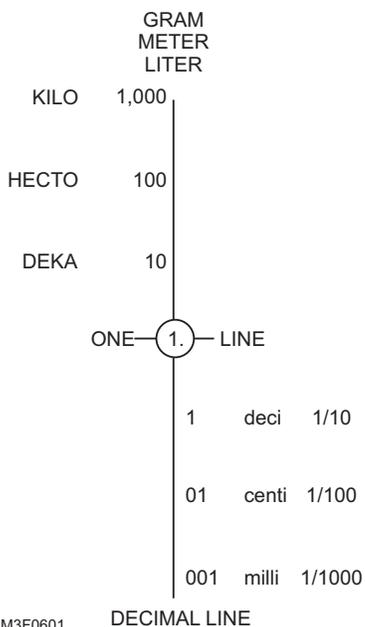


Figure 6-1.—Graph comparing the metric system with the decimal equivalent.

preparations is still used and must be taken into consideration. It has two divisions of measurement: weight and volume. In this system, the basic unit of weight is the **grain** (abbreviated “gr”), and the basic unit of volume is the **minim** (abbreviated “m”).

The Avoirdupois System

The avoirdupois system is a system used in the United States for ordinary commodities. The basic units of the avoirdupois system are dram (27.344 grains), ounce (16 drams), and pound (16 ounces).

Table of Weights and Measures

See table 6-1, a table of weights and measures; study it thoroughly.

Converting Weights and Measures

Occasionally, there are times when it will be necessary to convert weights and measures from one system to another, either metric to apothecary or vice versa. Since patients can hardly be expected to be familiar with either system, always translate the dosage directions on the prescription into a household equivalent that they can understand. Household measurements are standardized, on the assumption that the utensils are common enough to be found in any home. Table 6-2 is a table of household measures, with their metric and apothecary equivalents.

CAUTION: For the conversion of specific quantities in a prescription or in converting a pharmaceutical formula from one system to another, exact equivalents must be used.

CONVERSION

As stated earlier, in the practice of pharmacy it may be necessary to convert from one system to another to dispense in their proper amounts the substances that have been ordered. Although the denominations of the metric system are not the same as the common systems, the Bureau of International Standards has established conversion standards that will satisfy the degree of accuracy required in almost any practical situation. Ordinary pharmaceutical procedures generally require something between two- and three-figure accuracy, and the following tables of conversion (tables 6-3 and 6-4) are more than sufficient for practical use. Naturally, if potent agents are involved, you must use a more precise conversion factor for purposes of calculation.

Table 6-1.—Measuring Equivalents

Systems of Weights	Systems of Volume Measures	Linear Measure
AVOIRDUPOIS		
Primary unit of weight is the grain.		
437.5 grains = 1 ounce (av. oz.)		
16.0 ounces = 1 pound (av. lb.)		
<hr/>		
APOTHECARY		
Primary unit of weight is the grain.		
20 grains (gr) = 1 scruple (℥)	Smallest unit of volume is the minim.	
3 scruples = 1 dram (ʒ)	60 minims (m) = 1 fluid dram (ʒ)	
8 drams (480 gr) = 1 ounce (℥)	8 fluid drams = 1 fluid ounce (ʒ)	
12 ounces = 1 pound (lb)	16 fluid ounces = 1 pint (0)	
	2 pints = 1 quart (qt.)	
	4 quarts = 1 gallon (Cong. or gal.)	
<hr/>		
METRIC		
Primary unit of weight is the gram.		
1000.000 grams = 1 kilogram (kg)	Primary unit of volume is the liter.	
100.000 grams = 1 hectogram (hg)	1000.000 liters = 1 kiloliter (kl)	
10.000 grams = 1 dekagram (dkg)	100.000 liters = 1 hectoliter (hl)	
1.000 gram = 1 gram (gm)	10.000 liters = 1 dekaliter (dkl)	
0.1 gram = 1 decigram (dg)	1.000 liter = 1 liter (l)	
0.01 gram = 1 centigram (cg)	0.1 liter = 1 deciliter (dl)	
0.001 gram = 1 milligram (mg)	0.01 liter = 1 centiliter (cl)	
	0.001 liter = 1 milliliter (ml)	
	Primary unit of linear measure is the meter.	
	1000.000 meters = 1 kilometer (km)	
	100.000 meters = 1 hectometer (hm)	
	10.000 meters = 1 dekameter (dkm)	
	1.000 meter = 1 meter (m)	
	0.1 meter = 1 decimeter (dm)	
	0.01 meter = 1 centimeter (cm)	
	0.001 meter = 1 millimeter (mm)	

NOTE: The relationship of the basic units in the Metric System should be noted. The meter, which is 1/40,000,000 of the earth's polar circumference, is the natural standard. The volume contained in 1/10 of a meter cubed is 1 liter. The weight of 1 cubic centimeter of distilled water is 1 gram. Grams of water are approximately equivalent at all temperature ranges. Current usage prefers that ml rather than cc be used since it has been found that 1000 cc do not equal exactly 1 liter.

Table 6-2.—Table of Metric Doses with Approximate Equivalents

Metric	Apothecary	Household
5 ml	1 fl dr	1 teaspoonful*
10 ml	2 fl dr	1 dessertspoonful
15 ml	4 fl dr	1 tablespoonful (½ fl oz)
30 ml	8 fl dr	2 tablespoons (1 fl oz)
60 ml	2 fl oz	1 wineglassful
120 ml	4 fl oz	1 teacupful
240 ml	8 fl oz	1 tumblerful
480 ml	16 fl oz	1 pint
960 ml	32 fl oz	1 quart
*Official U.S.P. teaspoonful is 5 ml.		

Table 6-3.—Conversion Table for Weights and Liquid Measures

Conversion Table for Weights and Liquid Measures
1 grain = 0.065 gram or 65 milligrams
1 gram = 15.432 grains
1 milliliter = 16.23 minims
1 fluid ounce = 29.57 milliliters

Table 6-4.—Examples of Weight and Liquid Conversions

Examples of Weight and Liquid Conversions	
gr to g	gr/15.432 = g
ml to fl oz	ml/29.57 = fl oz
minims to ml	minims/16.23 = ml
mg to gr	mg/65 = gr
g to gr	g x 15.432 = gr
fl oz to ml	fl oz x 29.57 = ml
ml to minims	ml x 16.23 = minims
gr to mg	gr x 65 = mg

PERCENTAGE CALCULATIONS

Percentage means “parts per hundred” or the expression of fractions with denominators of 100. Thus, a 10 percent solution may be expressed as 10%, 10/100, 0.10, or 10 parts per 100 parts.

It is often necessary for the pharmacist to compound solutions of a desired percentage strength. Percentage in that respect means **parts of active ingredient per 100 parts of total preparation.**

Following are the three basic rules to remember in solving percentage problems:

- To find the amount of the active ingredient when the percentage strength and the total quantity are known,** multiply the total weight or volume by the percent (expressed as a decimal fraction).

Example: Substance X contains 38% fat. How many grams of fat are required to prepare 120 g of substance X?

Solution: 38% is expressed as a decimal fraction (0.38) and multiplied by the amount of the finished product required.

$$\begin{array}{r}
 120 \text{ g} \\
 \times .38 \\
 \hline
 960 \\
 360 \\
 \hline
 45.60 \text{ g, the weight of fat needed.}
 \end{array}$$

2. **To find the total quantity of a mixture when the percentage strength and the amount of the active ingredient are known**, divide the weight or volume of the active ingredient by the percent (expressed as a decimal fraction).

Example: If a mixture contains 20% of substance Y, how many grams of the 20% mixture would contain 8 g of Y?

Solution: 20% is expressed as a decimal fraction (0.20). Divide the weight (8 g) by the percent, thus:

$$\begin{array}{r} \underline{40.0} \text{ g,} \\ .20 \text{) } 8.00 \\ \underline{80} \\ 00 \end{array} \quad \begin{array}{l} \text{the weight of 20\%} \\ \text{mixture that would} \\ \text{contain 8 g of} \\ \text{substance Y.} \end{array}$$

3. **To find the percentage strength when the amount of the active ingredient and the total quantity of the mixture are known**, divide the weight or volume of the active ingredient by the total weight or volume of the mixture. Then multiply the resulting answer by 100 to convert the decimal fraction to percent.

Example: Find the percentage strength of Z if 300 g of a mixture contains 90 g of substance Z.

Solution:

$$\begin{array}{r} \underline{0.3} \text{ g,} \\ 300 \text{) } 90.00 \\ \underline{90} \\ 00 \end{array} \quad \begin{array}{l} \text{is the percent of Z} \\ \text{expressed as a decimal} \\ \text{fraction} \end{array}$$

$$0.3 \times 100(\%) = \mathbf{30\%} \text{ of Z in the mixture}$$

ALTERNATE METHODS FOR SOLVING PERCENTAGE PROBLEMS

The alternate method for solving percentage problems, illustrated below, incorporates the three rules discussed above into one equation. This method is often preferred since it eliminates errors that may result from misinterpreting the values given in the problem.

$$\% \text{ strength} = \frac{\text{Amt of active ingredient} \times 100(\%)}{\text{Total amt of preparation}}$$

Example #1: Calculate the percent of A in a solution if 120 g of that solution contains 6 g of A.

Solution: Substitute the known values in the equation and use X for the percent (the unknown factor).

$$X = 6/120 \times 100(\%) = 5 (\%)$$

Therefore, **X = 5**, which is the percent strength of the solution.

Example #2: Calculate the amount of active ingredient in 300 g of a 5% mixture of active ingredient B.

Solution: Convert 5% to a decimal fraction (0.05). Substitute the known values in the equations, and use X for the amount of the unknown ingredient .

$$0.05 = X/300 \qquad \mathbf{X = 15 \text{ g}}$$

A variation of the alternate percentage equation, illustrated below, uses “parts per hundred” instead of percent, with X used as the unknown.

$$\frac{\text{Amt of active ingredient}}{\text{Amt of total preparation}} = \frac{\text{Parts of active ingredient}}{100 \text{ parts (total mixture)}}$$

Example: Ascertain the percent B in a mixture of 600 g that contains 15 g of B.

Solution:

$$\frac{15}{600} = \frac{X}{100} \qquad = \qquad 600X = 1500$$

$$X = \frac{1500}{600}$$

$$X = \mathbf{2.5}, \text{ the parts of active ingredient} \\ \text{per 100 parts of total mixture, or} \\ \mathbf{2.5\%}$$

RATIO AND PROPORTION CALCULATIONS

Ratio is the relationship of one quantity to another quantity of like value. Example ratios are 5:2, 4:1. These ratios are expressed as “5 to 2” and “4 to 1,” respectively. A ratio can exist only between values of the same kind, as the ratio of percent to percent, grams to grams, dollars to dollars. In other words, the denominator must be constant.

Proportion is two equal ratios considered simultaneously. An example proportion is

$$1:3::3:9$$

This proportion is expressed as “1 is to 3 as 3 is to 9.” Since the ratios are equal, the proportion may also be written $1:3 = 3:9$

Terms of Proportion

The first and fourth terms (the terms on the ends) are called the **extremes**. The second and third terms (middle terms) are called the **means**.

In a proportion, the product of the means equals the product of the extremes; therefore, when three terms are known, the fourth (or unknown) term may be determined.

Application of Proportion

The important factor when working proportions is to put the right values in the right places within the proportion. By following a few basic rules, you can accomplish this without difficulty and solve the problem correctly.

In numbering the four positions of a proportion from left to right (i.e., first, second, third, and fourth, observe the following rules):

- Let X (the unknown value) always be in the fourth position.
- Let the unit of like value to X be the third position.
- If X is smaller than the third position, place the smaller of the two leftover values in the second position; if X is larger, place the larger of the two values in the second position.
- Place the last value in the first position. When the proportion is correctly placed, multiply the extremes and the means and determine the value of X, the unknown quantity.

Example #1: What is the percent strength of 500 ml of 70% alcohol to which 150 ml of water has been added?

Solution: When adding 150 ml to 500 ml, the total quantity will be 650 ml; consequently, our four values will be **500 ml**, **650 ml**, **70%**, and **X** (the unknown percent). Following the rules stated above, the problem will appear as follows:

$$\begin{array}{ll} 4^{\text{th}} \text{ position:} & X (\%) \\ 3^{\text{rd}} \text{ position:} & 70\% \text{ (like value to X)} \end{array}$$

When we add water to a solution, the strength is diluted; consequently, the 70% strength of this solution will be lessened when we add the extra 150 ml of water. Therefore, of the two remaining given quantities (650 ml and 500 ml), the smaller (500 ml) will be placed in the second position, leaving the quantity 650 ml to be placed in the first position:

$$2^{\text{nd}} \text{ position:} \quad 500 \text{ ml}$$

$$1^{\text{st}} \text{ position:} \quad 650 \text{ ml}$$

The proportion appears as follows:

$$650 : 500 :: 70 : X$$

Multiplying the extremes and the means, we arrive at:

$$650X = 35,000, \text{ or } X = 53.8$$

When 150 ml of water is added to 500 ml of 70% alcohol, the result is 650 ml of 53.8% solution.

Example #2: When 1000 ml of 25% solution is evaporated to 400 ml, what is the percent strength?

Solution:

$$4^{\text{th}} \text{ position:} \quad X(\%)$$

$$3^{\text{rd}} \text{ position:} \quad 15\% \text{ (like value to X)}$$

When we evaporate a solution, it becomes stronger. Therefore, the larger of the two remaining given values (1000 ml and 400 ml), will be placed in the second position, leaving the quantity 400 ml to be placed in the first position:

$$2^{\text{nd}} \text{ position:} \quad 1000 \text{ ml}$$

$$1^{\text{st}} \text{ position:} \quad 400 \text{ ml}$$

The proportion appears as follows:

$$400 : 1000 :: 15 : X$$

Multiplying the extremes and the means, we arrive at:

$$400X = 25,000, \text{ or } X = 62.5$$

When 1000 ml of water is evaporated to 400 ml, the result is a 62.5% solution.

Ratio Solutions

Ratio solutions are usually prepared in strengths as follows: 1:10, 1:150, 1:1000, 1:25000, etc., using even numbers to simplify the calculations. When a solution is made by this method, the first term of the ratio expresses the part of the solute (the substance dissolved in a solvent), while the second term expresses the total amount of the finished product.

Rules for solving ratio-solution problems are as follows:

W/W (weight/weight) solution: Divide the total weight (grams) of solution desired by the larger number of the ratio, and the quotient will be the number of grams of the solute to be used.

Example: How many grams of KMNO_4 are needed to make 500 g of a 1:2000 solution?

Solution:

$$500 \div 2000 = 0.25 \text{ g of drug needed}$$

$$500 - 0.25 = \underline{499.75} \text{ g of solvent needed}$$

$$500.00 \text{ g total solution}$$

W/V (weight/volume) solution: Divide the total volume (in milliliters) of solution desired by the larger number of the ratio, and the quotient will be the number of grams of the solute needed.

Example: How many grams of bichloride of mercury are needed to prepare 500 ml of a 1:1000 solution?

Solution:

$$500 \div 1000 = 0.50 \text{ g of drug needed}$$

Add sufficient solvent to make 500 ml of solution.

V/V (volume/volume) Solution: Divide the total volume (in milliliters) of the solution desired by the larger number of the ratio, and the quotient will be the number of milliliters of the drug to be used.

Example: How many milliliters of HCl are needed to prepare a 1:250 solution with a total volume of 500 ml?

Solution:

$$500 \div 250 = 2.0 \text{ ml of drug needed}$$

Percentage solutions from stock and/or ratio solutions:

Example: From a 1:10 solution of silver nitrate in water, prepare 60 ml of a 1.5% solution of the same ingredients.

Solution: A 1:10 (W/V) solution contains 1 g of solute and enough solvent to total 10 ml of solution (finished product). Therefore, 1 ml of the solution would contain 0.1 g of the solute. Since it is required that 0.9 g of the solute be used to prepare 60 ml of the required strength, use 9 ml of the stock solution and enough solvent (water) to make the total volume measure 60 ml.

PHARMACEUTICAL PREPARATIONS

LEARNING OBJECTIVE: *Recall the composition and physical characteristics of commonly used pharmaceutical preparations.*

While assigned to a pharmacy or naval vessel, you may be required to make pharmaceutical preparations. The following sections will acquaint you with the composition and physical characteristics of some of these preparations.

Elixirs

Elixirs are aromatic, sweetened hydroalcoholic solutions containing medicinal substances. The color of elixirs varies according to the nature of the ingredients; some are artificially colored.

Suspensions

Suspensions are coarse dispersions comprised of finely divided insoluble material suspended in a liquid medium. To keep the insoluble material suspended, a third agent, called a suspending agent, is required. The process of mixing or combining the ingredients to form a suspension is called **reconstitution**.

Ointments

Ointments are semisolid, fatty, or oily preparations of medicinal substances. These preparations are of such a consistency as to be easily applied to the skin and gradually liquefy or melt at body temperature. Ointments vary in color according to their ingredients. The base of an ointment is generally greasy in texture,

and the medicinal substances combined with it are always intended to be very fine particles, uniformly distributed.

Suppositories

Suppositories are solid bodies intended to introduce medicinal substances into the various orifices of the body (rectum, vagina, and urethra). The ingredients are incorporated in a base that melts at body temperature.

Capsules

Capsules are gelatin shells containing solid or liquid medicinal substances to be taken orally. A common type of capsule contains medicine in the form of a dry powder that is enclosed in transparent cases made of gelatin. Capsules are sized by universally designated numbers: 5, 4, 3, 2, 1, 0, 00, 000. The number 5 has the capacity of about 65 mg of powder (such as aspirin) and the number 00 capsule contains about 975 mg of the same substance. Only sizes 3 through 00 are available through the Federal Stock System.

PHARMACEUTICAL INSTRUMENTS

LEARNING OBJECTIVE: *Identify commonly used pharmaceutical instruments and describe the purpose of each.*

In the process of preparing some pharmaceutical preparations, you may need to use specialized instruments. To acquaint you with some of the more commonly used pharmaceutical instruments, the following sections will give you a description of each instrument and explain its purpose. See figure 6-2 for an illustration of each instrument discussed.

Pharmaceutical Balances

Two types of pharmaceutical balances are in common use in the Navy: torsion balances (shown in figure 6-2) and electronic balances (not shown). These balances are classified as either “Class A” or “Class B.” Class A balances are used for weighing loads from 120 mg to 120 g. All dispensing pharmacies are required to have at least one Class A balance on hand at all times. Class B balances weigh loads of more than 648 mg, and they must be conspicuously marked

“Class B.” Class B balances are optional equipment in the pharmacy.

Ribbed Funnel

Ribbed funnels are utensils used in the filtering process. They are most commonly made of glass, but other substances (tin, copper, rubber) are occasionally used. The funnel is shaped so that the inside surface tapers at a 60° angle, ending in a tapered delivery spout. The inside surface is “ribbed” to allow air to escape from between the glass and the filtering medium (improving the filtration process).

Erlenmeyer Flask

The Erlenmeyer flask is a glass container with metric measurements inscribed on it. It is used for mixing and measuring various medicinal ingredients.

Mortar and Pestle

These two items always go together, one being useless without the other. The mortar is basically a heavy bowl, with one distinct property: the inside concavity is geometrically hemispheric. The accompanying pestle is primarily a handtool that has a tip made of identical material as the mortar, and its convexity forms a perfect hemisphere. The reason for the two opposing hemispheres is to provide an even grinding surface. Mortars and pestles are made of glass, metal, or unglazed pottery called wedgewood. Glass is used when triturating (reducing substances to fine particles or powder by rubbing or grinding) very pure products (such as eye ointments), and when the preparations contain stains.

NOTE: Metal mortars and pestles should never be used when the drugs are likely to react with the metals.

Spatula

The spatula is a knifelike utensil with a rounded, flexible, smoothly ground blade, available in various sizes. The spatula is used to “work” powders, ointments, and creams in the process of levigation (the rubbing, grinding, or reduction to a fine powder with or without the addition of a liquid) and trituration. It is also used to transfer quantities of drugs from their containers to the prescription balance. Spatulas should not be used to pry open cans or as knives for opening boxes. Once the surface is scratched or the edges bent,



PRESCRIPTION
BALANCE

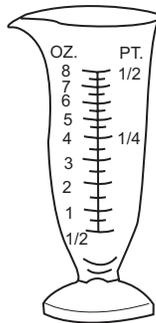


MORTAR
AND
PESTLE

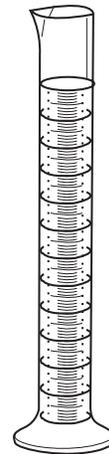


SPATULA

HM3F0802



GRADUATE
(CONICAL)



GRADUATE
(CYLINDRICAL)

Figure 6-2.—Pharmaceutical instruments.

the spatula is ruined, and it becomes useless for pharmacy work.

Graduates

Graduates are conical or cylindrical clear glass containers, graduated in specified quantities and used to measure liquids volumetrically. Measuring should always be done at eye level.

DRUG INCOMPATIBILITIES, CONTRAINDICATIONS, AND ADVERSE EFFECTS

Occasionally, the drugs we use to improve a person's condition may not work in the manner intended. The outcome may be contrary to that which was expected, and, indeed, could even cause harm to the patient. It is important to be aware of symptoms that may indicate a drug is not doing its job properly.

Incompatibilities

LEARNING OBJECTIVE: *Identify the three classifications of drug incompatibility, and recall what causes these drug incompatibilities to occur.*

There are instances when a drug used simultaneously with another drug or substance does not perform as it was intended. These drugs or substances may be incompatible together and, therefore, should not be administered at the same time. A drug incompatibility can also occur when drugs are compounded together in the pharmacy. There are three classes of drug incompatibilities: therapeutic, physical, and chemical. In the following sections, each class of drug incompatibility is discussed.

THERAPEUTIC INCOMPATIBILITIES.—Therapeutic incompatibilities occur when agents

antagonistic to one another are prescribed together. Such circumstances seldom occur, but when they do, the Hospital Corpsman should bring the perceived incompatibility to the attention of the physician. The pharmaceutical agents may have been used together for one agent to modify the activity of the other. The physician will verify the prescription as necessary.

PHYSICAL INCOMPATIBILITIES.—

Physical incompatibilities are often called pharmaceutical incompatibilities and are evidenced by the failure of the drugs to combine properly. It is virtually impossible for uniform dosages of medicine to be given from such solutions or mixtures. Ingredients such as oil and water (which are physically repellant to each other) and substances that are insoluble in the prescribed vehicle are primary examples of physical incompatibilities.

CHEMICAL INCOMPATIBILITIES.—

Chemical incompatibilities occur when prescribed agents react chemically upon combination to alter the composition of one or more of the ingredients (constituents).

MANIFESTATIONS OF INCOMPATIBILITY.—

The following list outlines the various ways incompatibility between or among drug agents may be manifested. The respective type of incompatibility is also noted.

- Insolubility of prescribed agent in vehicle (physical)
- Immiscibility of two or more liquids (physical)
- Precipitation due to change in menstrum that results in decreased solubility (called **salting out**) (physical)
- Liquification of solids mixed in a dry state (called **eutexia**) (physical)
- Cementation of insoluble ingredients in liquid mixtures (physical)
- Evolution in color (chemical)
- Reduction or explosive reaction (called **oxidation**) (chemical)
- Precipitation due to chemical reaction (chemical)
- Inactivation of sulfa drugs by procaine HCl (therapeutic)

Although it is, of course, impossible to eliminate all drug-agent incompatibilities, some combinations

may respond to one of the following corrective measures.

- Addition of an ingredient that does not alter the therapeutic value (such as the addition of an ingredient to alter solubility of an agent)
- Omission of an agent that has no therapeutic value or that may be dispensed separately
- Change of an ingredient (e.g., substitution of a soluble form of an ingredient for an equivalent insoluble form)
- Change of a solvent
- Utilization of special techniques in compounding

Contraindications

LEARNING OBJECTIVE: *Recall drug contraindications, adverse drug reactions, and interactions.*

A contraindication is any condition the patient might display that makes a particular treatment or procedure inadvisable. These conditions include, but are not limited to, the disease process and other administered medications.

Adverse Drug Reactions

Adverse drug reactions may occur when a drug, administered in a dose appropriate for human prophylaxis, diagnosis, or therapy, has an unintended and noxious effect on the patient receiving it. As a Hospital Corpsman, you must be aware of the possibility of adverse effects of medications so that you can prevent an occurrence, or at least minimize the impact on the patient.

Drug Interactions

Patients may receive more than one medication at a time (as happens frequently in the case of hospitalized patients). Combining medications can cause the individual drugs to interact with each other—either positively or negatively—to produce an outcome that would not have occurred if each drug had been administered singly. Such interactions may affect the intensity of a drug's response, the duration of its effect, and side effects that may occur. As stated above, drug interactions can be positive as well as

negative, and two or more medications are often administered to achieve a greater therapeutic effect.

Information Concerning Drug Contraindications, Adverse Reactions, and Interactions

Descriptions of drug contraindications, adverse reactions, and interactions may be found in several publications, most notably the *Physicians' Desk Reference*. However, the most important location for finding this information is the manufacturer's package insert and associated literature that accompanies each drug.

PRESCRIPTIONS

LEARNING OBJECTIVE: *Recall the parts of a prescription, authorized prescribers and how prescriptions are written, filled, verified, labeled, and filed.*

The most important tool used by the pharmacy is the prescription. A prescription is a written or computerized order from a healthcare provider (prescriber) directing the pharmacy to compound and dispense a drug or medication for a patient to use.

Of special importance is your understanding and conformance to the following protocols:

- All information pertaining to a prescription is confidential and should not be divulged to any persons not specifically involved in the treatment.
- No prescription or any of its parts may be applied or transferred to any person other than the patient specified.

To fill a prescription correctly, you must thoroughly understand the prescription writing and filling process. Because regulations and policies governing pharmacies sometimes change, it is important for you to be familiar with pharmacy policies in the *Manual of the Medical Department* (MANMED), NAVMED P-117. The MANMED is the basic guide to pharmacy operations.

PARTS OF THE PRESCRIPTION

Currently, there are two standardized forms used for prescriptions: the *DoD Prescription*, DD Form

1289 (fig. 6-3) and the *Polyprescription*, NAVMED 6710/6 (fig. 6-4). Information placed on these forms must be either typewritten or legibly handwritten in ink or indelible pencil. In addition to these two forms, many of today's fixed medical facilities (e.g., naval hospitals and medical clinics) now have automated pharmacy systems that allow healthcare providers to enter prescription requests into computers in their offices instead of handwriting prescriptions. Prescriptions, written or computerized, have, for the most part, the same information requirements. The only major difference is that automated prescriptions do not require the prescriber's signature.

DD 1289 is used extensively for outpatient prescriptions. For this reason, the key parts of DD 1289 will be discussed in the following sections. See figure 6-3 for examples of specific block entries.

Patient Information Block

In the patient information block, located at the top of the DD 1289, the patient's full name and date of birth are required. At most medical facilities, however, additional patient information is added to this block. This additional information usually includes the patient's duty station; social security number with family member prefix; rate; and branch of service.

Medical Facility and Date Block

The medical facility block, located below the patient information block, should contain the name of the medical facility or ship where the prescription was written. Completion of this block is important if the source of the prescription needs to be traced.

The date block, located to the right of the medical facility block, should contain the date in which the prescription was written.

Prescription Block

The large block in the center of the DD 1289 is the prescription block. It contains four parts: the superscription, the inscription, the subscription, and the signa.

SUPERSSCRIPTION.—The superscription “Rx” means “take” or “take thou” or, in effect, “I want this patient to have the following medication.”

INSCRIPTION.—The inscription is that part of the prescription that lists the names and quantities of the ingredients to be used. This part of the prescription

is of utmost importance, since the spelling of many unrelated drugs is similar. Whenever there is doubt as to the drug or the amount listed in the inscription, the individual filling the prescription should always verify the inscription with the prescriber.

NOTE: The drug should be written generically, and the dosage size or strength written metrically.

SUBSCRIPTION.—The subscription follows the inscription and is that part of the prescription that gives directions to the compounder.

DD FORM 1289	
1 NOV 71	
DOD PRESCRIPTION	
FOR (Full name, address, & phone number) (If under 12, give age)	
<i>John R. Doe, HM3, USN</i>	
<i>U.S.S. Neverforgotten (DD 178)</i>	
MEDICAL FACILITY	DATE
<i>U.S.S. Neverforgotten (DD 178)</i>	<i>23 JAN 99</i>
R_s (Superscription)	gm or ml.
(Inscription)	
<i>Tn Belladonna</i>	<i>15 ml</i>
<i>Amphogel qsad</i>	<i>120 ml</i>
(Subscription)	
<i>M & FT Solution</i>	
(Signa)	
<i>Seg: 5ml tid a.c.</i>	
MFGR: <i>Wyeth</i>	EXP DATE: <i>12/02</i>
LOT NO: <i>P39K106</i>	FILLED BY: <i>KMT</i>
R_s NUMBER <i>10072</i>	<i>Jack R. Frost</i> <i>LCDR, MD, USNR</i> SIGNATURE RANK AND DEGREE
EDITION OF 1 JAN 60 MAY BE USED FOR S/N 0102-LF-012-6201	

HM3F0603

Figure 6-3.—DOD Prescription form.

FOR (Mechanically Imprint, Type or Print Full Name, Address & Phone)

20-222-22-2222
 31AUG02
 DOE, JANE B.
 901 STAFF E-7
 20MAR70 F ACDU-N
 12 NOV 99 ◀ DATE

NOTE: CONTROLLED SUBSTANCES MUST BE PRESCRIBED ON DD FORM 1289, DOD PRESCRIPTION, AND MUST BE FILED IN A SEPARATE FILE.

MEDICAL FACILITY: *NH Bath* AGE (if under 12 years):
 INPATIENT
 OUTPATIENT

DRUG NAME	FORM	STRENGTH	NUMBER	DIRECTIONS	PRESCRIPTION NUMBER
1 <i>Amoxicillin</i>	<i>Caps</i>	<i>250mg</i>	<i>30</i>	<i>Sig: 250mg p.o. tid x10 days</i>	<i>02689</i> NDC: EXP/MPG DATE: <i>9/01</i> LOT: <i>(3) AB</i> FILLED BY: <i>Jul</i>
2 <i>Ertex L.A.</i>	<i>Caps</i>		<i>30</i>	<i>t p.o. q 12^o pm Conjuction</i>	<i>02690</i> NDC: EXP/MPG DATE: <i>7/00</i> LOT: <i>(6)</i> FILLED BY: <i>Jul</i>
3 <i>Naproxen</i>	<i>tab</i>	<i>250mg</i>	<i>40</i>	<i>t p.o. BID</i>	<i>02691</i> NDC: EXP/MPG DATE: <i>12/00</i> LOT: <i>(7) 215m</i> FILLED BY: <i>Jul</i>
4					NDC: EXP/MPG DATE: LOT: FILLED BY:

SIGNATURE OF PRESCRIBER: *Walter T. Door* GRADE: *CDR* DEGREE (MD, DDS, etc.): *MC* SOCIAL SECURITY NUMBER: *555 - 55 - 5555*

POLYPRESCRIPTION NAVMED 6710/6 (5-73) S/N 0105-228-7190 **DETACH BEFORE WRITING**

HM3F0604

Figure 6-4.—Polyprescription form.

SIGNA.—The signa, not to be confused with the prescriber’s signature, is the part of the prescription that gives the directions for the patient. This portion is preceded by the abbreviation “Sig.”

Prescriber Signature Block

Finally, the prescriber signature block, located at the bottom of the form, **must** contain a legible signature of the prescriber, as well as the prescriber’s full name, rank, corps, and service, stamped, typed, or handprinted. Mimeographed, preprinted, or rubber-stamped prescriptions may be used, but signatures must be original and in the handwriting of the prescriber. Facsimiles are not acceptable.

AUTHORIZED PRESCRIBERS

According to the MANMED, the following persons are authorized to write prescriptions:

- Medical and Dental Corps Officers
- Medical Service Corps optometrists, physician assistants, and podiatrists
- Civilian physicians employed by the Navy

- Independent duty Hospital Corpsmen
- Nurse practitioners (may prescribe when authorized in writing by the commanding officer)
- Nurse anesthetists and midwives (may prescribe within the scope of their practice when authorized in writing by the CO or delegated representative)

Prescriptions written by civilian prescribers, other than those employed by the Navy, may be filled for authorized beneficiaries, provided the prescribed item is on the medical facility’s formulary (a published listing of medications) and the prescribed quantity is within limitations established by the command.

With the exception of the polyprescription, prescriptions are limited to one item per prescription. The quantity of the drug prescribed should be a reasonable amount needed by the patient. Excessive or unrealistic quantities should not be prescribed. Erasures on prescriptions are prohibited, and interlineations (information inserted between lines of writing) must be initialed.

Finally, persons authorized to prescribe cannot write prescriptions for themselves or members of their immediate families.

FILLING PRESCRIPTIONS

When you receive a prescription for filling, you should follow certain basic steps to make sure that the right patient gets the right medicine in the right amount in the right way. There are no shortcuts—in the pharmacy things are done right or not at all!

Prescription Verification

First of all, satisfy yourself that the prescription you have received is a bonafide one and that the person you have received it from is entitled to have it filled by your pharmacy. You don't need to be tedious about verification. The simplest and best way is to ask for an ID card and verify the expiration date on the ID card.

Study the prescription carefully and make sure that the drug prescribed is reasonable, that its amount or dosage is realistic in consideration of the patient's age, and that the quantity of the medication is practical. A prescription calling for 1,000 tetracycline tablets or a pint of paregoric, for example, warrants further inquiry.

If, in the process of verification, you feel that there is a discrepancy, an ambiguity, or an incompatibility, or for any reason you find it is necessary to consult the prescriber, never allow the patient to suspect that anything is amiss. You should never fill a prescription you do not completely understand or that you feel is incorrect. What appears to be an overdose may be the desired dose for a specific patient, but the prescriber will appreciate being called for verification.

When you are sure you understand the prescription and are satisfied that it is in all respects correct, you should give its filling your undivided attention. Most mistakes are made when the person filling the prescription is either interrupted while doing so or is trying to accomplish more than one task at a time.

During the process of filling a prescription, the label on the containers used in filling the prescription should be verified at least three times. Initially, the label should be read when the container is taken from the shelf. Then it should be read again when the contents are removed from the container. And finally, the container's label should be read before it is returned to the shelf. By following these three verification steps for each prescription you fill, you

will reduce the possibility of making a prescription error.

Prescription Labeling

Proper labeling of a prescription is as important as filling it correctly. It is reasonable to assume that if a great deal of accuracy is necessary to properly compound a prescription, it is just as important that the patient take the correct amount of medication in the right manner to receive its maximum benefits. Improperly written or misunderstood directions on a prescription label can be disastrous. Make sure all labels are typed clearly and their directions translated into simple layman's language. Keep in mind that the prescription label serves two purposes. First and most important, it gives the patient directions pertaining to the medication; second, in case of misuse or error, it is the quickest means by which the contents of the prescription container, the person who wrote the prescription, and the person who filled it can be traced. Consequently, the following information, illustrated in figure 6-5, should always be on the label:

- The name and phone number of the dispensing facility
- A serialized number that corresponds with the number on the prescription form, (see figure 6-3)
- The date the prescription is filled
- The patient's name
- The directions to the patient, transcribed accurately from the prescription, in clear, concise layman's language
- The prescriber's name and rate or rank
- The initials of the compounder
- Authorized refills, if any
- The expiration date, if applicable
- Name, strength, and quantity of medication dispensed

NOTE: Pharmaceutical preparations should be identified and labeled with the generic name. However, trade or brand names may be used if the trade or brand name is actually on the container.

Other information that may need to be attached to the prescription container are labels reading "Shake Well Before Using" or "For External Use Only." "Poison" labels should be omitted when a preparation

NAVAL HOSPITAL		Phone
BETHESDA, MD	20814	295-2113
(keep out of reach of children)		295-550
John R. Doe, HM2, USN		4/28/99kk
Take one (1) tablet every 12 hours if needed for cold symptoms.		
Dimetapp #30	Dr. Johnson	
No Refills		
		117765

HM3F0605

Figure 6-5.—Prescription label.

is intended for external use, as many physicians prefer the “For External Use Only” labels.

After the prescription is labeled, check the ingredients again by some systematic method to ensure accuracy.

As an added precaution and to aid expeditious identification of drugs in case of undesirable effects, note the manufacturer and the lot number of the proprietary drug dispensed on the prescription form (fig. 6-3). This procedure, however, does not apply to medications consisting of a mixture of several ingredients. The initials or the code of the person filling the prescription must also be written on the prescription form (fig. 6-3).

FILING PRESCRIPTIONS

Prescriptions that have been filled must be maintained in one of several separate files:

- **Schedule II and III narcotics**—Prescriptions containing narcotics are numbered consecutively, preceded by the letter “N,” and filed separately.
- **Alcohol**—These prescriptions are numbered consecutively, preceded by the letter “A,” and filed separately.
- **Schedule III (nonnarcotic), IV, and V drugs**—These prescriptions are part of and are numbered in the same manner as the general files; however, they are maintained separately.
- **General files**—All other prescriptions are numbered consecutively and filed together.

Currently, prescriptions are required to be kept on file for at least 2 years after the date of issue.

REGULATIONS AND RESPONSIBILITIES PERTAINING TO CONTROLLED SUBSTANCES, ALCOHOL, AND DANGEROUS DRUGS

LEARNING OBJECTIVE: *Recall Hospital Corpsman responsibilities and accountability pertaining to controlled substances; identify controlled substance schedules; and recall controlled substance security, custody, inventory, and survey procedures.*

Hospital Corpsmen who handle controlled substances and other drugs are held responsible for the proper distribution and custody of those substances and drugs. Nowhere is the demand for strict integrity more important. Misuse, abuse, loss, and theft of these substances have always, sooner or later, ended in tragedy and severe consequences. No one has ever profited by their misappropriation.

It behooves every Hospital Corpsman to thoroughly understand the responsibility concerning the custody and handling of controlled substances and other drugs and to be familiar with the regulations and laws pertaining to them.

RESPONSIBILITY

Although the MANMED specifically assigns custodial responsibility for controlled substances, alcohol, and dangerous drugs to a commissioned officer (and more specific control to the Nursing Service), you, as a Hospital Corpsman, have the responsibilities of administering and securing them properly. All controlled substances and other drugs are to be kept under lock and key. Neither keys nor drugs should ever be entrusted to a patient.

ACCOUNTABILITY

Hospital Corps personnel are held accountable for drugs entrusted to them. Great care should be exercised to prevent the loss or unauthorized use of drugs. No drug should be administered without proper authority. In addition, U.S. Navy Regulations forbid the introduction, possession, use, sale, or other transfer of marijuana, narcotic substances, or other controlled substances.

CONTROLLED SUBSTANCE SCHEDULES

Controlled substances and drugs require special handling and security measures. The Controlled Substance Act of 1970 established five schedules (categories) related to a drug's potential for abuse, medical usefulness, and degree of dependency, if abused.

Controlled substances may migrate between schedules, and new products may be added. These changes will be promulgated by the Navy Materiel Support Command in the Medical and Dental Materiel Bulletin.

Schedule I

Schedule I substances have high abuse potential and no accepted medical use (e.g., heroin, marijuana, LSD).

Schedule II

Schedule II substances have high abuse potential and severe psychological and/or physical dependence liability. Examples of schedule II substances include narcotics, amphetamines, and barbiturates. Prescriptions for schedule II substances can never be ordered with refills and must be filled within 7 days of the date originally written.

Schedule III

Schedule III substances have less abuse potential than schedule II substances and moderate dependence liability. Examples of schedule III substances include nonbarbiturate sedatives, nonamphetamine stimulants, and medications that contain a limited quantity of certain narcotics. Prescriptions must be filled within 30 days of the date written and may be refilled up to five times within 6 months.

Schedule IV

Schedule IV substances have less abuse potential than schedule III substances and limited dependence liability. Prescriptions must be filled within 30 days of the date written and may be refilled up to five times within a 6-month period.

Schedule V

Schedule V substances have limited abuse potential. Schedule V substances are primarily

antitussives or antidiarrheals that contain small amounts of narcotics (codeine). Prescriptions must be filled within 30 days of the date written and may be refilled up to five times within 6 months.

DANGEROUS DRUGS

Poisonous drugs, chemicals, and similar substances are classified as dangerous drugs. Because these substances are powerful, their containers should have a distinctive color, size, or shape, and the container should be placed in a special storage area so they are not mistaken for other drugs. In addition, the following safeguards should be enforced:

- Label all containers of dangerous substances appropriately.
- Store caustic acids (such as glacial acetic, sulfuric, nitric, concentrated hydrochloric, or oxalic acids) in appropriate containers, and do not issue to wards or outpatients.
- Account for and issue methyl alcohol (methanol) to be used by medical activities in the same manner as other controlled substances. Methanol should not be stored, used, or dispensed by the pharmacy, ward, or outpatient treatment facility.

SECURITY AND CUSTODY OF CONTROLLED SUBSTANCES

Schedule I and II controlled substances and ethyl alcohol require vault or safe storage and inventory by the Controlled Substance Inventory Board (discussed in more detail in the section entitled "Inventory of Controlled Substances"). Working stock may be kept in a locked area within the pharmacy. A copy of the safe combination must be kept in a sealed envelope deposited with the CO or representative.

Schedule III, IV, and V controlled substances require locked cabinet security for storage of bulk drugs. A minimum amount of working stock may be dispersed among other pharmacy stock, provided the pharmacy stock itself is secure. Otherwise, all stock in this category must be kept in locked cabinets.

Custodial responsibility for controlled substances, ethyl alcohol, and dangerous drugs at naval hospitals is entrusted to a commissioned officer or a civilian pharmacist who is appointed in writing by the CO. At remote branch clinics that do not have a commissioned officer or a civilian pharmacist, the CO will designate

in writing a member of the branch clinic as custodian. On board large naval vessels, the CO will appoint an officer of the Medical Department or another officer in writing as the bulk custodian. This officer will be responsible for, and maintain custody of, all bulk controlled substances. On board smaller naval vessels, access to controlled substances is limited to the bulk custodian and the senior medical department representative (SMDR). Only individuals whose official duties require access to such spaces are provided the safe combinations.

INVENTORY OF CONTROLLED SUBSTANCES

Monthly (or more frequently, if necessary), the Controlled Substances Inventory Board takes an unannounced inventory of controlled substances.

NOTE: An exception to this frequency may be made for ships with an Independent Duty Corpsman. On these ships, the inventory may be conducted on a quarterly basis if there have been no transactions of controlled substances (including filled prescriptions or receipts of items requisitioned from supply).

The CO appoints the members of the board in writing. The board consists of three members, at least two of whom are commissioned officers. After the board conducts the inventory, it submits a report to the CO. The officer having custodial responsibility cannot be a member of the board. On small ships and installations, the SMDR may be a board member. For further guidance on controlled substance inventory procedures, refer to NAVMEDCOMINST 6710.9, *Guidelines for Controlled Substances Inventory*.

SURVEY OF CONTROLLED SUBSTANCES

Schedule I and II controlled substances, ethyl alcohol, and locally controlled drugs that have become outdated, deteriorated to the point of not being usable, are of questionable purity or potency, or have had their identity compromised, must be reported to the CO. If destruction is indicated and directed by the CO, destruction must be accomplished in the presence of a member of the Controlled Substance Inventory Board. A certification of destruction form contains the complete nomenclature and quantity of the substances to be destroyed together with the method of destruction to be used. After certification is completed, approved by the CO, and signed by the members witnessing the destruction, the certification of destruction is retained and filed as required by current instructions. The destroyed substances should then be removed from the stock records and the controlled substance log.

SUMMARY

Inpatients and the majority of outpatients will receive pharmaceutical products as part of their treatment. As a healthcare provider who may administer these products or fill prescriptions, it is crucial for you to have a good foundation of knowledge in pharmacology, toxicology, and the proper handling of prescriptions and controlled substances. This chapter touched on each of these topics to assist you in your duties. However, you should consult the recommended publications, such as the *Manual of the Medical Department*, *Drug Facts and Comparisons*, and the *Physicians' Desk Reference*, to provide you with the guidance and knowledge you will need to provide the best possible care for your patients.

CHAPTER 7

CLINICAL LABORATORY

A basic knowledge of clinical laboratory procedures is critical for all Hospital Corpsmen, particularly those working at small dispensaries and isolated duty stations without the supervision of a medical officer. A patient's complaint may be of little value by itself, but coupled with the findings of a few easily completed laboratory studies, a diagnosis can usually be surmised and treatment initiated.

Hospital Corpsmen who can perform blood and urine tests and interpret the results are better equipped to determine the cause of illness or request assistance. Since they can provide a more complete clinical picture to the medical officer, their patients can be treated sooner.

In this chapter, we will discuss laboratory administrative responsibilities, ethics in the laboratory, the microscope, blood collection techniques, and step-by-step procedures for a complete blood count and urinalysis. Also included are basic testing procedures for bacteriologic, serologic, and fungal identification.

THE HOSPITAL CORPSMAN AND THE CLINICAL LABORATORY

LEARNING OBJECTIVE: *Recall clinical laboratory administrative procedures and ethics policy.*

The Hospital Corpsman is not expected to make diagnoses from test findings or to institute definitive treatment based upon them. However, with the availability of modern communications facilities, having the results of these tests available will greatly assist the Corpsman in giving a clearer clinical picture to the supporting medical officer.

Needless to say, accuracy, neatness, and attention to detail are essential to obtain optimum test results. Remember also that these tests are only aids to diagnosis. Many other clinical factors must be taken into consideration before treatment may be started.

ADMINISTRATIVE PROCEDURES AND RESPONSIBILITIES

The ability to perform clinical laboratory tests is a commendable attribute of the Hospital Corpsman. However, the entire testing effort could be wasted if proper recording and filing practices are ignored and the test results go astray. As a member of the medical team, it is your responsibility to make sure that established administrative procedures are followed with regard to accurate patient and specimen identification. It is your further responsibility to ensure laboratory reports in your department are handled and filed properly.

Since the test results are a part of the patient's clinical picture, their precision and accuracy are vital. Test results have a vital bearing upon the patient's immediate and future medical history. They are, therefore, made part of the patient's health record (inpatient or outpatient). Laboratory reports of inpatients are placed in the inpatient health record, while laboratory reports of outpatients are placed in the outpatient health record.

Laboratory Request Forms

The armed forces have gone to great lengths to produce workable, effective laboratory forms that serve their purpose with a minimum of confusion and chance for error. These forms are standard forms (SF) in the 500 series. Their primary purpose is to request, report on, or record clinical laboratory tests. With the exception of SF-545 (*Laboratory Report Display*), SF laboratory forms are multicopied and precarbonized for convenience. The original copy of the laboratory report forms are attached to the SF-545 (located inside the patient's health record), and the carbon copy becomes part of the laboratory's master file. For a complete listing of SF forms and their purposes, refer to the *Manual of the Medical Department* (MANMED), NAVMED P-117.

SF laboratory request forms are not the only means by which healthcare providers can order laboratory tests. Many of today's naval medical facilities have computerized laboratory systems. Computerized laboratory systems enable healthcare providers to enter laboratory test requests into computers located in

Filing Laboratory Forms

After healthcare providers have reviewed laboratory test reports, they will initial the form. Initialing the form indicates the healthcare provider has reviewed the test results. After the healthcare provider releases the laboratory report, it should be filed in the patient's inpatient or outpatient health record, as appropriate. If a standard form is used to record test results, it should be attached **chronologically** to the SF-545, *Laboratory Report Display*, inside the patient's health record. The SF-545 functions as a display form for multiple laboratory reports. See figure 7-2. Use the preglued areas provided on the lab forms. However, since the glue is notorious for losing its grip after a while, you may use tape or staples to attach the form to the SF-545. Each SF-545 can accommodate a limited number of laboratory reports, so do not overcrowd the display form. When the SF-545 is full, add a new SF-545 to the health record and place it in front of the old SF-545. In this way, the most current lab reports will remain in chronological order.

Automated or computer-generated laboratory test reports, depending on the form's size, may be either mounted on the SF-545 or placed adjacent to the SF-545 in the health record. Keep in mind that these automated or computer-generated forms should also be filed chronologically.

ETHICS AND GOOD PRACTICES IN THE LABORATORY

The nature of laboratory tests and their results must be treated as a confidential matter between the patient, the healthcare provider, and the performing technician. Chapter 16 of the MANMED outlines the Navy's ethics policy with regard to disclosure of the contents of a patient's medical record, including lab reports. It is good practice to prevent unauthorized access to these reports, to leave interpretation of the test results to the attending provider, and to refrain from discussing the results with the patient.

BLOOD COLLECTION

LEARNING OBJECTIVE: *Identify the correct steps to perform blood collection by the finger puncture method and venipuncture method, and recall Standard Precautions and other safety precautions that apply to blood collection.*

There are two principal methods of obtaining blood specimens: the finger puncture method and the venipuncture method. For most clinical laboratory tests requiring a blood specimen, venous blood obtained by venipuncture is preferred. Blood collected by venipuncture is less likely to become contaminated, and the volume of blood collected is greater. Infection control practices, equipment requirements, and step-by-step instructions on performing both of these blood collection methods will be discussed in the following sections.

STANDARD PRECAUTIONS

Under the concept of "Standard Precautions" outlined by the Centers For Disease Control and Prevention (CDC), blood and other bodily fluids should be considered as potentially infectious. To protect medical personnel from direct contact with blood during phlebotomy (blood collection), gloves are required to be worn. Gloves should be disposed of after each patient.

Needles and sharps used in the blood collection process should be handled with extreme caution and disposed of in biohazard sharps containers. Sharps containers should be conveniently located near phlebotomy work sites.

Absorbent materials, such as cotton 2 x 2's used to cover blood extraction sites, normally contain only a small amount of blood and can be disposed of as general waste. However, if a large amount of blood is absorbed, the absorbent material should be placed in a biohazard waste container and treated as infectious waste.

Clean phlebotomy work site equipment and furniture daily with a disinfectant.

FINGER PUNCTURE

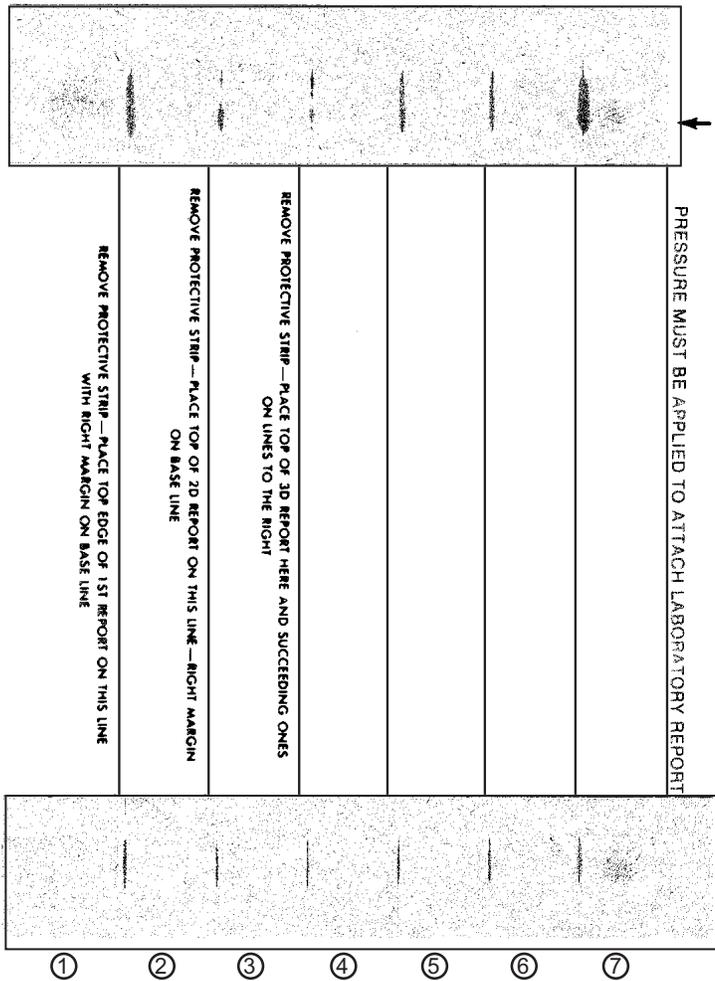
The finger puncture method is used when a patient is burned severely or is bandaged so that the veins are either covered or inaccessible. Finger puncture is also used when only a small amount of blood is needed.

Materials Required for Finger Puncture Procedure

To perform a finger puncture, the following materials are required:

- Sterile gauze pads (2" x 2")

LABORATORY REPORT DISPLAY



REMOVE PROTECTIVE STRIP—PLACE TOP EDGE OF 1ST REPORT ON THIS LINE WITH RIGHT MARGIN ON BASE LINE

REMOVE PROTECTIVE STRIP—PLACE TOP OF 2D REPORT ON THIS LINE—RIGHT MARGIN ON BASE LINE

REMOVE PROTECTIVE STRIP—PLACE TOP OF 3D REPORT HERE AND SUCCEEDING ONES ON LINES TO THE RIGHT

REMOVE PROTECTIVE STRIP—PLACE TOP OF 3D REPORT HERE AND SUCCEEDING ONES ON LINES TO THE RIGHT

PRESSURE MUST BE APPLIED TO ATTACH LABORATORY REPORT

ALIGN ALL LABORATORY REPORTS ALONG THIS BASE LINE

INSTRUCTIONS: This form may be used to display laboratory reports as a flow sheet to be read as a progressive table. If so, a separate sheet should be used for each type of report form. When assorted report forms are mounted on the display sheet, both test names and results should always be visible.

ENTER IN SPACE BELOW: PATIENT IDENTIFICATION—TREATING FACILITY—WARD NO.—DATE

FORMS DISPLAYED ON THIS SHEET ARE (Check one)	
<input type="checkbox"/> MOUNTED ON STRIPS 1 THROUGH 7	<input type="checkbox"/> MOUNTED ON STRIPS 1, 3, 5, AND 7
<input type="checkbox"/> CHEMISTRY I (SF 546)	<input type="checkbox"/> PARASITOLOGY (SF 552)
<input type="checkbox"/> CHEMISTRY II (SF 547)	<input type="checkbox"/> IMMUNOHEMATOLOGY (SF 556)
<input type="checkbox"/> CHEMISTRY III (SF 548)	<input type="checkbox"/> ASSORTED FORMS
<input type="checkbox"/> HEMATOLOGY (SF 549)	<input type="checkbox"/> OTHER (Specify)
<input type="checkbox"/> URINALYSIS (SF 550)	MOUNTED ON STRIPS 1, 4, AND 7
<input type="checkbox"/> SEROLOGY (SF 551)	<input type="checkbox"/> MICROBIOLOGY I (SF 553)
<input type="checkbox"/> SPINAL FLUID (SF 555)	<input type="checkbox"/> MICROBIOLOGY II (SF 554)
	<input type="checkbox"/> MISCELLANEOUS (SF 557)
	<input type="checkbox"/> ASSORTED FORMS

Figure 7-2.—SF-545, Laboratory Report Display.

- 70% isopropyl alcohol or povidone-iodine solution pads
- Blood lancets
- Capillary tubes
- Bandages

Arrange your equipment in an orderly manner and have it within easy reach. Also, wash your hands before and after each procedure.

Finger Puncture Procedure

To perform a finger puncture, follow the steps given below.

1. Explain the procedure to the patient.
2. Using the middle or ring finger, massage or “milk” the finger down toward the fingertip. Repeat this “milking” five or six times.
3. Cleanse the fingertip with an alcohol pad or povidone-iodine solution and let dry.
4. Take a lancet and make a quick deep stab on the side of the finger (off-center). To obtain a large rounded drop, the puncture should be across the striations of the fingertip. See figure 7-3.
5. Wipe away the first drop of blood to avoid dilution with tissue fluid. Avoid squeezing the fingertip to accelerate bleeding as this tends to dilute the blood with excess tissue fluid, but gentle pressure some distance above the puncture site may be applied to obtain a free flow of blood.
6. When the required blood has been obtained, apply a pad of sterile gauze and instruct the patient to apply pressure, then apply a bandage.

When dealing with infants and very small children, the heel or great toe puncture is the best method to obtain a blood specimen. This method is performed in much the same way.

VENIPUNCTURE (VACUTAINER METHOD)

The collection of blood from veins is called venipuncture. For the convenience of technician and patient, arm veins are best for obtaining a blood sample. If arm veins cannot be used due to interference from bandage or IV therapy, thrombosed or hardened veins, etc., consult your supervisor for instructions on the use of hand or foot veins.

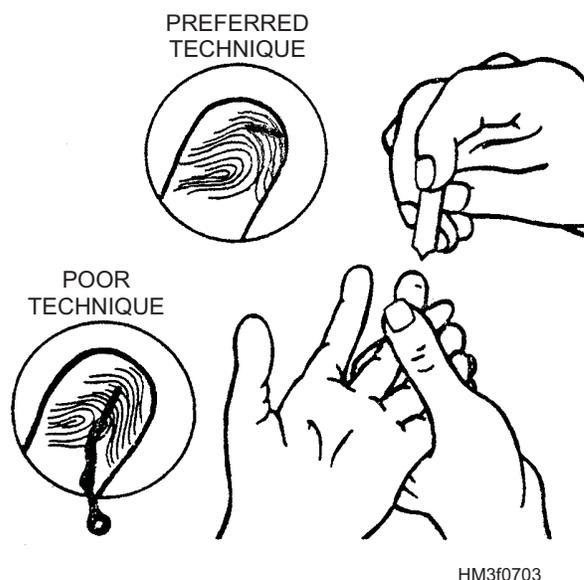


Figure 7-3.—Finger puncture.

NOTE: Do not draw blood from an arm with IV fluid running into it. Choose another site. The IV fluid will alter tests results.

Materials Required for Venipuncture Procedure

To perform a venipuncture, the following materials are required:

- Sterile gauze pads (2" x 2")
- 70% isopropyl alcohol or povidone-iodine solution pads
- Tourniquet
- Vacutainer needles and holder
- Vacutainer tube appropriate for the test to be performed

Arrange your equipment in an orderly manner and have it within easy reach. Also, wash your hands before the procedure.

Venipuncture Procedure

Position the patient so that the vein is easily accessible and you are able to perform the venipuncture in a comfortable position. Always have the patient either lying in bed or sitting in a chair with the arm propped up.

WARNING

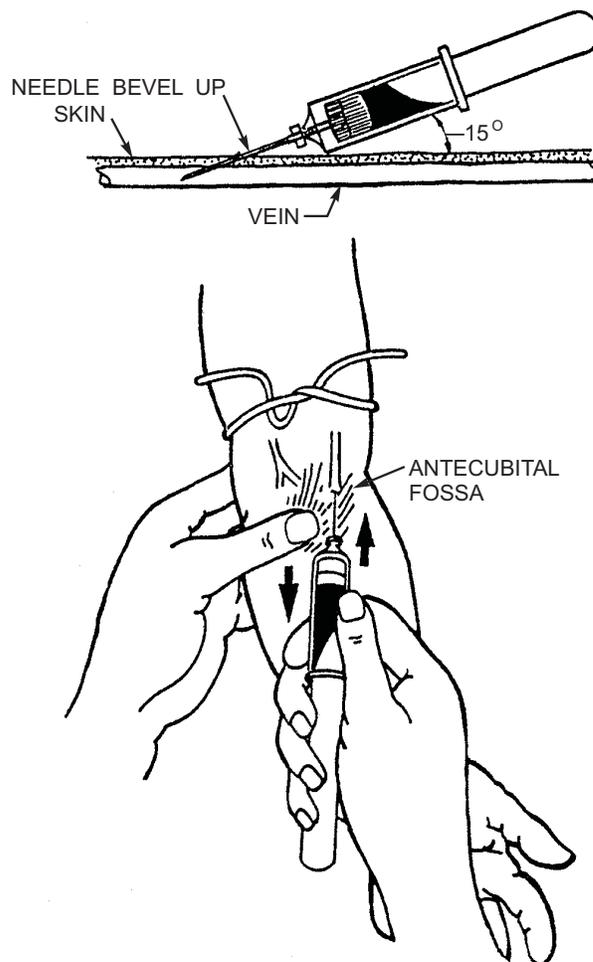
Never perform a venipuncture with the patient standing up. If patients should faint, they could seriously injure themselves. Also, safeguards should be in place to prevent patients from falling forward when they are seated.

To perform venipuncture, follow the steps given below.

1. Explain the procedure to the patient.
2. Apply tourniquet around the arm approximately 2 to 3 inches above the antecubital fossa (the depression in the anterior region of the elbow, see figure 7-4) with enough tension so that the VEIN is compressed, but not the ARTERY. A BP cuff (sphygmomanometer) may be used instead of a tourniquet if a patient is difficult to draw.
3. Position the patient's arm extended with little or no flexion at the elbow.
4. Locate a prominent vein by palpation (feeling). If the vein is difficult to find, it may be made more prominent by massaging the arm with an upward motion to force blood into the vein.
5. Cleanse the puncture site with a 70% alcohol pad or povidone-iodine solution and allow to dry.

CAUTION: After cleaning the puncture site, only the sterile needle should be allowed to touch it.

6. "Fix" or hold the vein taut. This is best accomplished by placing the thumb under the puncture site and exerting a slight downward pressure on the skin or placing the thumb to the side of the site and pulling the skin taut laterally (fig. 7-4).
7. Using a smooth continuous motion, introduce the needle, bevel side up, into the side of the vein at about a 15-degree angle with the skin (fig. 7-4).



HM3f0704

Figure 7-4.—Venipuncture.

8. Holding the vacutainer barrel with one hand, push the tube into the holder with the other hand and watch for the flow of blood into the tube until filling is completed.
9. Once all the specimens have been collected, hold the vacutainer with one hand and release the tourniquet with the other.
10. Place a sterile gauze over the puncture site and remove the needle with a quick, smooth motion.
11. Apply pressure to the puncture site and instruct the patient to keep the arm in a straight position. Have the patient hold pressure for at least 3 minutes.
12. Take this time to invert any tubes that need to have anticoagulant mixed with the blood.
13. Label specimens.
14. Reinspect the puncture site to make sure bleeding has stopped, and apply a bandage.

THE MICROSCOPE

LEARNING OBJECTIVE: *Identify the parts of the microscope, and determine their functions.*

Before any attempts are made to view blood smears, urinary sediments, bacteria, parasites, etc., it is absolutely essential that beginners know the instrument with which they will be spending considerable time—the microscope. The microscope is a precision instrument used extensively in clinical laboratories to make visible objects too small to be seen by the unaided eye. Most laboratories are equipped with binocular (two-eyepiece) microscopes, but monocular microscopes are also commonly used. The type of microscope most often used in the laboratory is referred to as the **compound microscope**. See figure 7-5. A compound microscope contains a system of lenses of sufficient magnification and resolving power (ability to show, separate, and

distinguish) so that small elements lying close together in a specimen appear larger and distinctly separated. In the following sections, the compound microscope's framework, illumination system, magnification system, and focusing system will be discussed.

FRAMEWORK

The framework of the compound microscope consists of four parts: the arm, the stage, the mechanical stage, and the base (fig. 7-5).

Arm

The arm is the structure that supports the magnification and focusing system. It is the handle by which the microscope is carried.

Stage

The stage is the platform on which a specimen is placed for examination. In the center of the stage is an aperture or hole that allows the passage of light from the condenser.

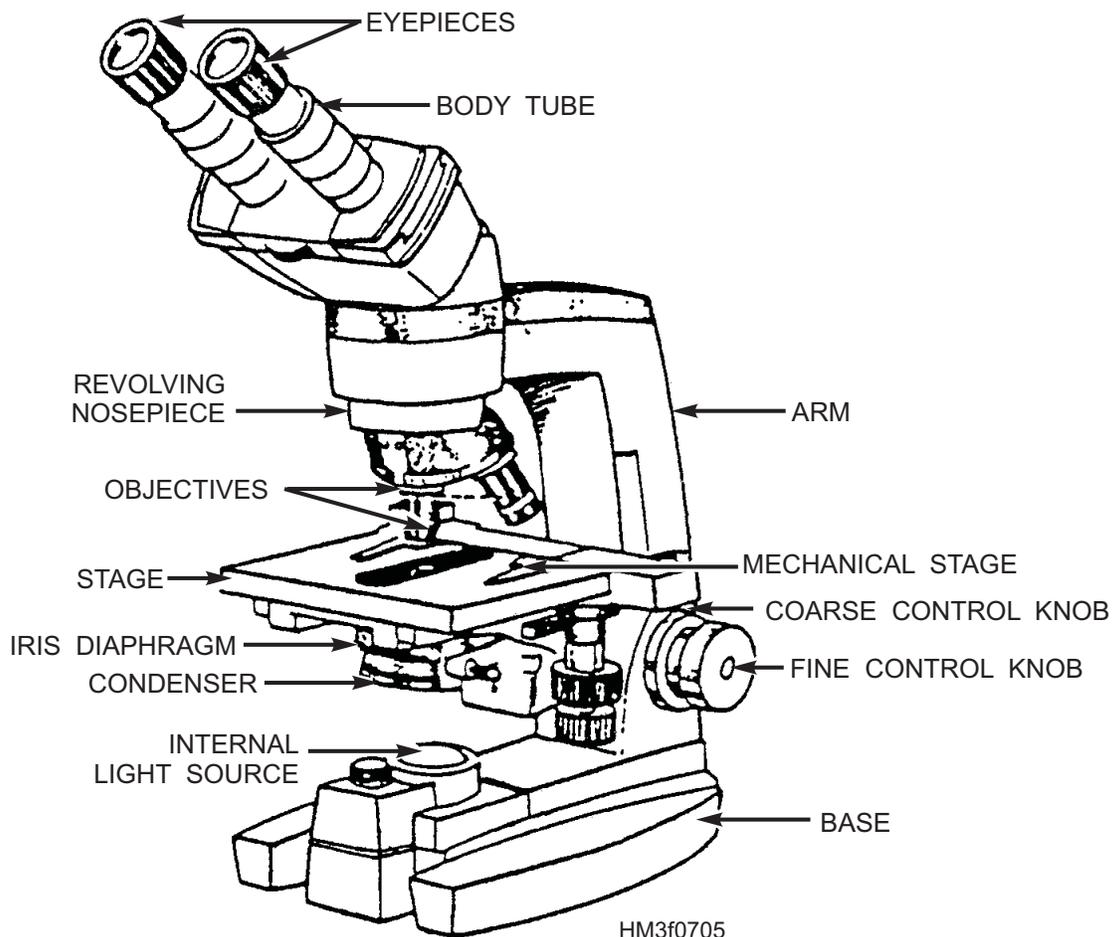


Figure 7-5.—Compound microscope.

Mechanical Stage

The mechanical (movable) stage holds the specimen in place and is the means by which the specimen may be moved about on the stage.

Base

The base is the structure on which the microscope rests.

ILLUMINATION SYSTEM

Ideal illumination of a specimen viewed under the microscope requires even light distribution. The objectives must also be entirely filled with light from the condenser. To fulfill these requirements, the illumination system of the compound microscope consists of three parts: an internal light source, a condenser, and an iris diaphragm. See figure 7-5.

Internal Light Source

The internal light source is built into the base of the microscope. It provides a precise and steady source of light into the microscope.

Condenser

The condenser is composed of a compact lens system and is located between the light source and stage. The condenser concentrates and focuses light from the light source directly through the specimen.

Iris Diaphragm

An iris diaphragm located on the condenser controls the diameter of the light source's beam. To improve resolution, the operator should adjust the opening of the iris diaphragm to approximately the same size as the face of the objective lens. In addition to the diaphragm on the condenser, an iris diaphragm may be located on the internal light source. This iris diaphragm controls the amount of light sent to the condenser from the internal light source.

MAGNIFICATION SYSTEM

The magnification system of the compound microscope contains at least two lens systems. The two lens systems are mounted on either end of a tube called the body tube. The lens nearest the object is called the objective lens, and the lens nearest the eye is the ocular lens or eye piece. See figure 7-5.

Objective Lenses

On a compound microscope, there is usually a set of three objective lenses (or "objectives"). This set of objectives is the component most responsible for the magnification and resolution of detail in a specimen. Each objective lens has a different focus distance and magnification power. A set of objectives normally consists of a low-power lens (approximate focus 16 mm, magnification 10X), a high-power lens (approximate focus 4 mm, magnification 45X), and an oil-immersion lens (approximate focus 1.8 mm, magnification 100X). Objective lenses are color coded for easy recognition: 16 mm-10X (green), 4 mm-45X (yellow), and 1.8 mm-100X (red).

Revolving Nosepiece

The revolving nosepiece contains openings into which objective lenses are fitted, and revolves objectives into desired position.

Body Tube

The body tube is a tube that permits light to travel from the objective to the ocular lens.

Ocular Lenses

Ocular lenses, or eyepieces, are located on top of the body tube and usually have a magnification power of 10X. To calculate the total magnification of a specimen, you multiply the magnification power of the objective by the magnification power of the ocular lens. Examples of total magnifications are provided in table 7-1.

FOCUSING SYSTEM

Focusing is accomplished by moving the stage up or down with the coarse and fine control knob (fig. 7-5). Whether the stage needs to be raised or lowered depends on the focal length of the objective

Table 7-1.—Examples of Total Magnifications

Objective Lens	Color Code	10X Ocular	Total Magnification
16 mm-10X	Green	10X	100X
4 mm-45X	Yellow	10X	450X
1.8 mm-100X	Red	10X	1000X

being used. For example, the high-powered objective of short focal length (4 mm) will need the stage raised so the objective is very close to the specimen, while the low-powered objective of a longer focal length (16 mm) will need the stage lowered so the objective is farther from the specimen.

The coarse control knob is used initially to bring the specimen's image into approximate focus. Once this is accomplished, the fine control knob sharpens the image.

Coarse Control Knob

The coarse control knob is the larger and inner knob. Rotating the coarse control knob allows the image to appear in approximate focus.

Fine Control Knob

The fine control knob is the smaller and outer knob. Rotating this control knob renders the image clear and well-defined.

FOCUSING THE MICROSCOPE

The process of focusing consists of adjusting the relationship between the optical system of the microscope and the object to be examined so that a clear image of the object is obtained. The distance between the upper surface of the glass slide on the microscope stage and the faces of the objective lens varies depending upon which of the three objectives is in the focusing position. It is a good practice to obtain a focus with the low-power objective first, then change to the higher objective required to avoid accidentally damaging the objective lens, the specimen, or both. Most modern microscopes are equipped with parfocal objectives (meaning that if one objective is in focus, the others will be in approximate focus when the nosepiece is revolved). With the low-power objective in focusing position, observe the following steps in focusing.

1. Seat yourself behind the microscope, then lower your head to one side of the microscope until your eyes are approximately at the level of the stage.
2. Using the coarse adjustment knob, lower the body tube until the face of the objective is within 1/4 inch of the object. Most microscopes are constructed in such a way that the low-power (green) objective cannot be lowered and make contact with the object on the stage.

3. While you are looking through the ocular, you should use the coarse adjustment knob to elevate the body tube until the image becomes visible. Then use the fine adjustment knob to obtain a clear and distinct image. Do not move the focusing knob while changing lenses.
4. If the high-power objective (yellow) is to be used next, bring it into position by revolving the nosepiece (a distinct "click" indicates it is in proper alignment with the body tube). Use the fine adjustment knob only to bring the object into exact focus.
5. If specimen is too dark, you can increase lighting by opening the iris diaphragm of the condenser.
6. The oil-immersion objective (red) is used for detailed study of stained blood and bacterial smears. Remember that the distance between objective lens and object is very short, and great care must be employed so the specimen is not damaged. After focusing with the high-power objective and scanning for well-defined cells, raise the objective, place a small drop of immersion oil, free of bubbles, on the slide, centering the drop in the circle of light coming through the condenser. Next, revolve the nosepiece to bring the oil-immersion objective into place, and, by means of the coarse adjustment knob, slowly lower the body tube until the lens just makes contact with the drop of oil on the slide. The instant of contact is indicated by a flash of light illuminating the oil. The final step in focusing is done with the fine adjustment knob. It is with this lens in particular that lighting is important. The final focus, clear and well-defined, will be obtained only when proper light adjustment is made.

CARE OF THE MICROSCOPE

The microscope is an expensive and delicate instrument that should be given proper care.

Moving or transporting microscopes should be accomplished by grasping the arm of the scope in one hand and supporting the weight of the scope with the other hand. Avoid sudden jolts and jars.

Keep the microscope clean at all times; when not in use, microscopes should be enclosed in a dustproof cover or stored in their case. Remove dust with a camel hair brush. Lenses may be wiped carefully with lens

tissue. When the oil-immersion lens is not being used, remove the oil with lens tissue. Use oil solvents (such as xylene) on lenses only when required to remove dried oil and only in the minimal amount necessary. **Never use alcohol or similar solvents to clean lenses.**

COMPLETE BLOOD COUNT

LEARNING OBJECTIVE: *Identify the five parts of a complete blood count, and recognize the testing procedures for the following: Unopette® Red Blood Cell Count, Microhematocrit, Unopette White Blood Cell Count, and Differential White Blood Cell Count.*

A complete blood count consists of the following five tests:

- Total red blood cell (RBC) count
- Hemoglobin determination
- Hematocrit reading
- Total white blood cell (WBC) count
- Differential white blood cell count

The complete blood count, commonly referred to as a CBC, is used in the diagnosis of many diseases. Blood collected for these tests are capillary or peripheral blood and venous blood. CBCs may be performed either manually or by using automated hematology analyzers. The manual method is used in isolated locations and on board some naval vessels where a hematology analyzer installation is not practical. For this reason, and because machines break down on occasion, the manual method will be covered in the following sections.

COUNTING BLOOD CELLS

To manually count red blood cells (erythrocytes) and white blood cells (leukocytes), you will need a microscope and an instrument called a **hemacytometer**. See figure 7-6. The hemacytometer is a thick glass slide with three raised parallel platforms on the middle third of the device. The central platform is subdivided by a transverse groove to form two halves, each wider than the two lateral platforms and separated from them and from each other by moats. The central platforms each contain a counting chamber and are exactly 0.1 mm lower than the lateral platforms.

Each counting chamber has precisely ruled lines etched into the glass, forming a grid. This grid or ruled area is so small that it can only be seen with the aid of a microscope. The grid used by most laboratories is the Improved Neubauer Ruling. See figure 7-7 for an example of the Improved Neubauer Ruling. The Improved Neubauer Ruling is 3 by 3 mm (9 mm²) and subdivided into nine secondary squares, each 1 by 1 mm (1 mm²).

A thick cover glass, ground to a perfect plane, accompanies the counting chamber (fig. 7-6). Ordinary cover glasses have uneven surfaces and should not be used. When the cover glass is in place on the platform of the counting chamber, there is a space exactly 0.1 mm thick between it and the ruled platform.

Counts of red blood cells and white blood cells are each expressed as concentration: cells per unit volume of blood. The unit of volume for cell counts is expressed as cubic millimeters (mm³) because of the linear dimensions of the hemacytometer chamber.

TOTAL RED BLOOD CELL COUNT

The total red blood cell (erythrocyte) count is the number of red cells in one cubic millimeter of blood. The normal red blood cell count is as follows:

Adult male.....	4.2 to 6.0 million per mm ³
Adult female.....	3.6 to 5.6 million per mm ³
Newborn.....	5.0 to 6.5 million per mm ³

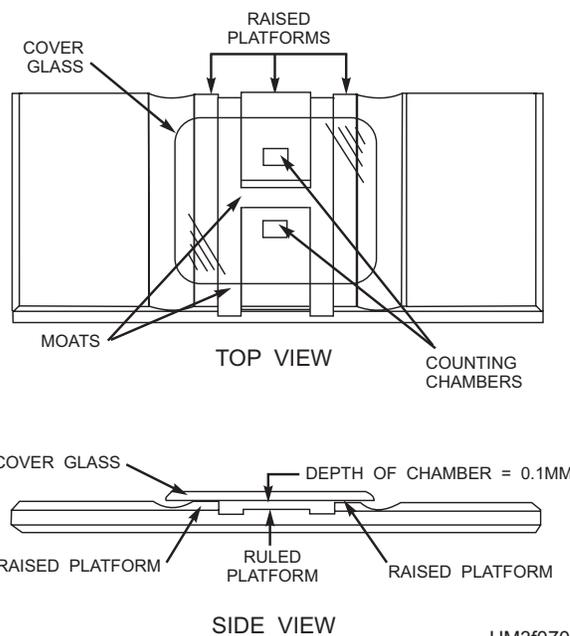


Figure 7-6.—Top and side views of a hemacytometer.

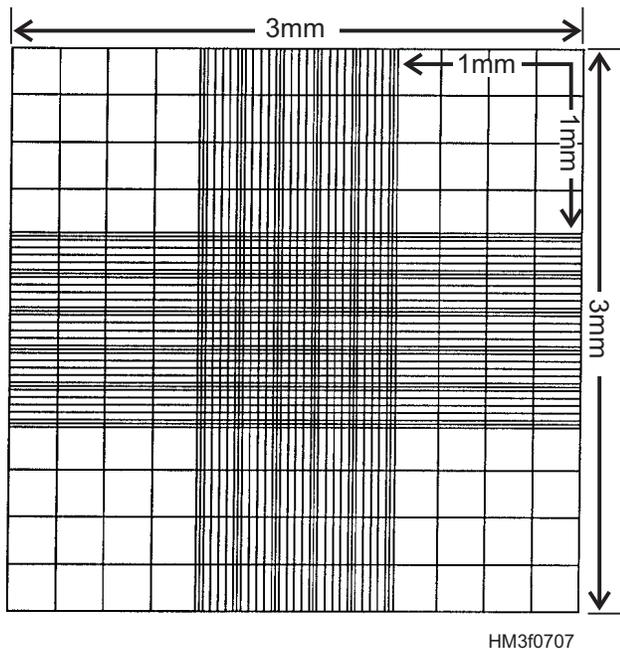


Figure 7-7.—Improved Neubauer Ruling.

As we said earlier, the red cell count is used in the diagnosis of many diseases. For example, a red cell count that drops below normal values may indicate anemia and leukemia. On the other hand, a red cell count that rises above the normal values may indicate dehydration.

The Unopette® Method is used to manually count red blood cells. Material requirements and the step-by-step procedures for performing this procedure are provided in the following sections.

Materials Required for Unopette Procedure

The Unopette procedure consists of a disposable diluting pipette system that provides a convenient, precise, and accurate method for obtaining a red blood cell count. To perform a red blood cell count using the Unopette method, you will need to obtain the following materials:

- A disposable Unopette (see fig. 7-8) for RBC counts. The Unopette consists of
 - a shielded capillary pipette (10 microliter (μ l) capacity), and
 - a plastic reservoir containing a premeasured volume of diluent (1:200 dilution).
- Hemacytometer and coverglass
- Microscope with light source

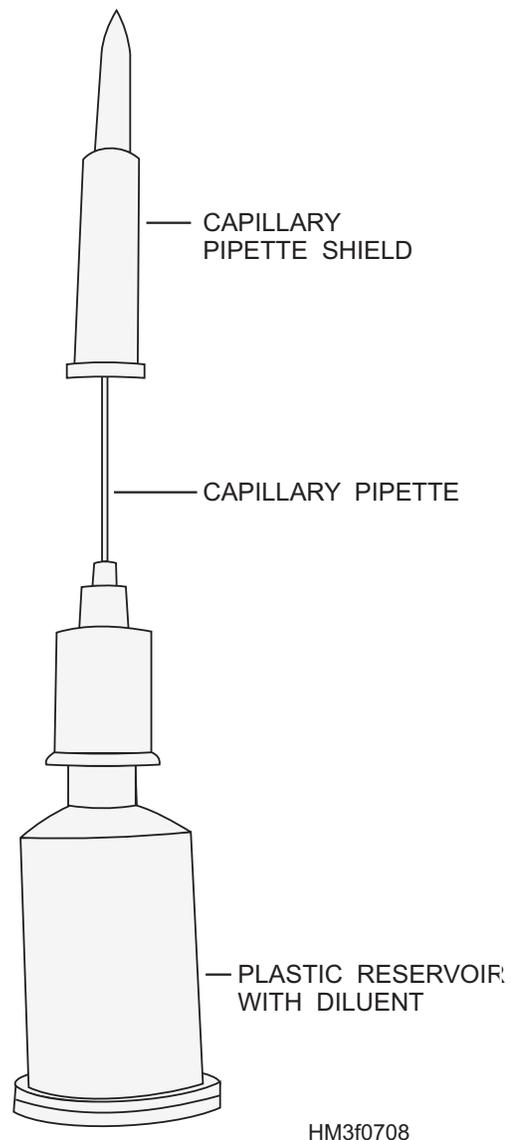


Figure 7-8.—Unopette® for RBC count.

- Hand-held counter
- Laboratory chit

Unopette Procedure

The Unopette procedure for counting red blood cells is as follows:

1. Puncture the diaphragm in the neck of the diluent reservoir with the tip of the capillary shield on the capillary pipette. See figure 7-9.
2. After obtaining free-flowing blood from a lancet puncture of the finger, remove the protective plastic shield from the capillary pipette. Holding the capillary pipette slightly above the horizontal, touch the tip to the blood source (see fig. 7-10, view A). The pipette will

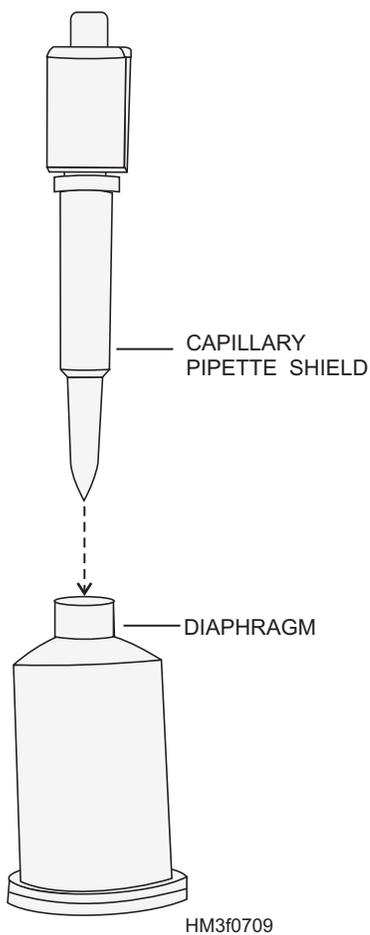


Figure 7-9.—Puncturing the diaphragm of diluent with the capillary pipette shield.

fill by capillary action. When blood reaches the end of the capillary bore in the neck of the pipette, filling is complete and will stop automatically. The amount of blood collected by the capillary tube is 10 μ l. Wipe any blood off the outside of the capillary tube, making sure no blood is removed from inside the capillary pipette. (An alternative source of blood is a thoroughly mixed fresh venous blood sample obtained by venipuncture. See figure 7-10, view B.)

3. With one hand, gently squeeze the reservoir to force some air out, but do not expel any diluent (fig. 7-11). Maintain pressure on the reservoir. With the other hand, cover the upper opening of the capillary overflow chamber with your index finger and seat the capillary pipette holder in the reservoir neck (see fig. 7-11).
4. Release pressure on the reservoir and remove your finger from the overflow chamber opening.

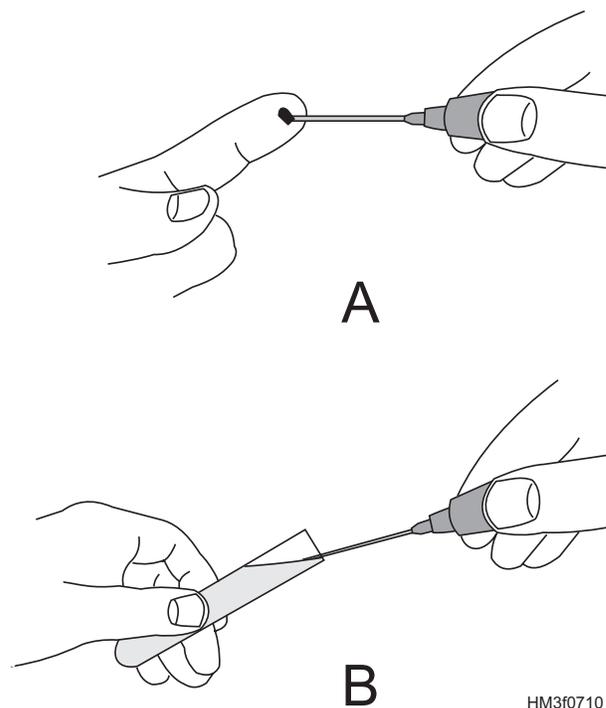


Figure 7-10.—Drawing blood into the Unopette capillary tube: A. From a finger puncture; B. From a venous blood sample.

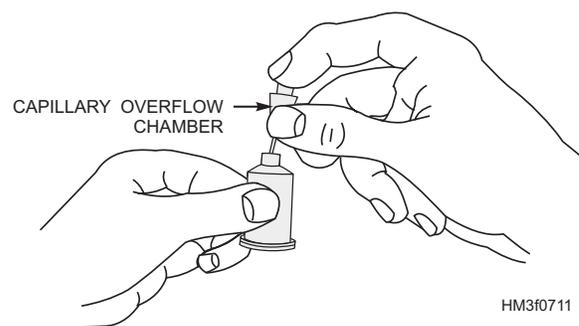


Figure 7-11.—Preparing reservoir to receive blood from the capillary tube.

Suction will draw the blood into the diluent in the reservoir.

5. Squeeze the reservoir gently two or three times to rinse the capillary tube, forcing diluent into but not out of the overflow chamber, releasing pressure each time to return diluent to the reservoir. Close the upper opening with your index finger and invert the unit several times to mix the blood sample and the diluent. See figure 7-12.
6. For specimen storage, cover the overflow chamber of the capillary tube with the capillary shield.

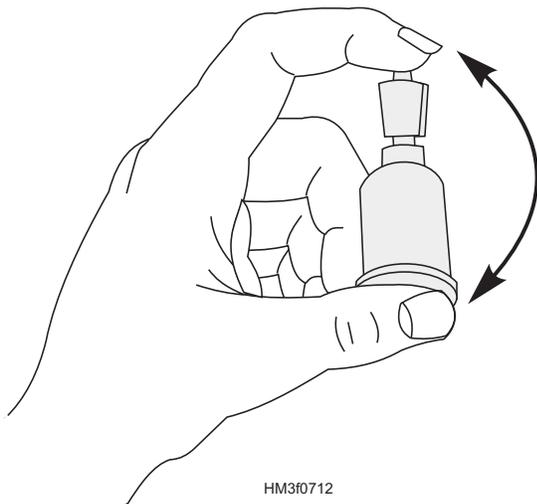


Figure 7-12.—Mixing blood sample and diluent.

7. Immediately prior to cell counting, mix again by gentle inversion, taking care to cover the upper opening of the overflow chamber with your index finger.
8. Place the coverglass on the hemacytometer counting chamber, making sure coverglass is clean and free of grease. (Fingerprints must be completely removed.)
9. Remove the pipette from the reservoir. Squeeze the reservoir and reseat the pipette in the reverse position, releasing pressure to draw any fluid in the capillary tube into the reservoir. Invert and fill the capillary pipette by gentle pressure on the reservoir. After discarding the first 3 drops, load (charge) the counting chamber of the hemacytometer by gently squeezing the

reservoir while touching the tip of the pipette against the edge of the coverglass and the surface of the counting chamber (fig. 7-13). A properly loaded counting chamber should have a thin, even film of fluid under the coverglass (fig. 7-14, view A). Allow 3 minutes for cells to settle. If fluid flows into the grooves (moats) at the edges of the chamber or if air bubbles are seen in the field, the chamber is flooded and must be cleaned with distilled water, dried with lens tissue, and reloaded (fig. 7-14, view B). If the chamber is underloaded, carefully add additional fluid until properly loaded.

10. Place the loaded hemacytometer into a petri dish with a piece of dampened tissue to keep the hemacytometer from drying out (fig. 7-15). Allow 5 to 10 minutes for the cells to settle.
11. Once the cells have settled, place the hemocytometer on the microscope. Use the low-power lens to locate the five small fields (1, 2, 3, 4, and 5) in the large center square bounded by the double or triple lines. See figure 7-16. Each field measures $1/25 \text{ mm}^2$, $1/10 \text{ mm}$ in depth, and is divided into 16 smaller squares. These smaller squares form a grid that makes accurate counting possible.
12. Switch to the high-power lens and count the number of cells in field 1. Move the hemacytometer until field 2 is in focus and repeat the counting procedure. Continue until the cells in all five fields have been counted. Note the fields are numbered clockwise around the chamber, with field 5 being in the center.

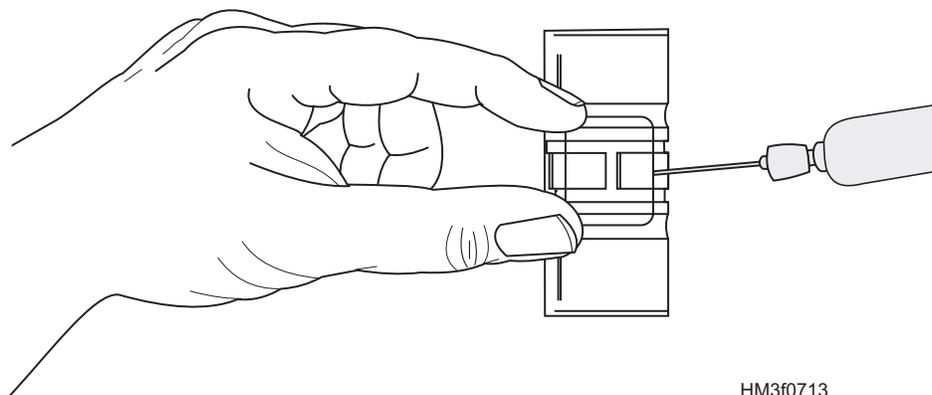


Figure 7-13.—Loading the counting chamber.

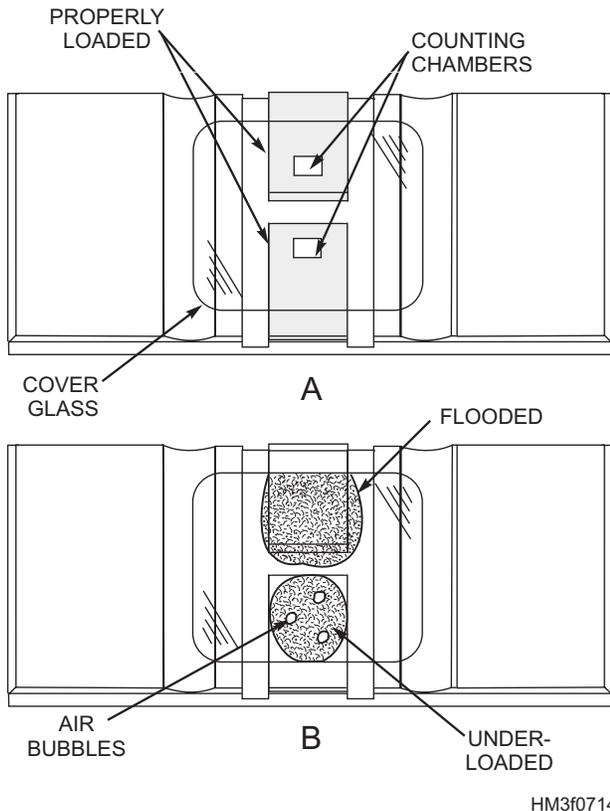


Figure 7-14.—Loading hemacytometer: A. Hemacytometer properly loaded; B. Hemacytometer improperly loaded.

Count the fields in this order. To count the cells in each field, start in the upper left small square and follow the pattern indicated by the arrow in field 1 of figure 7-16. Count all of the cells within each square, including cells touching the lines at the top and on the left. **Do not count any cells that touch the lines on the right or at the bottom.**

- Total the number of cells counted in all five fields and multiply by 10,000 to arrive at the number of red cells per cubic millimeter of blood.

Example: Total number of cells counted = 423.
Multiply:
423 x 10,000 = 4,230,000
Total red cell count = 4,230,000 cells/mm³

NOTE: The number of cells counted in each field should not vary by more than 20. A greater variation may indicate poor distribution of the cells in the fluid, resulting in

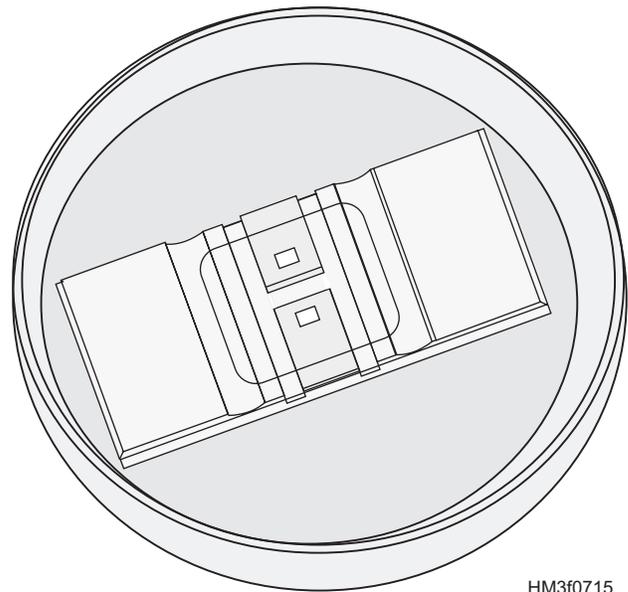


Figure 7-15—Loaded hemacytometer placed inside petri dish.

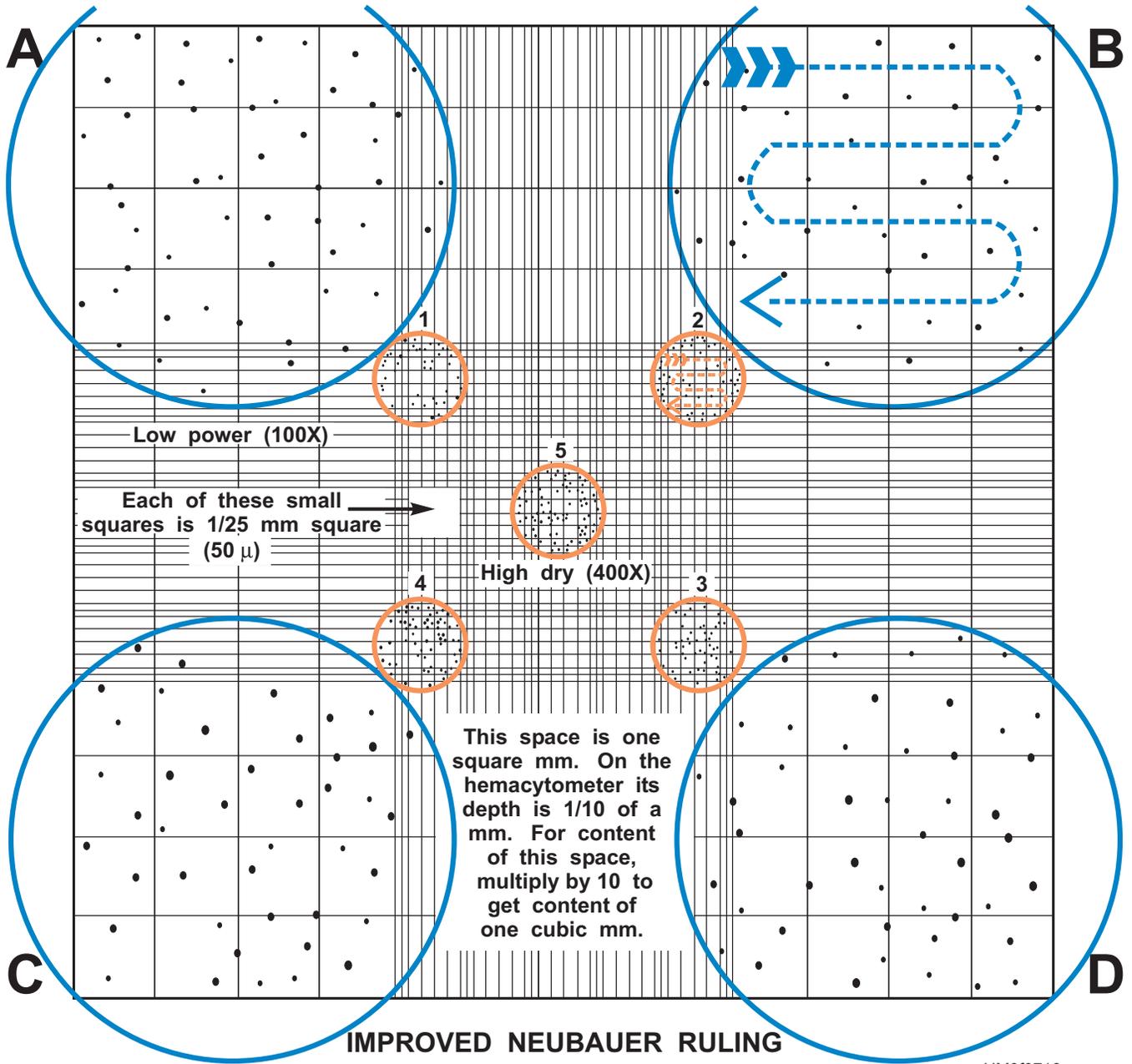
an inaccurate count. If this happens, the test must be repeated.

HEMOGLOBIN DETERMINATION

A routine test performed on practically every patient is the hemoglobin determination. Hemoglobin determination, or hemoglobinometry, is the measurement of the concentration of hemoglobin in the blood. Hemoglobin's main function in the body is to carry oxygen from the lungs to the tissues and to assist in transporting carbon dioxide from the tissues to the lungs. The formation of hemoglobin takes place in the developing red cells located in bone marrow.

Hemoglobin values are affected by age, sex, pregnancy, disease, and altitude. During pregnancy, gains in body fluids cause the red cells to become less concentrated, causing the red cell count to fall. Since hemoglobin is contained in red cells, the hemoglobin concentration also falls. Disease may also affect the values of hemoglobin. For example, iron deficiency anemia may drop hemoglobin values from a normal value of 14 grams per 100 milliliters to 7 grams per 100 milliliters. Above-normal hemoglobin values may occur when dehydration develops. Changes in altitude affect the oxygen content of the air and, therefore, also affect hemoglobin values. At higher altitudes there is less oxygen in the air, resulting in an increase in red cell counts and hemoglobin values. At lower altitudes there is more oxygen, resulting in a decrease in red cell counts and hemoglobin values.

HEMACYTOMETER (COUNTING CHAMBER)



A - B - C - D ARE FIELDS USED IN DOING THE WHITE BLOOD CELL COUNT.

1 - 2 - 3 - 4 - 5 ARE FIELDS USED IN DOING THE RED BLOOD CELL COUNT.

(Letters, numbers, and arrows are not actually seen in the counting chamber. They are for illustration only. Circles depict areas seen through the microscope.)

Figure 7-16.—Hemacytometer counting chamber.

The normal values for hemoglobin determinations are as follows:

	<u>Grams per</u> <u>100 ml blood</u>	<u>Percent</u>
Woman.....	12.5 to 15.....	83 to 110
Men.....	14 to 17.....	97 to 124
Newborn infants.....	17 to 23.....	97 to 138

Methods for hemoglobin determination are many and varied. The most widely used automated method is the **cyanmethemoglobin method**. To perform this method, blood is mixed with Drabkin's solution, a solution that contains ferricyanide and cyanide. The ferricyanide oxidizes the iron in the hemoglobin, thereby changing hemoglobin to methemoglobin. Methemoglobin then unites with the cyanide to form cyanmethemoglobin. Cyanmethemoglobin produces a color which is measured in a colorimeter, spectrophotometer, or automated instrument. The color relates to the concentration of hemoglobin in the blood.

Manual methods for determining blood hemoglobin include the **Haden-Hausse** and **Sahli-Hellige methods**. In both methods, blood is mixed with dilute hydrochloric acid. This process hemolyzes the red cells, disrupting the integrity of the red cells' membrane and causing the release of hemoglobin, which, in turn, is converted to a brownish-colored solution of acid hematin. The acid hematin solution is then compared with a color standard.

HEMATOCRIT (PACKED CELL VOLUME) DETERMINATION

The hematocrit or packed cell volume (PCV) determines the percentage of red blood cells (RBCs) in whole blood.

The normal hematocrit value for men is 42% to 52%; for women, 37% to 47%; and for newborns, 53% to 65%. When hematocrit determinations are below normal, medical conditions such as anemia and leukemia may be present. Above-normal hematocrit determinations indicate medical conditions like dehydration, such as occur in severe burn cases.

Currently, automated hematology analyzers supply most hematocrits. However, when hematology analyzers are not available, hematocrit determinations can be manually performed by the microhematocrit method or macrohematocrit method. Both methods call for the blood to be centrifuged, and the percentage of packed red cells is found by calculation.

The microhematocrit method is the most accurate manual method of determining blood volume and should be used whenever feasible. Material requirements and the step-by-step procedures for performing the microhematocrit method will be covered in the following sections.

Materials Required for Microhematocrit Procedure

To perform a hematocrit using the microhematocrit method, the following materials are required.

- Capillary tubes, plain or heparinized
- Modeling clay sealant
- Microhematocrit centrifuge
- Microhematocrit reader

Microhematocrit Procedure

To perform the microhematocrit method, you should follow the steps listed below:

1. Fill the capillary tube two-thirds to three-quarters full with well-mixed, oxalated venous blood or fingertip blood. (For fingertip blood use heparinized tubes, and invert several times to mix.)
2. Seal one end of the tube with clay.
3. Place the filled tube in the microhematocrit centrifuge, with the plugged end away from the center of the centrifuge.
4. Centrifuge at a preset speed of 10,000 to 12,000 rpm for 5 minutes. If the hematocrit exceeds 50 percent, centrifuge for an additional 3 minutes.
5. Place the tube in the microhematocrit reader. Read the hematocrit by following the manufacturer's instructions on the microhematocrit reading device.

TOTAL WHITE BLOOD CELL COUNT

The total white cell (leukocyte) count determines the number of white cells per cubic millimeter of blood. A great deal of information can be derived from white cell studies. The white blood cell count (WBC) and the differential count are common laboratory tests, and they are almost a necessity in determining the nature and severity of systemic infections. Normal WBC values in adults range from 4,500 to 11,000 cells per cubic millimeter; in children the range is from 5,000 to 15,000 cells per cubic millimeter; and in

newborns the range is from 10,000 to 30,000 cells per cubic millimeter.

White blood cell counts are performed either manually or with automated hematology analyzers. Only the manual method will be covered in this chapter. After a brief discussion on abnormal white blood cell counts, we will cover the Unopette method for manually counting white blood cells.

Abnormal White Cell Counts

When white cell counts rise above normal values, the condition is referred to as **leukocytosis**. Leukocytosis frequently occurs when systemic or local infections (usually due to bacteria) are present. Counts for infections are highly variable. Examples of some infections and their representative white cell counts are as follows:

Pneumonia—20,000 to 30,000/mm³

Meningitis—20,000 to 30,000/mm³

Appendicitis—10,000 to 30,000/mm³

Dyscrasia (the diseased condition) of blood-forming tissues, such as occurs in leukemia (due to a malfunctioning of lymph and marrow tissues) also results in leukocytosis, with extremely high white cell counts. These white cell counts sometimes exceed 1,000,000/mm³.

Other physiological conditions that can cause leukocytosis and a white cell count as high as 15,000/mm³ may occur as follows:

- Shortly after birth
- During late pregnancy
- During labor
- Accompanying severe pain
- After exercise or meals
- After cold baths
- During severe emotional upset

An abnormally low count, known as **leukopenia**, may be caused by the following conditions:

- Severe or advanced bacterial infections (such as typhoid, paratyphoid, and sometimes tularemia), or when the bacterial infection has been undetected for a period of time (as with chronic beta streptococcal infections of the throat).

- Infections caused by viruses and rickettsiae, such as measles, rubella, smallpox (until the 4th day), infectious hepatitis, psittacosis, dengue, tsutsugamushi fever, and influenza (when it may fall to 1,500/mm³, or shift to leukocytosis if complications develop).
- Protozoal infections (such as malaria) and helminthic infections (such as trichinosis). (For example, with victims of malaria, slight leukocytosis may develop for a short time during paroxysm (the sudden intensification of symptoms). Shortly thereafter, however, leukopenia ensues.)
- Overwhelming infections when the body's defense mechanisms break down.
- Anaphylactic shock
- Radiation

Materials Required for Unopette Procedure

The Unopette method uses a disposable diluting pipette system that provides a convenient, precise, and accurate method for obtaining a white blood cell count. When the Unopette method is used, whole blood is added to a diluent. The diluent lyses (destroys) the red blood cells, but preserves the white blood cells. Once the red cells are completely lysed, the solution will be clear. The diluted blood is then added to a hemacytometer. Once the hemacytometer is loaded, the cells should be allowed to settle for 10 minutes before counting proceeds.

The following materials are required to perform a white blood cell count using the Unopette method:

- Disposable Unopette for WBC counts, which consists of
 - a shielded capillary pipette (20 microliter (μ l) capacity), and
 - a plastic reservoir containing a premeasured volume of diluent (1:100 dilution).
- Hemacytometer and coverglass
- Microscope with light source
- Hand-held counter
- Laboratory chit

Unopette Procedure

The Unopette disposable diluting pipette system used to count WBCs is almost identical in shape and application to the Unopette system for RBC counts. The only major difference is that the reservoir contains a different diluent and the capillary pipette capacity differs (RBC 10 μl and WBC 20 μl). To assist you in performing the Unopette procedure for WBCs, we will refer to illustrations for the Unopette procedure for RBCs in this section.

The Unopette procedure for counting white blood cells is as follows:

1. Puncture the diaphragm in the neck of the reservoir with the tip of the capillary pipette shield. See figure 7-9.
2. After you obtain free-flowing blood from a lancet puncture of the finger, remove the protective plastic shield from the capillary pipette. Hold the capillary pipette slightly above the horizontal and touch the tip to the blood source (fig. 7-10, view A). The pipette will fill by capillary action. When blood reaches the end of the capillary bore in the neck of the pipette, filling is complete and will stop automatically. The amount of blood collected by the capillary tube is 20 μl . Wipe any blood off the outside of the capillary tube, making sure no blood is removed from inside the capillary pipette. (An alternative source of blood is a thoroughly mixed fresh venous blood sample obtained by venipuncture. See figure 7-10, view B.)
3. With one hand, gently squeeze the reservoir to force some air out, but do not expel any diluent (fig. 7-11). Maintain pressure on the reservoir. With the other hand, cover the upper opening of the capillary overflow chamber with your index finger and seat the capillary pipette holder in the reservoir neck (fig. 7-11).
4. Release pressure on the reservoir and remove your finger from the overflow chamber opening. Suction will draw the blood into the diluent in the reservoir.
5. Squeeze the reservoir gently two or three times to rinse the capillary tube, forcing diluent into but not out of the overflow chamber, releasing pressure each time to return diluent to the reservoir. Close the upper opening with your index finger and invert the unit several times to mix the blood sample and diluent. See figure 7-12.
6. For specimen storage, cover the overflow chamber of the capillary tube with the capillary shield.
7. Immediately prior to cell counting, mix again by gentle inversion, taking care to cover the hole with your index finger.
8. Place the coverglass on the hemacytometer counting chamber, making sure the coverglass is clean and grease-free. (Fingerprints must be completely removed.)
9. Remove the pipette from the reservoir. Squeeze the reservoir and reseat the pipette in the reverse position. Release pressure to draw any fluid in the capillary tube into the reservoir. Invert and fill the capillary pipette by gentle pressure on the reservoir. After discarding the first 3 drops, load (charge) the counting chamber of the hemacytometer by gently squeezing the reservoir while touching the tip of the pipette against the edge of the coverglass and the surface of the counting chamber (fig. 7-13). A properly loaded counting chamber should have a thin, even film of fluid under the coverglass (fig. 7-14, view A). Allow 3 minutes for the cells to settle. If fluid flows into the grooves (moats) at the edges of the chamber or if you see air bubbles in the field, the chamber is flooded and must be cleaned with distilled water, dried with lens tissue, and reloaded (fig. 7-14, view B). If the chamber is underloaded, carefully add additional fluid until properly loaded.
10. Place the loaded hemacytometer into a petri dish with a piece of dampened tissue to keep the hemacytometer from drying out (fig. 7-15). Allow 5 to 10 minutes for the cells to settle.
11. Once the cells have settled, place the hemacytometer on the microscope. Using the high-power objective, count the WBCs in the four corner fields of the hemacytometer chamber (fields A, B, C, and D of figure 7-16). Each field is composed of 16 small squares. To count the cells in each field, start in the upper left small square and follow the pattern indicated by the arrow in field B of figure 7-16. Count all of the cells within each square, including cells touching the lines at the top and on the left. **Do not count any cells that touch the lines on the right or at the bottom.**

12. When all the cells in the 4 fields have been counted, multiply the count by 50. This will give you the total number of white cells per cubic millimeter of blood.

Example:	25 cells in field #1
	23 cells in field #2
	26 cells in field #3
	<u>26 cells in field #4</u>
	100 total cells in all fields
Multiply:	
100 x 50	= 5,000
Total white cell count	= 5,000 cells/mm³

DIFFERENTIAL WHITE BLOOD CELL COUNT

A total white blood cell count is not necessarily indicative of the severity of a disease, since some serious ailments may show a low white cell count. For this reason, a differential white cell count is performed. A differential white cell count consists of an examination of blood to determine the presence and the number of different types of white blood cells. This study often provides helpful information in determining the severity and extent of an infection, more than any other single procedure used in the examination of the blood.

The role of white blood cells, or leukocytes, is to control various disease conditions. Although these cells do most of their work outside the circulatory system, they use the blood for transportation to sites of infection.

Five types of white cells are normally found in the circulating blood. They are

- eosinophils,
- basophils,
- neutrophils,
- lymphocytes, and
- monocytes.

Cell Identification

To perform a differential white cell count, you must be able to identify the different types of white cells. The ability to properly identify the different

types of white cells is not difficult to develop, but it does require a thorough knowledge of staining characteristics and morphology (the study of the form and structure of organisms). This knowledge can be gained only by extensive, supervised practice.

To acquaint you with the developmental stages of each type of leukocyte, a colorized illustration (fig. 7-17) has been provided. This illustration also displays the developmental stages of the red blood cell (erythrocyte) and the blood platelet cell (thrombocyte). To further assist you, identifying characteristics of each type of leukocyte as they appear on a stained blood smear will be covered in the following sections.

Laboratories use a **blood smear** to obtain a differential white cell count. To prepare a blood smear, a blood specimen is spread across a glass slide, stained to enhance leukocyte identification, and examined microscopically. Material requirements and the step-by-step procedure for performing a blood smear will be covered later in this chapter.

NEUTROPHILS.—Neutrophils account for the largest percentage of leukocytes found in a normal blood sample, and function by ingesting invading bacteria. On a stained blood smear, the cytoplasm of a neutrophil has numerous fine, barely visible lilac-colored granules and a dark purple or reddish purple nucleus (see figure 7-17). The nucleus may be oval, horseshoe, or “S”-shaped, or segmented (lobulated). Neutrophils are subclassified according to their age or maturity, which is indicated by changes in the nucleus. The subclassifications for neutrophilic cells are metamyelocyte, band, segmented, and hypersegmented.

Neutrophilic Metamyelocyte.—A neutrophilic metamyelocyte, also called a “juvenile” cell, is the youngest neutrophil generally reported. The nucleus is fat, indented, and is usually “bean”-shaped or “cashew nut”-shaped (fig. 7-17).

Neutrophilic Band.—A neutrophilic band, sometimes called a “stab” cell, is an older or intermediate neutrophil. The nucleus has started to elongate and has curved itself into a horseshoe or S-shape. As the band ages, it matures into a segmented neutrophil (fig. 7-17).

Segmented Neutrophil.—A segmented neutrophil is a mature neutrophil. The nucleus of a segmented neutrophil is separated into two, three, four, or five segments or lobes (fig. 7-17).

DEVELOPMENT OF BLOOD CELLS X 1500

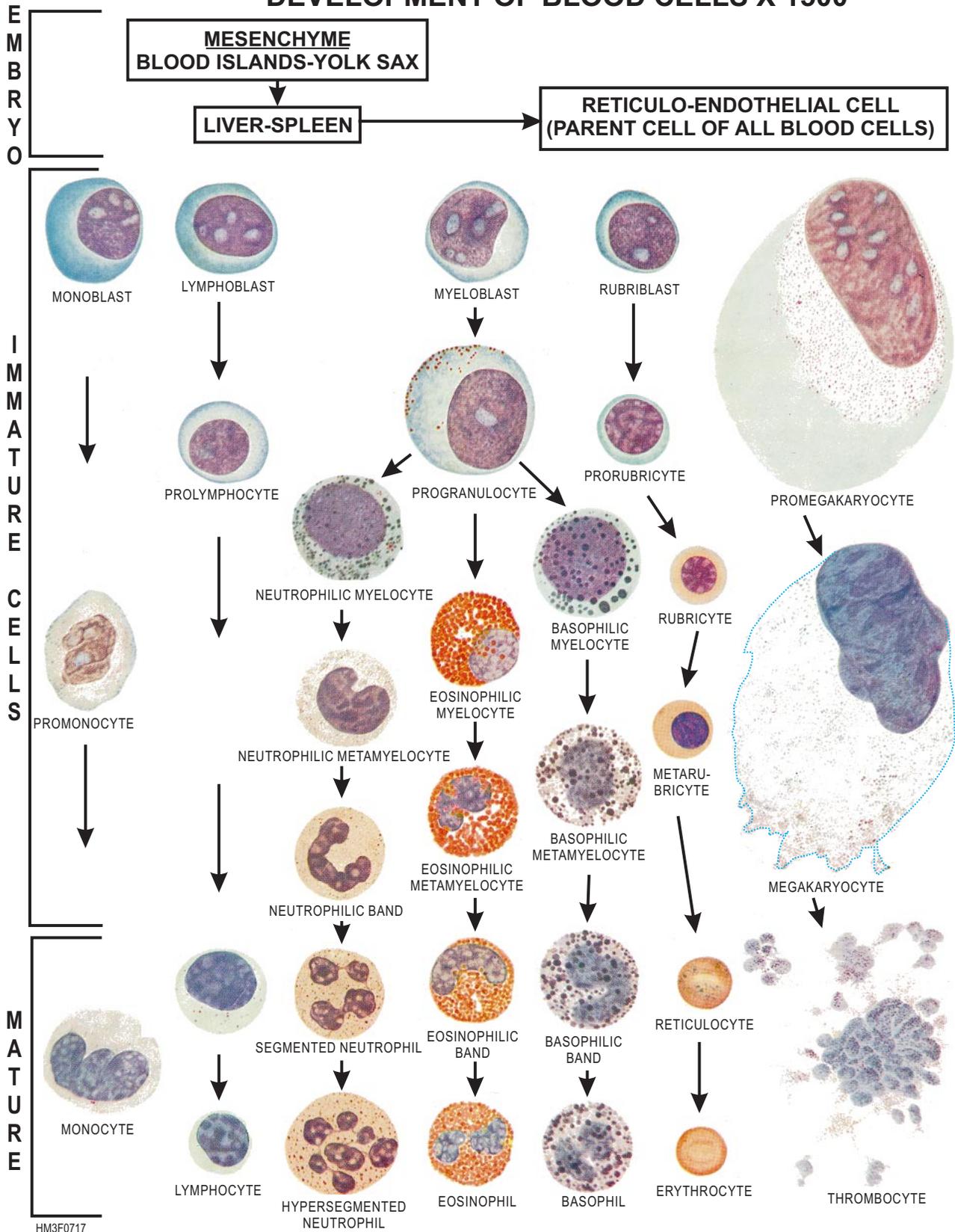


Figure 7-17.—Development of blood cells.

Hypersegmented Neutrophil.—A hypersegmented neutrophil is a mature neutrophil. The nucleus of a hypersegmented neutrophil is divided into six or more segments or lobes (fig. 7-17).

EOSINOPHIL.—Eosinophils aid in detoxification. They also break down and remove protein material. The cytoplasm of an eosinophil contains numerous coarse, reddish-orange granules, which are lighter colored than the nucleus (fig. 7-17).

BASOPHIL.—The function of basophilic cells is unknown. It is believed, however, that basophilic cells keep the blood from clotting in inflamed tissue. Scattered large, dark-blue granules that are darker than the nucleus, characterize the cell as a basophil (fig. 7-17). Granules may overlay the nucleus as well as the cytoplasm.

LYMPHOCYTE.—The function of lymphocytes is also unknown, but it is believed that they produce antibodies and destroy the toxic products of protein metabolism. The cytoplasm of a lymphocyte is clear sky blue, scanty, with few unevenly distributed, azurophilic granules with a halo around them (fig. 7-17). The nucleus is generally round, oval, or slightly indented, and the chromatin (a network of fibers within the nucleus) is lumpy and condensed at the periphery.

MONOCYTE.—The monocyte, the largest of the normal white blood cells, destroys bacteria, foreign particles, and protozoa. Its color resembles that of a lymphocyte, but its cytoplasm is a muddy gray-blue (fig. 7-17). The nucleus is lobulated, deeply indented or horseshoe-shaped, and has a relatively fine chromatin structure. Occasionally, the cytoplasm is more abundant than in the lymphocyte.

Materials Required for the Differential Count Procedure

To perform a differential count, the following materials are required:

- Four plain glass microscope slides, clean and dry
- Wright-Giemsa stain solution (follow manufacturer's directions for use and storage)
- Staining containers
- Deionized or distilled water
- Microscope with light source
- Immersion oil
- Blood cell counter

Differential Count Procedure

The procedure for the differential white cell count is done in 4 steps:

- Step 1: Making the blood smear
- Step 2: Staining the cells
- Step 3: Counting the cells
- Step 4: Reporting the count

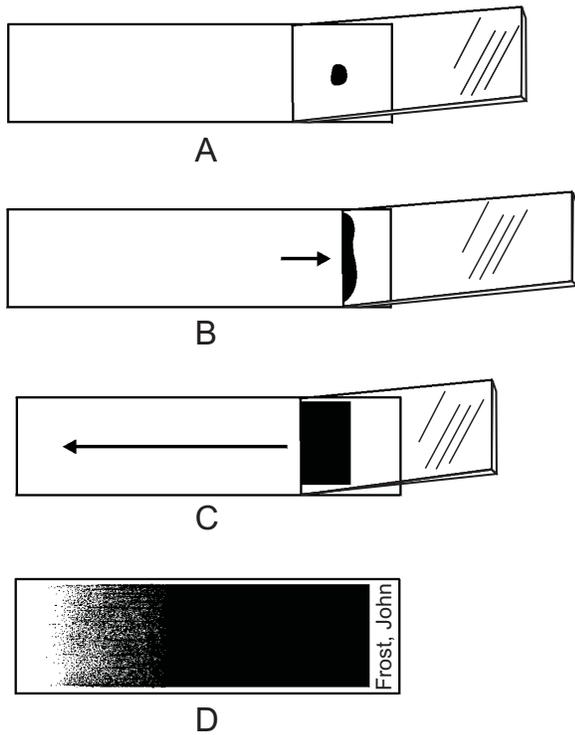
Each step of this procedure will be discussed in the following sections.

MAKING THE BLOOD SMEAR.—The simplest way to count the different types of white cells is to spread them out on a glass slide. The preparation is called a blood smear. There are two methods of making a blood smear: the slide method (covered in this chapter) and the cover glass method.

It is very important to make a good blood smear. If it is made poorly, the cells may be so distorted that it will be impossible to recognize them. You should make at least two smears for each patient, as the additional smear should be examined to verify any abnormal findings.

To prepare a blood smear for a differential count, follow the steps below:

1. Using a capillary tube, collect anticoagulated blood from a venous blood sample.
2. Deposit a drop of blood from capillary tube onto a clean, grease-free slide. Then place the slide on a flat surface, blood side up.
3. Hold a second slide between your thumb and forefinger and place the edge at a 23-degree angle against the top of the slide that holds the drop of blood (see figure 7-18, view A). Back the second slide down until it touches the drop of blood. The blood will distribute itself along the edge of the slide in a formed angle (see figure 7-18, view B).
4. Push the second slide along the surface of the other slide, drawing the blood across the surface in a thin, even smear (see figure 7-18, view C). If this is done in a smooth, uniform manner, a gradual tapering effect (or "feathering") of the blood will occur on the slide. This "feathering" of the blood is essential to the counting process and is the principal characteristic of a good blood smear (see figure 7-18, view D). When



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Figure 7-18.—Making a blood smear: A. Placing second slide at a 23° angle; B. Blood distributing itself along second slide's edge; C. Drawing blood across surface of slide; D. Example of a properly prepared blood smear.

you are making the smear, prevent blood from reaching the extreme edges of the slides. Allowing the smear to reach the edges of the slide will aggravate the tendency of large cells to stack up on the perimeter of the smear. A smear with wavy lines or blank spots should be discarded, and a new smear made.

5. Once the blood smear is made, let it dry (it will take a few minutes). Then write the patient's name in pencil on the bottom edge of the slide, as illustrated in figure 7-18, view D). Proceed to step 2, staining the cells.

STAINING THE CELLS.—Once a blood smear is made, it should be stained. Staining the blood smear highlights the differences among the different types of leukocytes for easier recognition during the counting process. The most popular stain used for this purpose is Wright's stain. Wright's stain is a methyl alcohol (methanol) solution of an acid dye and a basic dye. The acid dye in Wright's stain is known as eosin and is red in color. The basic dye in Wright's stain is known as methylene blue and is blue in color. Generally, white cells are identified by their affinity to the dye they prefer. For example, cells that prefer the acid dye

(eosin) are called eosinophils. Other cells that prefer the basic dye are called basophils.

WARNING

Wright's staining solution contains methanol, which is considered a hazardous material. It is classified as flammable, a poison, and an irritant. Methanol must be kept away from heat, sparks, and open flames. Good ventilation in usage areas is paramount since exposure to vapors can irritate eyes, nose, throat, and mucous membranes of the upper respiratory tract. When not in use, methanol containers should be closed tightly and stored upright to prevent leakage. Gloves and protective clothing (e.g., lab coat or apron) and eyewear should be worn to avoid contact with the solution. Absorption through skin can cause permanent blindness. Death may result from ingestion or exposure to high vapor concentrations of methanol.

There are a variety of staining products on the market today. Some of these staining products have combined Wright's solution with other staining solutions, such as Giemsa stain. When using a new product, you should always review the manufacturer's usage and safety recommendations.

The staining process that we will cover in this chapter is known as a **quick stain**. A quick stain has very few equipment requirements and only a few procedural steps. An example of a quick stain is One Step II Wright-Giemsa Stain Solution® by Criterion Sciences. To stain a blood smear with this product, follow the steps below.

1. Prepare two staining containers by filling one with One Step II stain solution and the other with deionized or distilled water. The use of tap water instead of deionized or distilled water is not recommended since the pH of tap water varies. If tap water is used, its pH should be between 5.8 and 7.03.
2. Immerse the slide (blood smear) in the stain for 15 to 30 seconds. (To prevent debris or precipitate from contaminating the slide, do not add new stain to old.)
3. Remove the slide and allow excess stain to drain from the edge of the slide.
4. Immerse the slide in the deionized or distilled water for 5 to 15 seconds. (Change the water

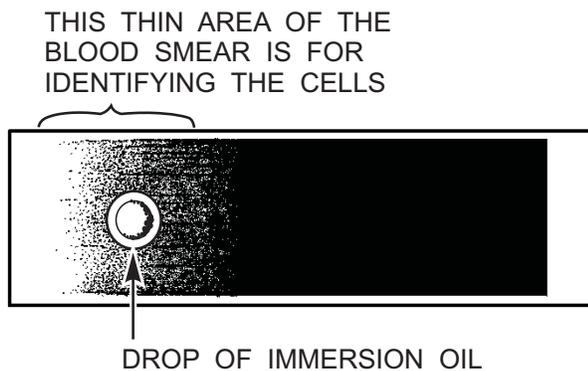
when it becomes dark blue or when film forms on the surface.) **NOTE:** Rinse time is critical and must be shorter than the stain time.

5. Drain excess water and wipe the back of the slide to reduce background color.
6. Place slide in horizontal position on table and allow to air dry. **NOTE:** Do not accelerate drying time by placing slide on a warmer or in front of a fan. The film of water on the slide is important for the color development.
7. Once the slide is dry, proceed to step 3, counting the cells.

COUNTING THE CELLS.—Once the blood smear has been stained, it is placed under a microscope, and the differential count is conducted.

To perform a differential white cell count, you should follow the steps listed below:

1. Place the slide under the microscope. Switch the oil immersion objective (red) (100X) into position above the stage. Turn the coarse adjustment to raise the oil immersion objective about 1 inch above the opening in the stage. Open the condenser and switch on the microscope light.
2. Place a large drop of immersion oil on the thin area of the blood smear. See figure 7-19.
3. Hold the slide so the thin area is on your left. Then fix the slide firmly in the jaws of the mechanical (movable) stage. Move the mechanical stage so the drop of oil on the slide is directly over the bright light coming up from the condenser.
4. Using the coarse control knob, you should now slowly lower oil immersion objective into the



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Figure 7-19.—Placement of immersion oil on blood smear.

drop of oil (on the slide). When the objective is in the drop of oil, continue turning the coarse adjustment until the objective is touching the glass slide.

5. Now, while continually looking through the eyepiece, **VERY SLOWLY** rotate the coarse adjustment toward you until you see some cells. After you have brought the cells into view with the coarse adjustment, bring the cells into perfect focus by rotating the fine adjustment. **NOTE:** Always rotate the fine adjustment back and forth when identifying cells. This step will help you see the various layers of the cell and thereby help you to identify the different types of white cells.
6. Count 100 consecutive white cells, pressing the correct key on the cell counter for each type of white cell identified. (If the cell counter is not available, record cell type and number of cells encountered on a piece of paper.) Follow path similar to one illustrated in figure 7-20 to count cells.
7. Total each type of white cell. If you count 20 lymphocytes among the 100 cells, the differential count for lymphocytes is 20%. Continue this process until your count totals 100%. This differential count is referred to as a **relative count**. Another differential count that may be requested is an **absolute count**. To perform an absolute count, multiply the total white cell count by the individual cell percentages. See the example below.

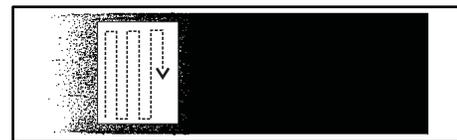
Example:

Patient has a total white cell count of 8,000. Differential count shows 20% leukocytes.

Multiply:

$$8,000 \times 0.20 (20\%) = 1,600$$

Patient has 1,600 lymphocytes/mm³



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Figure 7-20.—Counting path for differential count.

NOTE: When performing the white cell count, you may observe abnormal white cells such as distorted lymphocytes, smudge cells, and disintegrated cells.

Distorted lymphocytes, which appear squashed or distorted, are caused by excessive pressure on the cell during the process of making the smear. Distorted cells should be recorded as normal lymphocytes. **Smudge cells** are white cells that have ruptured and only the nucleus remains. A few smudge cells may be found in a normal blood smear. Smudge cells should not be added to the count or recorded. **Disintegrated cells** are ruptured cells, but the nucleus and cytoplasm still remain. Disintegrated cells should not be counted as one of the 100 cells, but should be recorded on the report as “disintegrated cells.”

8. Once the differential count is completed, proceed to step 4, reporting the count.

NOTE: If it is desirable to save a smear for reexamination, remove the immersion oil by placing a piece of lens tissue over the slide and moistening the tissue with xylene. Draw the damp tissue across the slide, and dry the smear with another piece of lens paper.

REPORTING THE COUNT.—When you have calculated the differential count, the report is given according to either the **Schilling classification** or **filament and nonfilament classification methods**. We will be covering the Schilling classification, since it is the simplest and most popular method.

The Schilling Classification.—The Schilling classification was established when Victor Schilling, a German hematologist, noticed that in many diseases there is an increase in the percentage of immature neutrophils. The blood chart he developed reported the percentages of the different neutrophilic cell types and (in part) was arranged in the following manner:

Normal %	Myelocytes	Meta-myelocytes	Band Cells	Segmented Cells
	0	0	2 to 6	55 to 75

Note that the immature cells are on the left side of the chart. If percentages of immature cell increased, Schilling referred it as a “shift to the left.” When the

shift to the left was accompanied by a low white cell count, Schilling called it a “degenerative shift to the left.” A degenerative shift to the left is seen in such diseases as typhoid fever. This shift is caused by a depression of the cell factories in the bone marrow.

When the shift to the left is accompanied by a high white cell count, it is called a “regenerative shift to the left.” A regenerative shift to the left is seen in such diseases as pneumonia. This shift is caused by a stimulus of the cell factories in the bone marrow.

A “shift to the right” implies an increase in hypersegmented neutrophils. It may be seen in pernicious anemia, an anemia caused by the malabsorption of vitamin B₁₂.

The Schilling classification for an adult differential white cell count is provided below in table 7-2.

NOTE: Normal values for differential counts vary with the age of the patient. For example, children’s blood normally contains 0% to 2% basophils, 0% to 5% eosinophils, 25% to 75% neutrophils, 30% to 70% lymphocytes, and 0% to 8% monocytes. Normal values may also be adjusted by hospitals that have evaluated the normal differential value for their local population.

General Interpretations of Leukocyte Changes.—Together, the total white cell count and differential count aid physicians in interpreting the severity of infections. Some general interpretations of leukocyte changes are as follows:

- Leukocytosis with an increase in the percentage of neutrophils indicates a severe infection with a

Table 7-2.—Schilling Classification of the Differential White Cell Count

Cell	Normal %
Neutrophilic myelocytes	0
Neutrophilic metamyelocytes	0
Neutrophilic band cells	2 to 6
Neutrophilic segmented cells	55 to 75
Lymphocytes	20 to 35
Monocytes	2 to 6
Eosinophilic segmented cells	1 to 3
Basophilic segmented cells	0 to 1

good response of the bone marrow. The primary bacteria-destroying cells (known as phagocytes) are the neutrophils, and the bone marrow should supply large numbers of these to combat the infection. The greater the “shift to the left” (increase in immature neutrophils), the more severe the infection. The appearance of numerous juvenile cells (metamyelocytes) indicates irritation of the bone marrow with regeneration. If the infection continues and the patient’s resistance declines, the shift advances further to the left. If improvement ensues, the shift declines and recedes to normal.

- A falling white cell count with the number and maturity of neutrophils progressing toward normal indicates recovery.
- A continued “shift to the left” with a falling total white cell count indicates a breakdown of the body’s defense mechanism and is a poor prognosis.
- The percentage of eosinophils, lymphocytes, and monocytes generally decreases in acute infections.
- In tuberculosis, an increase in monocytes (monocytosis) indicates activity in the infected area. An increase in lymphocytes (lymphocytosis) indicates healing.
- Eosinophils increase in parasitic infections and allergic conditions.

BACTERIOLOGY

LEARNING OBJECTIVE: *Recall bacteria classifications, common bacteria, and procedural steps for making smears, Gram staining, and reading and reporting smears.*

Bacteriology is the study of bacteria. Of primary interest to Hospital Corpsman is medical bacteriology, which deals with the bacteria that cause disease in man.

Bacteria are prokaryotic microorganisms of the kingdom Protista. They reproduce asexually by transverse binary fission in which the cell divides into two new cells. Bacteria are found almost everywhere, and the human body harbors vast numbers. Many bacteria are beneficial and essential to human life; only a few are harmful to man.

BACTERIA CLASSIFICATION

Since there are thousands of types of bacteria, a method of classification is essential. Bacteria are classified according to their respective

- disease-producing ability,
- growth requirements,
- morphologic characteristics,
- colonial morphology,
- toxins produced, and
- Gram’s stain reaction.

Disease-Producing Ability

The disease-producing ability of bacteria is referred to as either **pathogenic** or **nonpathogenic**. Pathogens are bacteria that cause diseases, and nonpathogens are harmless bacteria. Bacteria that are essential to our body are, in their proper environment, called common or normal flora. For example, alpha streptococcus in the throat is common flora, but when it is found elsewhere (such as in the blood stream, possibly as a result of tooth extraction), it may cause diseases such as septicemia and endocarditis.

Growth Requirements

The four growth requirements for bacteria are

- temperature,
- oxygen,
- nutrition, and
- moisture.

TEMPERATURE REQUIREMENTS.—Temperature requirements are divided into the following three categories.

- **Psychrophilic**—bacteria that reproduce best at 15°C to 20°C
- **Mesophilic**—bacteria that reproduce best at 20°C to 45°C
- **Thermophilic**—bacteria that reproduce best at 50°C to 55°C

OXYGEN REQUIREMENTS.—The amount of oxygen needed for an organism to grow or reproduce varies with the type of organism. **Aerobes** are organisms that reproduce in the presence of oxygen. **Obligate aerobes** are organisms that grow only in the

presence of free oxygen. **Anaerobes** are organisms that do not reproduce in the presence of oxygen, and **obligate anaerobes** are organisms that grow only in the absence of free oxygen and are killed if exposed to free oxygen. **Facultative organisms** are organisms that grow in the presence of free oxygen and in an oxygen-free atmosphere. **Microaerophilic organisms** are organisms that grow only in low amounts of free oxygen.

NUTRITION REQUIREMENTS.—Nutrition requirements for the various types of bacteria depends on what their particular environment provides. **Autotrophic bacteria** are self-nourishing, and **heterotrophic bacteria** are not self-sustaining.

MOISTURE REQUIREMENTS.—Moisture is indispensable for bacterial growth.

Morphologic Characteristics

The structural (or morphologic) characteristics of bacteria are based on three distinct shapes or categories:

- **Coccus** (*pl. cocci*)—spherical, appears singly, in pairs, chains, clusters, or packets.
- **Bacillus** (*pl. bacilli*)—rod-shaped, appears singly, in chains, or in palisades.
- **Spirillum** (*pl. spirilla*)—spiral-, corkscrew-, or comma-shaped, appearing singly only.

Three special structures, present on some bacteria, aid in the classification process of bacteria. The special structures are the capsule, the spore, and the flagellum. The **capsule** is a gummy, gelatinous, or mucoid structure surrounding certain bacteria. The **spore** is an inactive, resting, and resistant form produced within the organism, usually as a result of unfavorable environmental conditions. The third and final special structure is the **flagellum**, a hairlike structure that provides motility.

Colonial Morphology

A colony is a cohesive mass composed of many millions of bacterial cells, growing on or in a medium (such as blood agar, a gel enriched with blood that is used in the preparation of solid culture media for microorganisms) as a result of the multiplication and division of a single cell. The size, color, shape, edge, topography, consistency, and odor of the colony vary with each organism.

Toxins Produced

Generally, toxins produced are waste products of metabolism in a bacterial cell. Some bacteria produce toxins that attack red blood cells in a culture medium such as blood agar. Examples of toxins produced by bacteria are listed below:

- **Alpha hemolysin**—produces partial hemolysis (the disruption of the integrity of the red cell membrane causing release of hemoglobin) and changes the medium to a green color.
- **Beta hemolysin**—completely lyses the RBC, leaving a clear zone of hemolysis.
- **Endotoxin** (low potency)—comprises part of the cell wall and is released as the bacterial cell spontaneously destroys itself with self-generated enzymes (a process known as autolysis).
- **Exotoxin** (high potency)—derives from the bacteria during its growth but is found outside the bacterial cell in the surrounding medium. Exotoxins are highly poisonous, soluble, and protein in nature.

Gram's Stain Reaction

To differentiate and identify bacteria, you must make them visible by staining. The staining procedure, devised by Dr. Hans Christian Joachim Gram, stains microorganisms such as bacteria with crystal violet, treats them with 1:15 dilution of strong iodine solution, decolorizes them with ethanol or ethanol-acetone, and counterstains them with a contrasting dye, usually safranin. Microorganisms that retain the crystal violet stain (a dark blue-black color) are said to be gram-positive, and those that lose the crystal violet stain by decolorization but stain with counterstain (a deep pink or reddish color) are said to be gram-negative.

COMMON BACTERIA

Bacteria are named by genus and species. The first word (capitalized) indicates the genus; the second word (not capitalized) indicates the species, a subdivision of the genus. For example:

<u>GENUS</u>	<u>SPECIES</u>
Neisseria	gonorrhoeae

Table 7-3 will familiarize you with commonly encountered bacteria. This table lists the bacteria's morphologic shape, Gram stain response, genus and species, and the type of infection it produces.

BACTERIOLOGIC METHODS

There are a variety of methods used in the laboratory to identify bacteria. However, only a few of these bacteriologic methods can be performed in isolated duty locations or on board naval vessels. One of these methods is the smear. The smear permits healthcare personnel to examine specimens microscopically. Material requirements and the step-by-step procedures for making smears is covered in the following sections.

Smear

A smear is the procedure in which a specimen—a body fluid or a discharge—is spread across a glass slide for microscopic examination. To enhance the visualization of microorganisms on the smear, Gram staining (introduced earlier in this chapter) is used. Once the smear is stained, it is ready to be examined under the microscope. Normally, smears are examined by laboratory technicians who prepare reports of their findings.

MATERIALS REQUIRED FOR SMEAR.—To perform a smear, the following materials are required:

- Glass slide

Table 7-3.—Common Bacteria

COMMON BACTERIA			
Morphologic Shape	Gram-Positive or -Negative	Genus & Species	Type of Infection
Cocci	Positive	Streptococcus pneumoniae	Pneumonia
		Streptococcus pyogenes (Beta Streptococci Group A)	Strep throat
		Staphylococcus aureus	Boils, furuncles, osteomyelitis, pneumonia, septicemia, endocarditis, and impetigo
	Negative	Neisseria gonorrhoeae	Gonorrhea
		Neisseria meningitidis (meningococcus)	Meningitis
Bacilli	Positive	Corynebacterium diphtheriae	Diphtheria
		Clostridium (all are anaerobic and spore producers) <ul style="list-style-type: none"> • perfringens (welchii) • tetani • botulinum 	Gas gangrene Tetanus Botulism
		Yersinia (Pasteurella) pestis	Bubonic plague
	Negative	Brucella abortus	Brucellosis
		Bordetella pertussis	Whooping cough

- Microscope
- Wooden applicator stick
- Saline solution
- Forceps
- Bunsen burner

PROCEDURE FOR MAKING SMEARS.—To prepare smears for microscopic examination, follow these steps:

1. Spread the specimen with a wood applicator stick across a slide that has been cleaned with alcohol or acetone and polished with lens paper. The smear should be thin and uniformly spread. If the smear is opaque, it is too thick and should be emulsified with a drop or two of saline.
2. Label the smear and circle the material to be stained with a diamond point pen for easier identification and location of the material after staining.
3. Let the smear air dry. Do not use forced heat drying; forced drying will distort bacterial cells and other materials.
4. Hold the smear with forceps and fix the smear by passing it through a flame (smear side up) three or four times. Avoid overheating the smear; overheating will cause cellular wall destruction.
5. Let the slide cool. Once the slide is cooled, it is ready to be stained.

Gram's Stain

As previously explained, the most common staining procedure used in bacteriologic work is the Gram stain. This method yields valuable information and should be used on all smears that require staining. Gram's stain is also used for examining cultures to determine purity and for identification purposes.

PRINCIPLE OF GRAM STAINING.—As touched on previously, the crystal violet stain, the primary stain, stains everything in the smear blue. The Gram's iodine acts as a mordant, a substance that causes the crystal violet to penetrate and adhere to the gram-positive organisms. The acetone-alcohol mixture acts as the decolorizer that washes the stain away from everything in the smear except the gram-positive organisms. The safranin is the counter-stain that stains everything in the smear that has been decolorized: pus cells, mucus, and

gram-negative organisms. The gram-negative organisms will stain a much deeper pink than the pus cells and mucus will stain even lighter pink than the pus cells.

MATERIALS REQUIRED FOR GRAM STAINING.—To Gram stain a smear, the following materials are required:

- Gram stain kit, which consists of:
 - Crystal violet stain
 - Iodine or stabilized iodine (mordant)
 - Acetone-alcohol decolorizer
 - Safranin stain
- Staining rack
- Blotting paper or paper towel

PROCEDURE FOR GRAM STAINING SMEARS.—After smears have been dried, heat-fixed, and cooled, proceed as follows:

1. Place the slide on a staining rack. Then flood slide with primary stain (crystal violet). Let stand 1 minute.
2. Remove the primary stain by gently washing with cold tap water.
3. Flood the slide with mordant (iodine or stabilized iodine) and retain on slide for 1 minute.
4. Remove mordant by gently washing with tap water.
5. Tilt slide at a 45-degree angle and decolorize with the acetone-alcohol solution until the solvent that runs from the slide is colorless (30 to 60 seconds).
6. Wash the slide gently in cold tap water.
7. Flood the slide with counter-stain (safranin) and let stand for 30 to 60 seconds.
8. Wash slide with cold tap water.
9. Blot with blotting paper or paper towel or allow to air dry.
10. Examine the smear under an oil immersion objective.

Reading and Reporting Smears

Place a drop of oil on the slide and, using the oil immersion objective of the microscope, read the

smear. All body discharges contain extraneous materials, such as pus cells and mucus. Of interest, however, are the types of bacteria that may be present. The stained smear reveals only two features: the morphology and the staining characteristics of the bacteria present. Positive identification requires cultures and further studies.

Hospital Corpsmen should report only what they see. For example, “Smear shows numerous gram-negative bacilli.” If two or more types of bacteria are seen in a smear, the rule is to report them in order of predominance. For example:

- “1. Numerous gram-positive cocci in clusters
2. Few gram-negative bacilli”

Gram-positive organisms are easy to see because they stain a deep blue or blue-black. Gram-negative organisms stain a deep pink, but since the background material is also pink, minute and detailed inspection is necessary before reporting the results.

In the presence of gonorrhea, the smear will reveal large numbers of pus cells with varying numbers of intracellular and extracellular gram-negative, bean-shaped cocci in pairs. Such a finding could be considered diagnostic. It is important to point out that only a few of the thousands of pus cells on the slide may contain bacteria, and sometimes it requires considerable search to find one.

SEROLOGY

LEARNING OBJECTIVE: *Recall principles and procedures for the Rapid Plasma Reagin (RPR) Card Test and the Monosticon DRI-DOT® Slide Test.*

Serology consists of procedures by which antigens and reacting serum globulin antibodies may be measured qualitatively and quantitatively. Serologic tests have been devised to detect either antigens present or antibodies produced in a number of conditions. Most tests are based on agglutination reactions between an antigen and a specific antibody.

An **antigen** is a substance that, when introduced into an individual who does not already possess that substance, may stimulate the individual’s cells to produce specific antibodies that react to this substance in a detectable way. The five basic characteristics of an antigen are that it must be foreign to the body, it must

possess a high molecular weight, it must be structurally stable, it must be complex, and it must have a high specificity to stimulate tissues to produce a defensive protein substance called an antibody.

Antibodies are the specific defensive proteins produced when an antigen stimulates individual cells. Antibodies are produced by the host in response to the presence of an antigen and are capable of reacting with antigens in some detectable way.

The **antigen-antibody reaction** takes place when a reaction occurs between specific antibodies in the plasma and the antigen present on cell surfaces.

Principles and procedures of two serologic tests, the rapid plasma reagin (RPR) card test and the Monosticon DRI-DOT® Slide Test are covered in the following sections.

RAPID PLASMA REAGIN (RPR) CARD TEST

The RPR Card test is a sensitive, easily performed screening test for syphilis. The test is performed on unheated plasma or serum. Everything needed for the test is in a kit that is available commercially. This test kit is very useful aboard ship and at small stations.

Principle of the RPR Card Test

In the RPR Card test method of syphilis detection, a specific antigen (carbon-particle cardiophilin) detects “reagin,” a substance present in the serum of persons who are infected with syphilis. Specimens that contain reagin cause formation of particles (called flocculation) or coagulation of the carbon particles to occur on the RPR Card antigen. Reactive specimens appear as black clumps against a white background. Nonreactive specimens appear as an even, light-gray color.

Materials Required for RPR Test

To perform an RPR Card test, the following materials are required:

- Serum sample—venous blood collected in tubes without anticoagulant. **NOTE:** Use clear, unhemolyzed serum that has been separated from the blood cells as soon after collection as possible.
- RPR Card Test Kit, which consists of the following components:
 - RPR Card antigen suspension

- Plastic dispensing bottle
- 20-gauge, galvanized needle, blunt cut
- Test cards
- Pipette/stirrers, 50 microliter (μ l)
- One 1 ml tuberculin syringe
- Distilled water
- Mechanical rotator (adjusted to 100 rpm)
- RPR Card Test Control Cards (each consisting of three labeled test areas containing lyophilized (meaning a stabilized preparation of a biological substance, such as blood, that has been frozen rapidly and then dehydrated under a high vacuum) control specimens with designated patterns of reactivity: Reactive, Reactive-Minimal-to-Moderate, and Nonreactive.)

NOTE: RPR Card Test Antigen and Control Cards must be stored at 4°C when not in use. Both items are stable until the expiration date. Store “in use” antigen suspension in the dispensing bottle at 4°C. The antigen suspension is stable for 3 months or until the expiration date, whichever occurs first.

Preliminary Preparations for RPR Test

The following preliminary preparations must be performed before RPR testing can begin:

1. Remove the antigen suspension vial and one control card envelope from the refrigerator. Allow the items to warm to room temperature.
2. Resuspend the contents of the vial by vigorously shaking the antigen vial.
3. Snap the neck of the vial.
4. Attach the needle (provided in the kit) to a 1 ml tuberculin syringe. Slowly draw up into the syringe from the vial approximately 1 ml of the antigen suspension.
5. Hold the syringe perpendicular to the surface and count the number of drops dispensed from a 0.5 ml volume. Allow the drops to fall into the antigen vial. **NOTE:** The needle is accurate if 30 drops, plus or minus 1 drop, are dispensed from the 0.5 ml volume.
6. Slowly expel the remainder of the antigen solution in the syringe back into the antigen vial.

7. Remove the needle from the syringe. Place the needle on the tapered fitting of the plastic dispensing bottle (provided in the kit).
8. Slowly withdraw all the contents of the antigen vial by collapsing the dispensing bottle and using it as a suction device.
9. Allow the rotator to warm up for 5 to 10 minutes; adjust to 100 rpm.

RPR Test Procedure

To detect syphilis using the RPR Card test, follow the steps below:

1. Open the foil package and remove the control card.
2. Use a pipette/stirrer to reconstitute each control card circle with 0.5 ml of distilled water.
3. Mix solution in control card circle with pipette/stirrer until the dehydrated control specimen is dissolved. Spread specimen over entire area of circle. Use a separate pipette/stirrer for each circle.
4. Draw the patient’s sample by holding the pipette/stirrer between the thumb and forefinger near the stirring or sealed end and squeeze. Do not release pressure until the open end is below the surface of the specimen, then release pressure to draw up the sample.
5. Hold the pipette/stirrer in a vertical position, directly over the card test area where the specimen is to be delivered; squeeze pipette/stirrer, allowing 1 drop to fall onto the test area.
6. Invert the pipette/stirrer and, with the sealed end, spread specimen within the circle. Discard the pipette/stirrer when done.
7. Continue the steps above until one or two test cards are filled with patient’s samples.
8. Gently shake the antigen dispensing bottle before use. Hold the bottle in the vertical position and dispense several drops into the dispensing bottle cap to ensure the needle passage is clear. Allow 1 “free-falling” drop to fall onto each test area. Do not stir; the mixing of antigen suspension and specimen is accomplished by rotation.
9. Put the card(s) on the rotator and cover with the humidifying cover. Rotate cards for 8 minutes.

at 100 rpm. To help differentiate nonreactive from reactive results, you should briefly rotate and tilt the card by hand (3 or 4 back-and-forth motions).

10. Immediately read the card macroscopically (with the unaided eye) in the “wet” state under a high-intensity lamp.
11. Compare the patient’s tests to the controls for correct interpretations. The reactive control should show small to large clumps. The nonreactive control should show no clumping or very slight roughness. The reactive-minimal-to-moderate control should show slight but definite clumping.
12. Report the test as
 - **reactive**, if agglutination or flocculation is present, or
 - **nonreactive**, if no agglutination is present.

NOTE: The RPR Card test is used as a screen for syphilis. If a patient’s RPR is reactive, the patient should be sent to a laboratory to have a FTA-ABS (Fluorescent Treponemal Antibody Absorption Test) performed. The FTA-ABS, a more precise test, is used to confirm primary, secondary, and late syphilis.

MONOSTICON DRI-DOT SLIDE TEST

Mononucleosis imitates many diseases so well that diagnosis is confirmed only by selective serologic testing. The Monosticon DRI-DOT Slide Test is an accurate, 2-minute disposable test designed to detect the presence of infectious mononucleosis antibodies in serum, plasma, or whole blood.

Principle of the Monosticon DRI-DOT Slide Test

The Monosticon DRI-DOT Slide Test consists of specially prepared, stable sheep and/or horse erythrocyte antigen (dyed) and guinea pig antigen on a disposable slide. When serum, plasma, or whole blood is mixed with these antigens on the slide, the test result for infectious mononucleosis will be positive or negative. A positive result is indicated by agglutination and a negative result is indicated by no agglutination.

Materials Required for Monosticon DRI-DOT Slide Test

To perform the Monosticon DRI-DOT Slide Test, the following materials are required:

- Serum or plasma specimen
- Monosticon DRI-DOT Test kit, which consists of:
 - Monosticon DRI-DOT Test slides
 - Positive I.M. (infectious mononucleosis) serum control
 - Negative I.M. serum control
 - Dropper bottle
 - Dispensstirs® (designed to deliver a 0.03 ml drop)
- Distilled water
- Centrifuge
- DRI-DOT slide holder (available commercially, but not necessary to perform test)

Controls for Monosticon DRI-DOT Slide Test

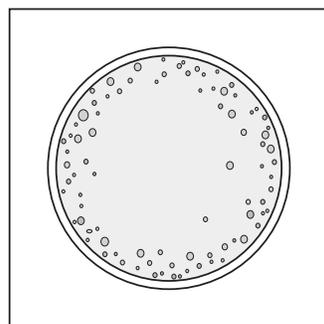
Both a positive and negative control are included in each kit to check the effectiveness of the reagents. The positive I.M. serum control (human) is a dilution of human sera (*sing.* serum) containing the specific heterophile antibody of infectious mononucleosis. The negative I.M. serum control (human) is a dilution of human sera containing no detectable antibody to infectious mononucleosis. Both controls have been dried and placed in a vial with color-coded cap and label. Since both controls are of human origin, they are potentially infectious and must be handled with care.

Both controls (positive and negative) should be tested before performing test with serum, plasma, or whole blood. Controls are prepared in the same manner as serum and plasma test described in the next section, but instead of adding serum or plasma to the slide, the control is added. Before each control is used, it must be reconstituted with 0.5 ml of distilled water. If results of the control tests are not as expected, do not use the test kit.

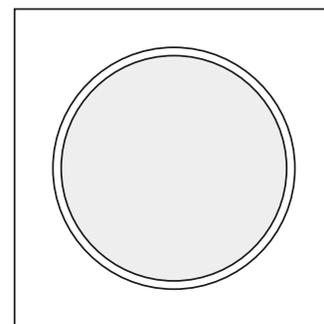
Monosticon DRI-DOT Slide Test Procedure

To detect mononucleosis using the Monosticon DRI-DOT Slide Test, follow the steps below.

1. Centrifuge the blood specimen for 10 minutes to obtain the plasma or serum to be tested.
2. Fill the dropper bottle with distilled water.
3. Remove the disposable slide by tearing the envelope where indicated. (Remove only enough slides to perform the tests at hand.)
4. Set the slide in a holder or on a flat surface.
5. Place one drop of water from the dropper bottle **next to but not on** the blue dot within the circle on the slide.
6. Use a Dispenstir to squeeze the closed end between thumb and forefinger, and place the open end into the plasma or serum to be tested. Release pressure to draw up the specimen into the Dispenstir.
7. Hold the Dispenstir perpendicularly over the buff-colored dot (guinea pig antigen) within the circle of the slide. Place one drop of specimen onto the dot.
8. Use the flared end of the Dispenstir to mix the water, specimen, and the guinea pig antigen (buff-colored dot) thoroughly.
9. Blend this mixture thoroughly with the blue dot (horse/sheep antigen).
10. Rock the slide (or slide holder) back and forth gently in a figure-8 motion for 2 minutes so that the liquid slowly flows over the entire area within the circle.
11. After 2 minutes, read the results under a strong, glaring light.



POSITIVE - AGGLUTINATION



NEGATIVE - NO AGGLUTINATION

HM3f0721

Figure 7-21.—Illustration of positive and negative Monosticon DRI-DOT Slide Test Results.

12. Report test as

- **positive**, if agglutination is present, or
- **negative**, if no agglutination is present.

See figure 7-21 for an illustration of positive and negative test results.

NOTE: A positive test result usually occurs between the fourth day and the twenty-first day of illness, and may persist for several months.

FUNGUS TEST

LEARNING OBJECTIVE: Recall how potassium hydroxide (KOH) preparation is used in the detection of fungi.

Fungi (*sing.* fungus) are chlorophyll-free, heterotrophic (not self-sustaining) of the same family of plants (i.e., Thyllophyta) as algae and lichens. They reproduce by spores that germinate into long filaments called **hyphae**. As the hyphae continue to grow and branch, they develop into a mat of growth called the mycelium (*pl.* mycelia). From the mycelium, spores are produced in characteristic patterns. These spores, when dispersed to new substances, germinate and form new growths. Reproduction is often asexual, usually by budding (as in yeast), but certain fungi have sexual reproduction.

Common superficial infections of the skin caused by fungi are athlete's foot and ringworm of the scalp.

A simple and frequently used method of detecting fungi is the **potassium hydroxide (KOH) preparation**. Fungi are seen in clustered round buds with thick walls, accompanied by fragments of

mycelia. Scrapings from the affected area of the skin are mounted in 10% KOH for positive laboratory diagnosis.

To detect fungi in infected tissue using the KOH preparation, follow the steps below.

1. Place skin, hair, or nail scrapings from the affected area on a glass slide and add one drop of 10% KOH. (Dissolve 10 g of KOH in 100 ml of distilled water.)
2. Place a coverslip on the preparation.
3. Warm the preparation gently over a flame, being careful not to boil it, and allow it to stand until clear. Do not allow the preparation to dry out.
4. Examine the preparation by using the high-power objective on microscope with subdued light.
 - Fungi on the skin and nails appear as refractile fragments of hyphae.
 - Fungi in the hair appear as dense clouds around the hair stub or as linear rows inside the hair shaft.

URINALYSIS

LEARNING OBJECTIVE: *Recall the three types of urine specimens, the methods used to preserve urine specimens, and the procedure for performing a urinalysis.*

Since the physical and chemical properties of normal urine are constant, abnormalities are easily detected. The use of simple tests provides the physician with helpful information for the diagnosis and management of many diseases.

This section deals with the three types of urine specimens, methods used to preserve urine specimens, the procedure for performing a routine and microscopic examination of urine specimens, and some of the simpler interpretations of the findings.

URINE SPECIMENS

Urine specimens for routine examinations must be collected in aseptically clean containers. Unless circumstances warrant, avoid catheterization because it may cause a urinary tract infection. Specimens of female patients are likely to be contaminated with

albumin and blood from menstrual discharge, or with albumin and pus from vaginal discharge. For bacteriologic studies, care must be taken to ensure that the external genitalia have been thoroughly cleansed with soap and water. The patient must void the initial stream of urine into the toilet or a suitable container and the remainder directly into a sterile container. All urine specimens should either be examined when freshly voided, or refrigerated to prevent decomposition of urinary constituents and to limit bacterial growth. In the following sections, we will cover three types of urine specimens: random, first morning, and 24-hour.

Random Urine Specimen

A random urine specimen is urine voided without regard to the time of day or fasting state. This sample is satisfactory for most routine urinalyses. It is the least valid specimen, since test results may reflect a particular meal or fluid intake.

First Morning Urine Specimen

The first morning urine specimen is the first urine voided upon rising. It is the best sample for routine urinalysis, because it is usually concentrated and more likely to reveal abnormalities. If positive results are obtained from the first morning specimen, the physician may order a 24-hour specimen for quantitative studies.

Twenty-Four Hour Urine Specimen

The 24-hour urine specimen measures the exact output of urine over a 24-hour period. Use the following steps to collect this specimen.

1. Have patient empty bladder early in the morning and record time. Discard this urine.
2. Collect all urine voided during next 24 hours.
3. Instruct patient to empty bladder at 0800 the following day (end of 24-hour period). Add this urine to pooled specimen.

Refrigerate specimen during collection, and, depending on the test being performed, add a preservative to the first specimen voided.

The normal daily urine volume for adults ranges from 800 to 2000 ml, averaging about 1,500 ml. The amount of urine excreted in 24 hours varies with fluid intake and the amount of water lost through perspiration, respiration, and bowel activity. Diarrhea

or profuse sweating reduces urinary output; a high-protein diet tends to increase it. Daytime urine output is normally two to four times greater than nighttime output.

PRESERVATION OF URINE SPECIMENS

To delay decomposition of urine, use the following methods of preservation:

- Refrigeration
- Preservatives
 - Hydrochloric acid
 - Boric acid
 - Glacial acetic acid

Other preservatives used include formaldehyde, toluene, and thymol. The preservative used must be identified on the label of the container. If no preservative is used, this, too, should be noted.

NOTE: Before adding a preservative to a urine specimen, contact the laboratory performing the test to find out what preservative to use and the quantity to add. Preservative requirements vary from laboratory to laboratory.

ROUTINE URINE EXAMINATION

A routine urinalysis includes the examination of physical characteristics, chemical characteristics, and microscopic structures in the sediment. A sample for urinalysis (routine and microscopic) should be at least 15 ml in volume (adult), and either a random or first morning specimen. Children may only be able to provide a small volume, but 10-15 ml is preferred.

Physical Characteristics

Physical characteristics evaluated during a routine urinalysis include color, appearance, and specific gravity.

COLOR.—The normal color of urine varies from straw to light amber. Diluted urine is generally pale; concentrated urine tends to be darker. The terms used to describe the color of urine follow.

- Colorless
- Light straw
- Straw
- Dark straw

- Light amber
- Amber
- Dark amber
- Red

The color of urine may be changed by the presence of blood, drugs, or diagnostic dyes. Examples are:

- **red or red-brown** (smokey appearance), caused by the presence of blood.
- **yellow or brown** (turning greenish with yellow foam when shaken), caused by the presence of bile.
- **olive green to brown-black**, caused by phenols (an extremely poisonous compound, used as an antimicrobial agent).
- **milky white**, caused by chyle. (Chyle, which consists of lymph and droplets of triglyceride, is a milky fluid taken up by lacteal vessels from the food in the intestine during digestion.)
- **dark orange**, caused by Pyridium® (a topical analgesic used in the treatment of urinary tract infections).
- **blue-green**, caused by methylene blue (used as a stain or dye for various diagnostic tests).

APPEARANCE.—Urine's appearance may be reported as clear, hazy, slightly cloudy, cloudy, or very cloudy. Some physicians prefer the term "turbidity" instead of "transparency," but both terms are acceptable.

Freshly passed urine is usually clear or transparent. However, urine can appear cloudy when substances such as blood, phosphates, crystals, pus, or bacteria are present. A report of transparency is of value only if the specimen is fresh. After standing, all urine becomes cloudy because of decomposition, salts, and the action of bacteria. Upon standing and cooling, all urine specimens will develop a faint cloud composed of mucus, leukocytes, and epithelial cells. This cloud settles to the bottom of the specimen container and is of no significance.

SPECIFIC GRAVITY.—The specific gravity of the specimen is the weight of the specimen compared to an equal volume of distilled water. The specific gravity varies directly with the amount of solids dissolved in the urine and normally ranges from 1.015 to 1.030 during a 24-hour period.

The first morning specimen of urine is more concentrated and will have a higher specific gravity than a specimen passed during the day. A high fluid intake may reduce the specific gravity to below 1.010. In the presence of disease, the specific gravity of a 24-hour specimen may vary from 1.001 to 1.060.

Specific gravity is measured with an index refractometer, available as standard equipment at most duty stations. See figure 7-22. The index refractometer may be held manually or mounted on a stand like a microscope. The specific gravity of urine is determined by the index of light refraction through solid material.

Measure the specific gravity with an index refractometer in the following manner:

1. Hold the index refractometer in one hand. Use the other hand and an applicator stick to place a drop of urine on the glass section beneath the coverglass.
2. Hold the refractometer so that the light reflects on the glass section, and look into the ocular end. Read the number that appears where the light and dark lines meet. This is the specific gravity.

Chemical Characteristics

Chemical characteristics evaluated during a routine urinalysis include pH, protein, glucose, ketones, and blood. Some laboratories also include tests for bilirubin, urobilinogen, and nitrite, depending on the test strip used. Currently, most medical facilities use the Multistix® and Color Chart, which detects pH, protein, glucose, ketones, blood, bilirubin, and urobilinogen. The Multistix is a specially prepared multitest strip. The strip is simply dipped into the urine specimen and compared to the color values for the various tests on the accompanying chart. The color chart also indicates numerical pH values, which should be reported.

Microscopic Examination of Urine Sediment

Microscopic examination of urine sediment is usually performed in addition to routine procedures.

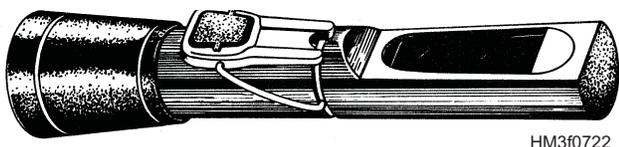


Figure 7-22.—Index refractometer.

This examination requires a degree of skill acquired through practice under the immediate supervision of an experienced technician. The specimen used for microscopic examination should be as fresh as possible. Red cells and many formed solids tend to disintegrate upon standing, particularly if the specimen is warm or alkaline.

PREPARING SPECIMENS FOR MICROSCOPIC EXAMINATION.—To prepare urine specimens for microscopic examination, follow the steps below.

1. Stir the specimen well.
2. Pour 15 ml of urine into a conical centrifuge tube, and centrifuge at 1,500 rpm for 5 minutes.
3. Invert the centrifuge tube and allow all of the excess urine to drain out. **Do not shake the tube while it is inverted.** Enough urine will remain in the tube to resuspend the sediment. Too much urine will cause dilution of the sediment, making an accurate reading difficult.
4. Resuspend the sediment by tapping the bottom of the tube.
5. With a medicine dropper, mount one drop of the suspension on a slide and cover it with a coverslip.
6. Place the slide under the microscope, and scan with the low-power objective and subdued lighting.
7. Switch to the high-power objective for detailed examination of a minimum of 10 to 15 fields.

CLINICALLY SIGNIFICANT FINDINGS.—Leukocytes, erythrocytes, and casts may all be of clinical significance when found in urine sediment.

Leukocytes.—Normally, 0 to 3 leukocytes per high-power field will be seen on microscopic examination. More than 3 cells per high-power field probably indicates disease somewhere in the urinary tract. Estimate the number of leukocytes present per high-power field and report it as the “estimated number per high-power field.”

Erythrocytes.—Red cells are not usually present in normal urine. If erythrocytes are found, estimate their number per high-power field and report it. Erythrocytes may be differentiated from white cells in several ways:

- White cells are larger than red cells.

- When focusing with the high-power lens, the red cells show a distinct circle; the white cells tend to appear granular with a visible nucleus.
- One drop of 5% acetic acid added to the urine sediment disintegrates any red cells, but it does not affect the white cells (except that the nuclei become more distinct).

Casts.—These urinary sediments are formed by coagulation of albuminous material in the kidney tubules. Casts are cylindrical and vary in diameter. The sides are parallel, and the ends are usually rounded. Casts in the urine always indicate some form of kidney disorder and should always be reported. If casts are present in large numbers, the urine is almost sure to be positive for albumin.

There are seven types of casts. They are as follows:

- **Hyaline casts** are the most frequently occurring casts in urine. Hyaline casts can be seen in even the mildest renal disease. They are colorless, homogeneous, transparent, and usually have rounded ends.
- **Red cell casts** indicate renal hematuria. Red cell casts may appear brown to almost colorless and are usually diagnostic of glomerular disease.
- **White cell casts** are present in renal infection and in noninfectious inflammation. The majority of white cells that appear in casts are hypersegmented neutrophils.
- **Granular casts** almost always indicate significant renal disease. However, granular casts may be present in the urine for a short time following strenuous exercise. Granular casts that contain fine granules may appear grey or

pale yellow in color. Granular casts that contain larger coarse granules are darker. These casts often appear black because of the density of the granules.

- **Epithelial casts** are rarely seen in urine because renal disease that primarily affects the tubules is infrequent. Epithelial casts may be arranged in parallel rows or haphazardly.
- **Waxy casts** result from the degeneration of granular casts. Waxy casts have been found in patients with severe chronic renal failure, malignant hypertension, and diabetic disease of the kidney. Waxy casts appear yellow, grey, or colorless. They frequently occur as short, broad casts, with blunt or broken ends, and often have cracked or serrated edges.
- **Fatty casts** are seen when there is fatty degeneration of the tubular epithelium, as in degenerative tubular disease. Fatty casts also result from lupus and toxic renal poisoning. A typical fatty cast contains both large and small fat droplets. The small fat droplets are yellowish-brown in color.

SUMMARY

Clinical laboratory medicine is a very dynamic field of medicine, with new testing procedures and equipment being invented all the time. The goal of this chapter is to introduce you to some basic laboratory tests that do not require state-of-the-art equipment and that can be easily performed in isolated duty stations and aboard naval vessels. These tests will assist you in establishing diagnoses and will enable you to provide the best possible medical care for your patients.

CHAPTER 8

MEDICAL ASPECTS OF CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL WARFARE

In this chapter we will discuss the history of chemical, biological, and radiological (CBR) warfare, and the recognition and treatment of CBR-produced conditions. We will also discuss the Medical Department's role in meeting the medical aspects of CBR defense, which includes protection from CBR hazards, mass casualty decontamination, decontamination stations, and supplies for decontamination. Table 8-1 provides a summary of CBR symptoms and treatments.

CHEMICAL WARFARE

LEARNING OBJECTIVE: *Select the appropriate treatment and decontamination procedure for chemical, biological, or radiological exposures.*

The use of chemical agents in warfare, frequently referred to as "gas warfare," is defined as the use of chemical agents in gaseous, solid, or liquid states to harass personnel, produce casualties, render areas impassable or untenable, or contaminate food and water. The chances of surviving a chemical attack are increased as knowledge of the nature of the agents and of the use of correct protective measures is increased.

HISTORY

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

During the interval between World Wars I and II, each of the major powers continued to develop its capability for chemical warfare, in spite of a ban by the Geneva Treaty. In isolated cases in the late 1930s, toxic chemicals were used; however, they were not used during World War II. Nor were toxic chemicals authorized for use in Korea, Vietnam, or Desert Storm.

Defoliants and riot-control agents were used with some degree of effectiveness in the jungles of Vietnam, in tunnel and perimeter-clearing operations.

DISPERSAL

Chemical agents are dispersed by modern weapons for strategic as well as tactical purposes. However, the areas of their use are limited by the range of the weapons or aircraft used by the combatant force.

A naval unit afloat finds itself in a unique situation with respect to defending against toxic chemical agents. Agents can be released as clouds of vapor or aerosol. These can envelope the exterior of a vessel and penetrate the hull of the ship. Extensive contamination can result from such an attack, and the ship must be decontaminated while the personnel manning it continue to eat, sleep, live, and fight on board.

To properly meet the medical needs of the ship, the medical officer or Hospital Corpsman on independent duty must organize the Medical Department well in advance of the actual threat of a chemical agent attack. All hands must be indoctrinated in the use of protective equipment and self-aid procedures, and close liaison and planning must be maintained with damage control personnel responsible for area decontamination.

SELF-PROTECTION AND TREATMENT

In a chemical attack, the first priority is to ensure your own survival so that you may then treat casualties. There are several items available to help you survive a chemical attack, and you should know how to use them. Along with protective clothing, there is a protective mask, which should be put on at the first indication of a chemical attack. The mask will filter out all known chemical agents from the air and allow you to work in a chemically contaminated area. A chemical agent on the skin can be removed effectively by using the M291 skin decontamination kit (fig. 8-1). The M291 skin decontamination kit replaces the M258A1 (fig. 8-2). Upon receipt of the M291, discontinue use of the M258A1.

Table 8-1.—Summary of CBR Agents, Effects, and Treatment

TYPE OF AGENT	PHYSICAL CHARACTERISTICS	SYMPTOMS IN MAN	EFFECTS ON MAN	RATE OF ACTION	PERSONNEL DECONTAMINATION	TREATMENT
NERVE AGENT Tabun (GA) Sarin (GB) Soman (GD) VX	Colorless to light brown liquid Odorless to faint sweetish or fruity vapor Tasteless	Miosis, rhinorrhea, dimmed vision, salivation, nausea, abdominal cramping, increased bronchial secretions, dyspnea, pulmonary edema, headache, vertigo	Incapacitates; kills if high concentrations are inhaled or if contaminated skin is not decontaminated in time.	Very rapid with inhalation Slow through the skin.	None for aerosols or vapors. Flush eyes with water. Wash skin with soap and water, or use skin pad from M-13 kit; M-5 kit for VX.	Atropine IM or IV Artificial ventilation Oximes (2-PAM Cl) as adjunct to atropine
VESICANTS Mustard (HD) Nitrogen Mustard (HN) Lewisite (L) Phosgene Oxime (CX)	Odor of garlic or horseradish (HD) None to slightly fishy odor (HN) Fruity or odor of geranium (L) Disagreeable (CX) Colorless to dark brown liquid Vapors not usually visible	Lacrimation, eye pain, photophobia, cough, respiratory irritation, abdominal pain, nausea, vomiting, diarrhea Skin erythema and itching, headache	Generally nonlethal. Blisters skin, is destructive to upper respiratory tract; can cause temporary blindness. Some agents sting and form welts on skin, and others sear eyes.	Mustards: delayed effect Arsenicals and CX: rapid and intense	Remove contaminated clothing, wash skin with soap and water, or use M-5 ointment or M-13 kit.	Analgesics, sterile dressings, antibiotics, and treat for shock. For arsenicals, BAL in oil IM. For CX, sodium bicarbonate dressings.
BLOOD AGENTS Hydrocyanic acid (AC) Cyanogen chloride (CK)	Colorless gas Faint bitter almond odor (AC) Irritating odor (CK)	Increased respiration followed by dyspnea, nausea, vertigo, headache, convulsions, and coma	Inhibits cytochrome oxidase. Incapacitates; lethal if high concentrations are inhaled.	Rapid	None needed.	Amyl nitrate ampules Artificial respiration Sodium thiosulfate/sodium nitrite IV
CHOKING AGENTS Phosgene (CG)	Colorless gas odor of corn, grass, or new mown hay	Coughing, choking, tightness in chest, nausea, and headache	Lethal. Floods lungs, causes pulmonary edema	Immediate to 3 hours	None needed.	Rest, oxygen, antibiotics
VOMITING AGENTS Adamsite (DM)	Yellow or white to nonvisible gas Odor of burning fireworks	Pepperlike irritation of upper respiratory tract and eyes with lacrimation Uncontrolled sneezing and coughing and excessive salivation	Incapacitates. Local irritant.	Immediate	None needed.	Supportive Chloroform inhalation for symptomatic relief Physical exercise shortens duration and speeds recovery Recovery spontaneous
INCAPACITATING AGENTS BZ	Odorless, colorless, tasteless	Unpredictable, irrational behavior; may be accompanied by coughing, nausea, vomiting, and headache. Dilation of pupils.	Temporarily incapacitates, mentally and physically. Anticholinergic. Psychotropic.	Delayed	Wash with soap and water.	Observation and physical restraint if indicated Physostigmine salicylate 2-3 mg IM every 1-2 hours for duration of symptoms
IRRITANTS Riot control agents CS, CN, CR, CA	Colorless to white vapor Pepperlike odor	Immediate lacrimation Coughing Skin irritation	Incapacitating. Local irritant.	Instantaneous	None needed.	Removal to fresh air
BIOLOGICAL AGENTS	Microscopic live organisms	Variable, depending on agent and resistance of victim	Lethal or incapacitating, depending on agent.	Delayed for days or longer	Wash with soap and water.	Variable, specific if agent is known Supportive
NUCLEAR BURST	Bright intense flash of light Heat, wind, shock wave Earth tremors	Temporary blindness Thermal burns Radiation burns Physical injuries	Blast destruction. Radiation sickness.	Immediate for blast Delayed for radiation	Wash with soap and water. Shower. Monitor.	Immediate decontamination Treatment of physical injuries Antibiotics for radiation exposure



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Figure 8-1.—M291 skin decontamination kit.

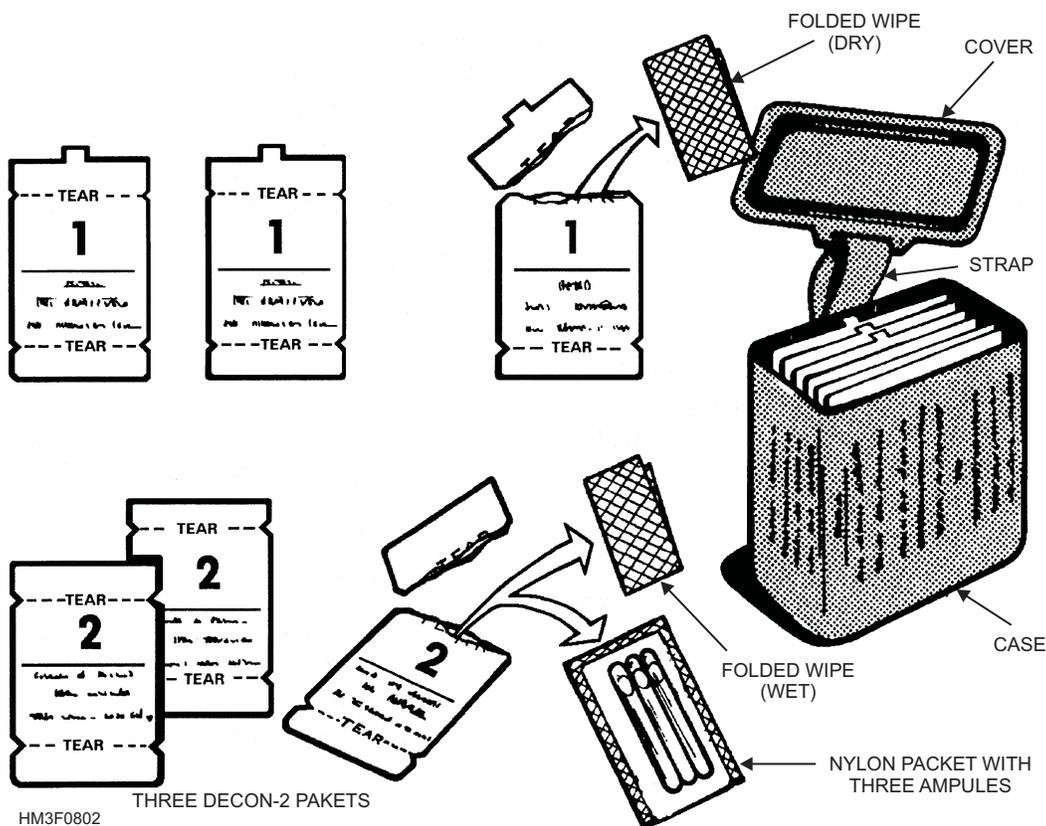


Figure 8-2.—M258A1 skin decontamination kit.

Chemical agents penetrate ordinary clothing rapidly. However, significant absorption through the skin requires a period of minutes. The effects of clothing penetration may be reduced by quickly removing the contaminated clothing and neutralizing the chemical agent on the skin by washing, blotting, or wiping it away.

Prompt decontamination (decon) of the skin is imperative. Decon of chemical agents on the skin within

1 minute after contamination is perhaps 10 times more effective than if decontamination is delayed 5 minutes. Detailed instructions on the use of skin decontamination kits can be found in the NAVMED P-5041, *Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries*, and in the kits themselves.

Finally, there are two types of antidote autoinjectors—atropine and 2-PAM Cl—for your own

use if you become a nerve-agent casualty. The autoinjectors will be discussed later in this chapter. Familiarize yourself with your equipment. Know how it works before you need it.

DECONTAMINATION

The guiding principle in personnel decontamination is to avoid spreading contamination to clean areas and to manage casualties without aggravating other injuries.

Casualty Priorities

It will often be necessary to decide whether to handle the surgical condition or the chemical hazard first. If the situation and the condition of the casualty permit, decontamination should be carried out first. The longer the chemical remains on the body, the more

severe will be the danger of spreading the chemical to other personnel and equipment.

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

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

The basic steps in sorting and handling casualties are indicated in figure 8-3. This plan should be modified to fit specific needs.

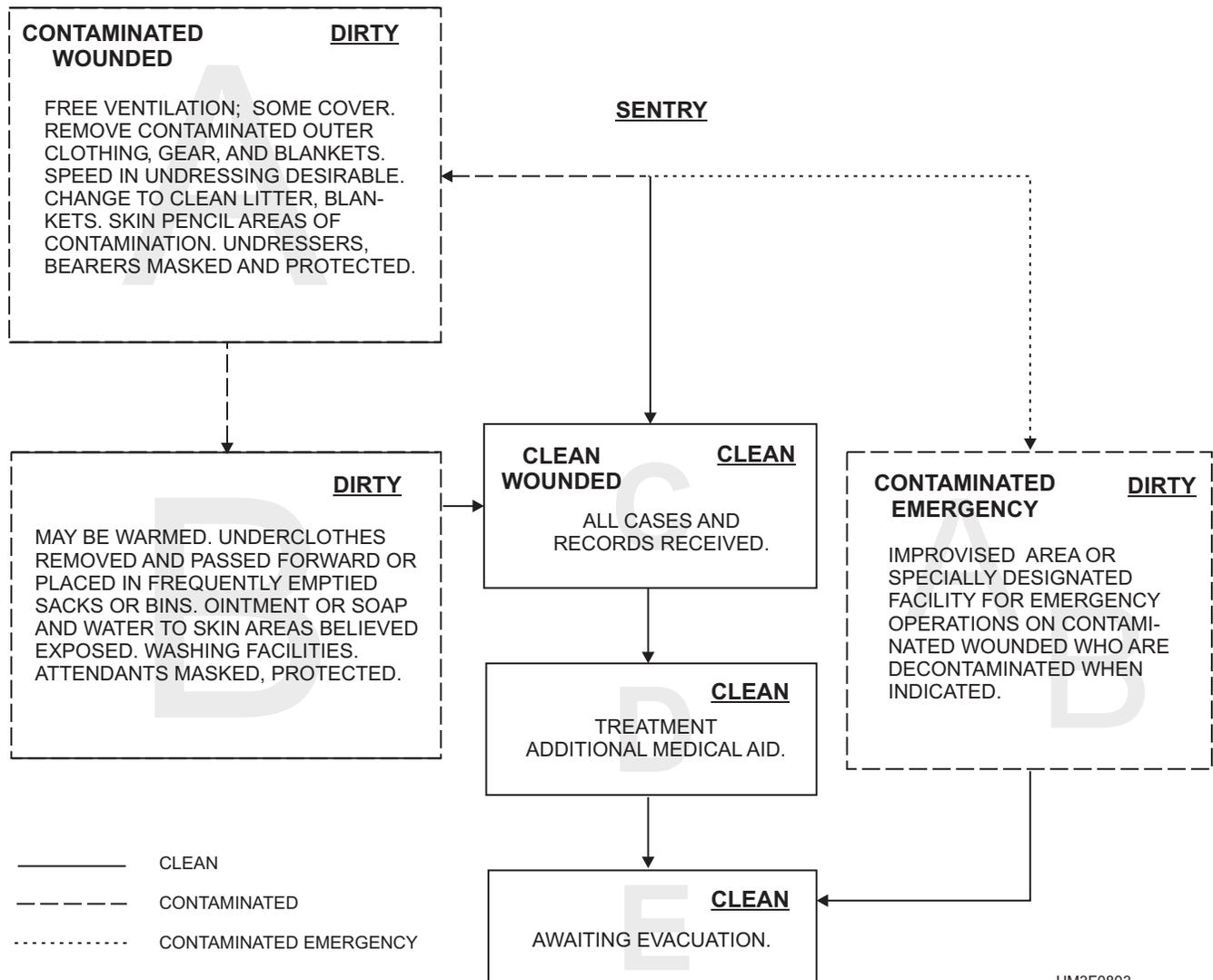


Figure 8-3.—Basic steps in sorting and handling casualties.

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Decontamination Station Organization

In general, the decontamination station, or “dirty” area, receives casualties contaminated with a chemical agent. The arrangement of this area will vary with the site of the medical unit and the facilities available for decontamination.

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

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

Handling of Contaminated Casualties

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

Supplies

The Medical Officer or Senior Medical Department Representative (SMDR) is responsible for maintaining adequate supplies for decontamination and treatment of CBR casualties. Medical decontamination supplies are supplied to ships on a personnel-strength basis, as listed in current Authorized Medical Allowance List (AMAL).

The decontamination supply cabinets will be kept locked, and the keys will be in custody of the Damage Control Assistant (DCA). Cabinets and chests will be stenciled with a red cross and marked “DECONTAMINATION MEDICAL SUPPLIES.”

CHEMICAL AGENTS

Chemical agents are grouped under several classifications. The broadest classification we will use

is based on the general effect produced (i.e., severe casualty, harassment, or incapacitation). Within each general group, there are further breakdowns, the most convenient of which (from a medical point of view) is the classification by physiologic effect. Chemical agents may also be classified as lethal or nonlethal. Nonlethal agents will not kill you. Lethal agents are those that result in a 10 percent or greater death rate among casualties. They are further classified as persistent or nonpersistent, depending on the length of time they retain their effectiveness after dissemination.

In the following paragraphs, we discuss the agents that produce the greatest number of fatalities and casualties among personnel who have been exposed to them.

Nerve Agents

Nerve agents produce their effect by interfering with normal transmission of nerve impulses in the parasympathetic autonomic nervous system. Physically, nerve agents are odorless, almost colorless liquids, varying greatly in viscosity and volatility. They are moderately soluble in water and fairly stable unless strong alkali or chlorinating compounds are added. They are very effective solvents, readily penetrating cloth either as a liquid or vapor. Other materials, including leather and wood, are fairly well penetrated. Butyl rubber and synthetics, such as polyesters, are much more resistant.

Pharmacologically, the nerve agents are cholinesterase inhibitors (interfering with normal transmission of nerve impulses in the parasympathetic autonomic nervous system). Their reaction with cholinesterase tends to be irreversible, and reaction time varies with the agent.

SIGNS AND SYMPTOMS OF EXPOSURE.—

Nerve-agent intoxication can be readily identified by its characteristic signs and symptoms. If a vapor exposure has occurred, the pupils will constrict, usually to a pinpoint. If the exposure has been through the skin, there will be local muscular twitching where the agent was absorbed. Other symptoms will include rhinorrhea, dyspnea, diarrhea and vomiting, convulsions, hypersalivation, drowsiness, coma, and unconsciousness.

TREATMENT.—Specific therapy for nerve agent casualties is atropine, an acetylcholine blocker. **When exposed**, each member of the Navy and Marine Corps is issued three 2 mg autoinjectors of atropine and three 600 mg autoinjectors of 2-PAM Cl. **DO**

NOT give nerve agent antidotes for preventive purposes **before** contemplated exposure to a nerve agent.

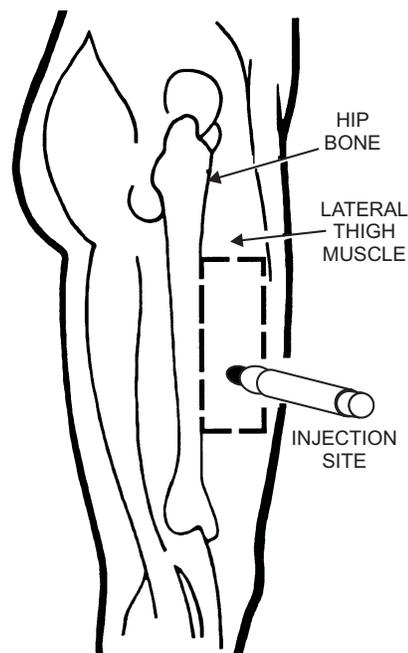
The atropine autoinjector consists of a hard plastic tube containing 2 mg (0.7 ml) of atropine in solution for intramuscular injection. It has a pressure-activated coiled-spring mechanism that triggers the needle for injection of the antidote solution. These injectors are designed to be used by individuals on themselves when symptoms appear. For medical personnel, the required therapy is to continue to administer atropine at 15-minute intervals until a mild atropinization occurs. This can be noted by tachycardia and a dry mouth. Atropine alone will not relieve any respiratory muscle failure. Prolonged artificial respiration may be necessary to sustain life.

A second autoinjector containing oxime therapy (using pralidoxime chloride, or 2-PAM Cl) can also be used for regeneration of the blocked cholinesterase. Since 2-PAM Cl is contained in the kit of autoinjectors, additional oxime therapy is not generally medically recommended for those who have already received treatment by autoinjection. The 2-PAM Cl autoinjector is a hard plastic tube that, when activated, dispenses 600 mg of 2-PAM Cl (300 mg/ml) solution. It also has a pressure-activated coiled-spring mechanism identical to that in the atropine autoinjector.

Self-Aid.—If you experience the **mild** symptoms of nerve-agent poisoning, you should **IMMEDIATELY** hold your breath and put on your protective mask. Then, administer **one set** of (atropine and 2-PAM Cl) injections into your lateral thigh muscle or buttocks, as illustrated in figures 8-4 and 8-5. Position the needle end of the **atropine** injector against the injection site and apply firm, even pressure (not jabbing motion) to the injector until it pushes the needle into your thigh (or buttocks). Make sure you **do not** hit any buttons or other objects. Using a jabbing motion may result in an improper injection or injury to the thigh or buttocks.

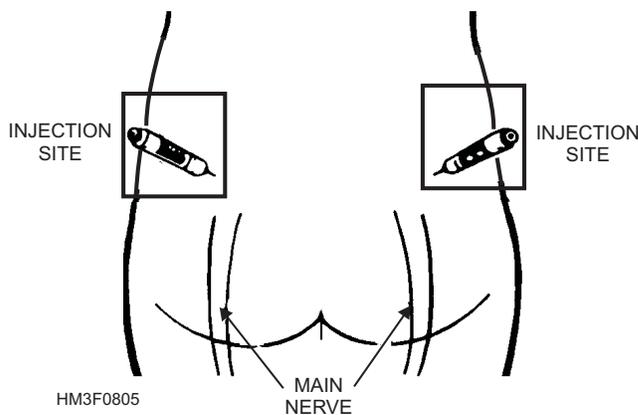
Hold the **atropine** injector firmly in place for **at least 10 seconds**. The seconds can be estimated by counting “one thousand one, one thousand two,” and so forth. Firm pressure automatically triggers the coiled mechanism and plunges the needle through the clothing into the muscle and at the same time injects the atropine antidote into the muscle tissue.

Next, inject yourself in the same manner with the **2-PAM Cl** injector, using the same procedure as you



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Figure 8-4.—Thigh injection site.



HM3F0805

Figure 8-5.—Buttocks injection site.

did for the atropine. This will now complete one set of nerve-agent antidotes. Attach the used injectors to your clothing (fig. 8-6) (to indicate the number of injections you have already received).

After administering the first set of injections, wait 10 to 15 minutes (since it takes that long for the antidote to take effect) before administering a second set, if needed. If the symptoms have not disappeared within 10 to 15 minutes, give yourself the second set of injections. If the symptoms still persist after an additional 15 minutes, a third set of injections may be given by nonmedical personnel.

After administering each set of injections, you should decontaminate your skin, if necessary, and put on any remaining protective clothing.

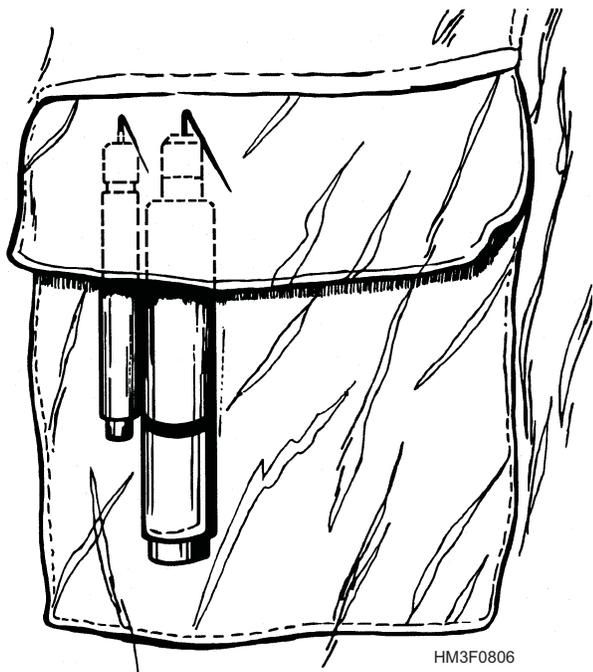


Figure 8-6.—One set of used autoinjectors attached to a pocket flap.

Buddy Aid.—If you encounter a service member suffering from severe signs of nerve-agent poisoning, you should provide the following aid:

- Mark the casualty, if necessary. Do not fasten the hood.
- Administer, in rapid succession, **three** sets of the nerve-agent antidotes. Follow the procedures for administration as described previously in the self-aid section.

NOTE: Use the casualty's own autoinjectors when providing aid. Do not use your injectors on a casualty. If you do, you may not have any antidote available when needed for self-aid.

Blister Agents (Vesicants)

Blister agents, or vesicants, exert their primary action on the skin, producing large and painful blisters that are incapacitating. Although vesicants are classed as nonlethal, high doses can cause death.

Common blister agents include mustard (HD), nitrogen mustard (HN), and Lewisite (L). Each is chemically different and will cause significant specific symptoms. They are all similar in their physical characteristics and toxicology. Mustards are particularly insidious because they do not manifest their symptoms for several hours after exposure. They attack the eyes and respiratory tract as well as the skin.

There is no effective therapy for mustard once its effects become visible. Treatment is largely supportive: to relieve itching and pain, and to prevent infection.

MUSTARD (HD) AND NITROGEN MUSTARD (HN).—HD and HN are oily, colorless or pale yellow liquids, sparingly soluble in water. HN is less volatile and more persistent than HD but has the same blistering qualities.

Signs and Symptoms of Exposure.—The eyes are the most vulnerable part of the body to mustard gas. Contamination insufficient to cause injury elsewhere may produce eye inflammation. Because the eye is the most sensitive part of the body, the first noticeable symptoms of mustard exposure will be pain and a gritting feeling in the eyes, accompanied by spastic blinking of the eyelids and photophobia. Vapor or liquid may burn any area of the skin, but the burns will be most severe in the warm, sweaty areas of the body: the armpits, groin, and on the face and neck. Blistering begins in about 12 hours but may be delayed for up to 48 hours. Inhalation of the gas is followed in a few hours by irritation of the throat, hoarseness, and a cough. Fever, moist rales, and dyspnea may develop. Brochopneumonia is a frequent complication. The primary cause of death is massive edema or mechanical pulmonary obstruction.

Treatment.—There is no specific antidotal treatment for mustard poisoning. Physically removing as much of the mustard as possible, as soon as possible, is the only effective method for mitigating symptoms before they appear. All other treatment is symptomatic, that is, the relief of pain and itching, and control of infection.

LEWISITE (L).—Lewisite is an **arsenical** (an arsenic-based compound). This blistering compound is a light- to dark-brown liquid that vaporizes slowly.

Signs and Symptoms of Exposure.—The vapors of arsenicals are so irritating that conscious persons are immediately warned by discomfort to put on the mask. No severe respiratory injuries are likely to occur, except in the wounded who are incapable of donning a mask. The respiratory symptoms are similar to those produced by mustard gas. While distilled mustard and nitrogen mustard cause no pain on the skin during absorption, Lewisite causes intense pain upon contact.

Treatment.—Immediately decontaminate the eyes by flushing with copious amounts of water to remove liquid agents and to prevent severe burns. Sodium sulfacetamide, 30 percent solution, may be

used to combat eye infection within the first 24 hours after exposure. In severe cases, morphine may be given to relieve pain.

In cases of systemic involvement, British Anti-Lewisite (BAL), dimercaprol, is available in a peanut oil suspension for injection. BAL is a specific antiarsenical that combines with the heavy metal to form a water-soluble, nontoxic complex that is excreted. However, BAL is somewhat toxic, and an injection of more than 3 mg/kg will cause severe symptoms.

Aside from the use of dimercaprol for the systemic effects of arsenic, treatment is the same as for mustard lesions.

Blood Agents

Blood agents interfere with enzyme functions in the body, i.e., block oxygen transfer. Hydrocyanic acid (AC) and cyanogen chloride (CK) are cyanide-containing compounds commonly referred to as blood agents. These blood agents are chemicals that are in a gaseous state at normal temperatures and pressures. They are systemic poisons and casualty-producing agents that interfere with vital enzyme systems of the body. They can cause death in a very short time after exposure by interfering with oxygen transfer in the blood. Although very deadly, they are nonpersistent agents.

SIGNS AND SYMPTOMS OF EXPOSURE.—

These vary with concentration and duration of exposure. Typically, either death or recovery takes place rapidly. After exposure to high concentrations of the gas, there is a forceful increase in the depth of respiration for a few seconds, violent convulsions after 20 to 30 seconds, and respiratory failure with cessation of heart action within a few minutes.

TREATMENT.—There are two suggested antidotes in the treatment of cyanides: amyl nitrite in crush ampules (provided as first aid) and intravenous sodium thiosulfate solution.

In an attack, if you notice sudden stimulation of breathing or an almond-like odor, hold your breath and don your mask immediately. In treating a victim, upon notification by competent authority that there are no blood agents remaining in the atmosphere, crush two ampules of amyl nitrite in the hollow of your hand and hold it close to the victim's nose. You may repeat this procedure every few minutes until eight ampules have been used. If the atmosphere is contaminated and the

victim must remain masked, insert the crushed ampules into the mask under the face plate.

Whether amyl nitrite is used or not, sodium thiosulfate therapy is required after the initial lifesaving measures. The required dose is 100 to 200 mg/kg, given intravenously over a 9-minute period.

The key to successful cyanide therapy is speed; cyanide acts rapidly on an essential enzyme system. The antidotes act rapidly to reverse this action. If the specific antidote and artificial respiration are given soon enough, the chance of survival is greatly enhanced.

Choking or Lung Agents

The toxicity of lung agents is due to their effect on lung tissues; they cause extensive damage to alveolar tissue, resulting in severe pulmonary edema. This group includes phosgene (CG) and chlorine (Cl), as well as chloropicrin and diphosgene. However, CG is most likely to be encountered, and its toxic action is representative of the group.

Phosgene is a colorless gas with a distinctive odor similar to that of new-mown hay or freshly cut grass. Unfortunately, even at minimal concentrations in the air (i.e., below the threshold of olfactory perception), CG can cause damage to the eyes and throat. Generally speaking, CG does not represent a hazard of long duration; therefore, an individual exposed to a casualty-producing amount should be able to smell it.

SIGNS AND SYMPTOMS OF EXPOSURE.—

There may be watering of the eyes, coughing, and a feeling of tightness in the chest. More often, however, there will be no symptoms for 2 to 6 hours after exposure. Latent symptoms are rapid, shallow, and labored breathing; painful cough; cyanosis; frothy sputum; clammy skin; rapid, feeble pulse; and low blood pressure. Shock may develop, followed by death.

TREATMENT.—Once symptoms appear, complete bed rest is mandatory. Keep victims with lung edema only moderately warm, and treat the resulting anoxia with oxygen. Because no specific treatment for CG poisoning is known, treatment has to be symptomatic.

Incapacitating Agents

Incapacitating agents, which are mainly comprised of psychochemicals, produce mental confusion and an inability to function intelligently.

The psychochemicals temporarily prevent an individual from carrying out assigned actions. These agents may be administered by contaminating food or water, or they may be released as aerosols. The following are characteristics of the incapacitants:

- High potency (i.e., an extremely low dose is effective) and logistic feasibility
- Effects produced mainly by altering or disrupting the higher regulatory activity of the central nervous system
- Duration of action comprising hours or days, rather than momentary or transient action
- No permanent injury produced

SIGNS AND SYMPTOMS OF EXPOSURE.—

The first symptoms appear in 30 minutes to several hours and may persist for several days. Abnormal, inappropriate behavior may be the only sign of intoxication. Those affected may make irrational statements and have delusions or hallucinations. In some instances, the victim may complain of dizziness, muscular incoordination, dry mouth, and difficulty in swallowing.

The standard incapacitant in the United States is 3-quinuclidinyl benzilate (BZ), a cholinergic blocking agent, which is effective in producing delirium that may last several days. In small doses it will cause an increase in heart rate, pupil size, and skin temperature, as well as drowsiness, dry skin, and a decrease in alertness. As the dose is increased to higher levels, there is a progressive deterioration of mental capability, ending in stupor.

TREATMENT.—The first aid is to prevent victims from injuring themselves and others during the toxic psychosis. Generally, there is no specific therapy for this type intoxication. However, with BZ and other agents in the class of compounds known as glycolates, physostigmine is the drug treatment of choice. It is not effective during the first 4 hours following exposure; after that, it is very effective as long as treatment is continued. However, treatment does not shorten the duration of BZ intoxication, and premature discontinuation of therapy will result in relapse.

Riot-Control/Harassment Agents

“Riot-control agents” is the collective term used to describe a collection of chemical compounds, all having similar characteristics which, though relatively nontoxic, produce an immediate but temporary effect

in very low concentrations. These agents are used to harass enemy personnel or to discourage riot actions. Generally, patients require no therapy; removal from the environment is sufficient to effect recovery in a short time.

There are two classes of riot-control/harassment agents: lacrimators and vomiting agents.

LACRIMATORS.—Lacrimators (or tear gases) are essentially local irritants that act primarily on the eyes. In high concentrations, they also irritate the respiratory tract and the skin. The principal agents used are chloracetophenone (CN) and orthochlorobenzilidene malanonitrile (CS). Although CS is basically a lacrimator, it is considerably more potent than CN and causes more severe respiratory symptoms. CN is the standard training agent and is the tear gas most commonly encountered because it is not as potent. CS is more widely used by the military as a riot-control agent.

Protection against all tear agents is provided by protective masks and ordinary field clothing secured at the neck, wrists, and ankles. Personnel handling CS should wear rubber gloves for additional protection.

Signs and Symptoms of Exposure.—

Lacrimators produce intense pain in the eyes with excessive tearing. The symptoms following the most severe exposure to vapors seldom last over 2 hours. After moderate exposure, they last only a few minutes.

Treatment.—First aid for lacrimators is generally not necessary. Exposure to fresh air and letting wind blow into wide open eyes, held open if necessary, is sufficient for recovery in a short time. Any chest discomfort after CS exposure can be relieved by talking.

An important point to remember is that this material adheres tenaciously to clothing, and a change of clothing may be necessary. Do not forget the hair (both head and facial) as a potential source of recontamination.

VOMITING AGENTS.—Vomiting agents comprise the second class of agents in the riot-control category. The principal agents of this group are diphenylaminochloroarsine (Adamsite (DM)), diphenylchloroarsine (DA), and diphenylcyanoarsine (DC). They are used as training and riot-control agents. They are dispersed as aerosols and produce their effects by inhalation or by direct action on the eyes. All of these agents have similar properties and pathology.

Signs and Symptoms of Exposure.—Vomiting agents produce a strong pepper-like irritation in the upper respiratory tract, with irritation of the eyes and lacrimation. They cause violent uncontrollable sneezing, coughing, nausea, vomiting, and a general feeling of malaise. Inhalation causes a burning sensation in the nose and throat, hypersalivation, and rhinorrhea. The sinuses fill rapidly and cause a violent frontal headache.

Treatment.—It is of the utmost importance that the mask be worn in spite of coughing, sneezing, salivation, and nausea. If the mask is put on following exposure, symptoms will increase for several minutes in spite of adequate protection. As a consequence, victims may believe the mask is ineffective and remove it, further exposing themselves. While the mask must be worn, it may be lifted from the face briefly, if necessary, to permit vomiting or to drain saliva from the face piece. Carry on duties as vigorously as possible. This will help to lessen and shorten the symptoms. Combat duties usually can be performed in spite of the effects of vomiting agents if an individual is motivated.

First aid consists of washing the skin and rinsing the eyes and mouth with water. A mild analgesic may be given to relieve headache. Recovery is usually spontaneous and complete within 1 to 3 hours.

SCREENING SMOKES.—Screening smokes fit in with riot-control agents. Their primary use is to obscure vision and to hide targets or areas. When used for this purpose outdoors, they are not generally considered toxic. However, exposure to heavy smoke concentration for extended periods, particularly near the source, may cause illness or death. Under no circumstances should smoke munitions be activated indoors or in closed compartments.

Symptomatic treatment of medical problems or discomfort resulting from exposure to screening smokes will generally suffice.

WHITE PHOSPHORUS.—White phosphorus (WP) is a pale, waxy solid that ignites spontaneously on contact with air to give a hot, dense, white smoke composed of phosphorus pentoxide particles. While field concentrations of the smoke may cause temporary irritation to the eyes, nose, and throat, casualties from the smoke have not occurred in combat operations. No treatment is necessary, and spontaneous recovery is rapid once the patient is removed from the WP source.

White phosphorus smoke not only creates an obscuring smoke, but it also has a secondary effect upon personnel if it contacts the skin. When burning particles of WP embed in the skin, they must be covered with water, a wet cloth, or mud. A freshly mixed 0.5 percent solution of copper sulfate (which produces an airproof black coating of copper phosphide) may be used as a rinse but must not be used as a dressing. The phosphorus particles must be removed surgically.

BIOLOGICAL WARFARE

Epidemics arising from natural causes have plagued military forces for centuries and in many instances have determined the outcome of campaigns. Recognition of this drain on personnel undoubtedly has led to attempts to produce illness in epidemic proportions, through pollution of water and food supplies as well as through other means. The dissemination of disease-producing organisms has never been employed on any significant scale as a weapon of war.

HISTORY

Biological warfare has become a very real possibility since World War II because of the advance of knowledge in the various biological science fields. Many countries have indulged in research on the use of microorganisms as a weapon of war, and in the hands of an unscrupulous enemy, antianimal and antiplant agents could be powerful instruments of war, reducing or destroying a nation's food supply. In this chapter, however, we are concerned only with agents that would be effective against populations. Although their effectiveness has never been established by actual use in war, they are considered to have grave military capabilities.

DISPERSAL

Biological warfare has certain aspects in common with chemical warfare in that biological agents can be dispersed in the air and travel downwind in the same manner as a gas cloud. These agents may be inhaled unless a protective mask is worn, and they may cause disability or death. They are capable of contaminating clothing, equipment, food, and water supplies. Some types of agents may persist in the target area for considerable periods of time.

Biological agents, unlike most war gases or vapors, cannot be detected by the physical senses or by chemical detectors. Their presence or identity can be determined only by laboratory examination of air samples or contaminated objects. The time between exposure and onset of disease symptoms will usually be a matter of days rather than hours, as is the case with most chemical agents. Though they may be exposed to the same dosage of biological agent, not all personnel will be affected the same way. Some may become seriously ill, while others may have a very mild attack. Still others may escape the disease entirely.

PROTECTION

In this section, we will discuss both individual and group protection, as well as the methods of protecting food and water supplies.

Individual Protection

The natural resistance of the body and its maintenance in the best possible physical condition constitute important lines of defense against biological agents. Immunity and good health alone, however, cannot be expected to triumph over massive onslaughts of biological agents. These agents may have been tailored to create varying degrees of incapacitation, including death. To reduce the effectiveness of such attacks, the military provides protective equipment and a series of protocols to its members. In general, these measures closely parallel those provided for defense against chemical attack.

PORTALS OF ENTRY.—Inhalation of airborne organisms is considered the greatest potential hazard in biological warfare. The protective mask is an important piece of defensive equipment. A mask that is in good condition and has been properly fitted will greatly reduce the possibility of your inhaling infectious material. Since you cannot detect the presence of biological agents, the use of the mask and other protective equipment will depend upon early warning.

To produce disease, biological agents must gain entrance into the body. A concentration of biological agents on the skin might, in time, be transferred to a portal of entry. Any type of clothing will provide some protection by reducing the quantity of agents coming in contact with the skin. The degree of protection afforded is dependent upon how well the fabric stops penetration and the number of layers of clothing being worn. Since this protective effect is due to the

mechanical filtering or screening action of the cloth, it is important that shirt and jacket collars be fastened. Sleeves should be rolled down and cuffs buttoned, trouser cuffs stuffed inside tops of boots or socks, and all other garment openings tied or otherwise secured. Following this procedure will minimize the entry of airborne organisms and reduce the risk of bodily contact with biological agents that may be present on the surface of the ground or in the air.

EQUIPMENT AND ACTION.—Military headgear helps safeguard the hair from heavy contamination, and ordinary gloves or mittens provide protection for the hands. The type of clothing issued for protection against chemical agents is impregnated with an impermeable barrier and provides a higher degree of protection than the ordinary uniform. Whenever it is available, it should be used.

Upon notification of an attack with biological agents, or before entering an area known to be contaminated by them, the following steps should be taken:

1. Put on protective mask and check it for correct fit.
2. Button clothing. Tie clothing at wrists and ankles with string or extra shoelaces. Put on special protective clothing, if available.
3. Put on gloves, if available.
4. While in the contaminated area, maintain the provisions outlined above.

Upon leaving the area, proceed with decontamination measures to the extent the situation permits.

Group Protection

In biological as well as chemical and radiological warfare, a tightly constructed shelter offers great protection. The shelter must be pressurized to prevent entrance of the microorganisms. Pressurization is accomplished by introducing filtered air into the shelter. If the shelter is reasonably tight, this incoming air will force exhausted and/or contaminated air outward. Nonpressurized buildings, shelters, or field fortifications provide only limited protection from aerosols. Eventually, microorganisms will penetrate through cracks, creating a respiratory hazard requiring the use of a protective mask. As in the case of other protective equipment, the sooner a shelter is used following contamination, the more effective the shelter will be in arresting or staying in contact with biological agents.

Protection of Food and Water

Food and water supplies are especially susceptible to deliberate contamination. Civilian supplies—which all too frequently do not receive careful supervision and protection—must always be suspected of accidental or deliberate contamination. It should also be emphasized that water is not necessarily pure just because it comes from a faucet. In some countries pure water is the exception rather than the rule. The safest rule is to consume only food and drinks received from military sources. Procedures for protection of the water supply and routines for inspection and decontamination are well defined in the military and, if diligently observed, will protect from deliberate contamination.

FOOD.—In the event of a known or suspected biological attack, all exposed or unpackaged foods not in critical supply should be destroyed. In most instances, food can be rendered safe for consumption by application of moist-heat cooking procedures. In some instances, deep-fat cooking is adequate. Some foods, however, cannot be sterilized because the treatment would render them unacceptable for consumption.

WATER.—Chlorination is by far the almost universal method of purifying water, and it destroys most of the biological agents. Boiling may be required to ensure proper decontamination in exceptional cases.

The military establishes water points in the field whenever possible. The equipment location at these points provides for filtration as well as chlorination and, when properly operated, is effective in removing organisms that produce disease. Some biological agents cannot be destroyed by normal water-purification techniques. When biological agents are known to have been used, all drinking water must be boiled. In the preparation of water for large numbers, the boiling procedure should be supervised. Water boiling may, of necessity, become an individual responsibility and may be so directed.

For small groups of people, the Lyster bag is provided as a suitable container for the storage of water that has already been treated. Water that has not been made potable previously is purified in the Lyster bag by means of chemicals. Water purification procedures are discussed in detail in the *Preventive Medicine Manual*, NAVMED P-5010.

DECONTAMINATION

Personal decontamination following actual or suspected exposure to biological agents will depend upon the existing tactical situation and the facilities available. If the situation permits, contaminated clothing should be carefully removed and the body washed thoroughly with soap and water before donning fresh clothing. Specific attention should be given to decontamination and treatment of skin lesions.

Normally, each individual is responsible for his own decontamination. If a person is physically unable to decontaminate himself, this process has to be performed by other available personnel. Since illness resulting from exposure to biological warfare may be delayed because of the incubation period, decontamination may occur before the individual becomes ill. Decontamination of the wounded is the responsibility of Medical Department personnel. When the situation and the condition of the casualty permit, decontamination should come first. However, massive hemorrhage, asphyxia, or other life-endangering conditions naturally receive priority.

In general, all candidates for decontamination should first have all exposed areas thoroughly washed with soap and large amounts of water, the mask adjusted, and all contaminated clothing removed. The casualty may then be moved to a clean area where the wounds can be treated.

Decontamination procedures are the same as those used for casualties of chemical warfare.

RADIOLOGICAL WARFARE

Radiological—the “R” in CBR—warfare is more frequently referred to as nuclear warfare. The principles of treatment of casualties, as developed from previous experiences in conventional warfare, are applicable in the treatment of casualties produced by radiological warfare. With the exception of ionizing radiation effects, the type of injuries produced in nuclear warfare are similar to those of conventional warfare. Standardized techniques of treatment must be adopted for all types of casualties so the greatest number of patients can receive maximum medical care in the shortest period of time with the greatest economy of medical personnel and equipment.

HISTORY

The death and devastation evidenced by the first and only use of nuclear power in wartime (in Hiroshima and Nagasaki, Japan, at the end of World War II) has, to date, kept it from being used again. Although a nuclear nonproliferation treaty has been signed by most of the major powers, nuclear weaponry is still a part of the arsenal of many countries of the world, some of which, if given the opportunity and excuse, would not hesitate to employ it to achieve victory at any cost.

History has shown that nuclear warfare is capable of producing a large disparity between the available medical care and the number of casualties requiring care. The capabilities of medical facilities and personnel must be surveyed to determine how and where they can best be utilized. Both professional and nonprofessional personnel must be trained in additional skills related as far as possible to their primary duties. Within medical organizations, efficiency will depend upon controlled patient flow, adequate supplies, and continuing essential housekeeping and administrative functions. To meet the requirements, it is essential that all medical service personnel be trained to assume some additional responsibilities.

EXPOSURE FACTORS

Teams entering contaminated areas to either remove casualties or work in decontamination stations have two major concerns. The first concern is the prevention of their own contamination, and the second is the prevention or reduction of radioactive exposure. Contamination can be avoided by decontaminating patients and equipment before handling, wearing appropriate protective clothing and equipment, avoiding highly contaminated areas, and strictly observing personal decontamination procedures. Exposure to radiation should also be avoided or minimized. Alpha and beta particles and gamma rays are emitted from radioactive contaminants and present a direct risk to the health and safety of personnel in the contaminated area. This risk can be avoided (or at least minimized) by following some simple guidelines and using common sense. Time, distance, and shielding are the major elements that guide actions to avoid exposure.

Time

Radioactive decay and the decomposition of fallout products progress rapidly in the early hours after a nuclear blast, and the hazards to rescue workers can be reduced considerably if operations can be delayed until natural decay has reduced the level of radioactivity. Use teams trained in the use of survey instruments since they will determine the intensity of radiation and mark perimeters of danger zones.

Limiting the time of exposure is essential if total avoidance is not possible. Rotating personnel entering an exposure risk area, planning actions to minimize time in the area, and prompt decontamination reduce the total time the individual is exposed, thereby reducing the dose of radiation absorbed by the body.

Distance

Both radioactive particles and electromagnetic waves (gamma rays) lose energy and consequently lose their ability to harm tissue as they travel away from their source. Therefore, the farther one is from the source, the more the danger of an exposure is minimized.

Shielding

Shielding is an essential component in preventing radiation exposure. Alpha and beta particles have very little penetrating power, and the intact skin forms an adequate barrier in most cases. Gamma radiation has much greater penetrating power and presents the greatest risk of exposure and damage to tissue.

Lead is the most effective shielding material. Wood, concrete, other metals, and heavy clothing will somewhat reduce the amount of gamma radiation that reaches the body. Most particle exposure is the result of inhalation or ingestion, although radiation particles may enter the body through burned, abraded or lacerated skin. In avoiding particle exposure, full personnel-protective clothing and a protective mask with hood provides the best protection. The protective mask and foul-weather gear will provide lesser but adequate protection. In cases where no protective breathing devices are available, some protection is afforded by breathing through a folded towel, handkerchief, or several surgical masks. Avoid hand-to-mouth contact, eating, or smoking in contaminated areas.

EFFECTS ON PERSONNEL

The injuries to personnel resulting from a nuclear explosion are divided into three broad classes: blast and shock injuries, burns, and ionizing radiation effects.

Apart from the ionizing radiation effects, most of the injuries suffered in a nuclear weapon explosion will not differ greatly from those caused by ordinary high explosives and incendiary bombs. An important aspect of injuries in nuclear explosions is the “combined effect,” that is, a combination of all three types of injuries. For example, a person within the effective range of a weapon may suffer blast injury, burns, and also from the effects of nuclear radiation. In this respect, radiation injury may be a complicating factor, since it is combined with injuries due to other sources.

Blast and Shock Wave Injuries

Injuries caused by blast can be divided into primary (direct) blast injuries and secondary (indirect) blast injuries.

Primary blast injuries are those that result from the direct action of the air shock wave on the human body. These injuries will be confined to a zone where fatal secondary blast and thermal damage may be anticipated. Therefore, most surviving casualties will not have the severe injuries that result from the direct compressive effects of the blast wave.

Secondary blast injuries are caused by collapsing buildings and by timber and other debris flung about by the blast. Persons may also be hurled against stationary objects or thrown to the ground by the high winds accompanying the explosions. The injuries sustained are thus similar to those due to a mechanical accident: bruises, concussions, cuts, fractures, and internal injuries.

At sea, the shock wave accompanying an underwater burst will produce various “mechanical” injuries. These injuries will resemble those caused aboard ship by more conventional underwater weapons, such as noncontact mines and depth charges. Instead of being localized, however, they will extend over the entire vessel.

Equipment, furniture, gas cylinders, boxes, and similar gear, when not well secured, can act as missiles and cause many injuries.

Burn Injuries

A weapon detonated as an air burst may produce more burn casualties than blast or ionizing radiation casualties. Burns due to a nuclear explosion can also be divided into two classes: direct and indirect burns. **Direct burns** (usually called **flash** burns) are the result of thermal (infrared) radiation emanating from a nuclear explosion, while **indirect burns** result from fires caused by the explosion. Biologically, they are similar to any other burn and are treated in the same manner.

Since all radiation travels in a straight line from its source, flash burns are sharply limited to those areas of the skin facing the center of the explosion. Furthermore, clothing will protect the skin to some degree unless the individual is so close to the center of the explosion that the cloth is ignited spontaneously by heat. Although light colors will absorb heat to a lesser degree than dark colors, the thickness, air layers, and types of clothing (wool is better than cotton) are far more important for protection than the color of the material.

Eye Burns

In addition to injuries to the skin, the eyes may also be affected by thermal radiation. If people are looking in the general direction of a nuclear detonation, they may be flash blinded. This blindness may persist for 20 to 30 minutes.

A second and very serious type of eye injury may also occur. If people are looking directly at the fireball of a nuclear explosion, they may receive a retinal flash burn similar to the burn that occurs on exposed skin. Unfortunately, when the burn heals, the destroyed retinal tissue is replaced by scar tissue that has no light-perception capability, and the victims will have scotomas, blind or partially blind areas in the visual field. In severe cases, the net result may be permanent blindness. The effective range for eye injuries from the flash may extend for many miles when a weapon is detonated as an air burst. This effective range is far greater at night when the pupils are dilated, permitting a greater amount of light to enter the eye.

Radiation Injuries

Radioactivity may be defined as the spontaneous and instantaneous decomposition of the nucleus of an unstable atom with the accompanying emission of a particle, a gamma ray, or both. The actual particles and

rays involved in the production of radiation injuries are the alpha and beta particles, the neutron, and the gamma ray. These particles and rays produce their effect by ionizing the chemical compounds that make up the living cell. If enough of these particles or rays disrupt a sufficient number of molecules within the cell, the cell will not be able to carry on its normal functions and will die.

ALPHA.—Alpha particles are emitted from the nucleus of some radioactive elements. Alpha particles produce a high degree of ionization when passing through air or tissue. Also, due to their large size and electrical charge, they are rapidly stopped or absorbed by a few inches of air, a sheet of paper, or the superficial layers of skin. Therefore, alpha particles do not constitute a major external radiation hazard. However, because of their great ionization power, they constitute a serious hazard when taken into the body through ingestion, inhalation, or an open wound.

BETA.—Beta particles are electrons of nuclear origin. The penetration ability of a beta particle is greater than an alpha particle, but it will only penetrate a few millimeters of tissue and will most probably be shielded out by clothing. Therefore, beta particles, like alpha particles, do not constitute a serious external hazard; however, like alpha particles, they do constitute a serious internal hazard.

NEUTRONS.—Neutrons are emitted from the nucleus of the atom. Their travel is therefore unaffected by the electromagnetic fields of other atoms. The neutron is a penetrating radiation which interacts in billiard-ball fashion with the nucleus of small atoms like hydrogen. This interaction produces high-energy, heavy-ionizing particles that can cause significant biological damage similar to that produced by alpha particles.

GAMMA RAYS.—Gamma rays are electromagnetic waves. Biologically, gamma rays are identical to x-rays of the same energy and frequency. Because they possess no mass or electrical charge, they are the most penetrating form of radiation. Gamma rays produce their effects mainly by knocking orbital electrons out of their path—thereby ionizing the atom so affected—and imparting to the ejected electron. Neutrons and gamma rays are emitted at the time of the nuclear explosion, along with light. Gamma rays and beta particles are present in nuclear fallout along with alpha particles from unfissioned nuclear material. Neutrons and gamma rays are an important medical consideration in a nuclear explosion since their range

is great enough to produce biologic damage, either alone or in conjunction with blast and thermal injuries.

PROTECTION AND TREATMENT

Preparations for the protection and treatment of projected casualties of a nuclear attack must be made in advance of any such assault.

Action before Nuclear Explosion

If there is sufficient warning in advance of an attack, head as quickly as possible for the best shelter available. This is the same procedure as would be used during an attack by ordinary, high-explosive bombs. At the sound of the alarm, get your protective mask ready. Proceed to your station or to a shelter, as ordered. If you are ordered to a shelter, remain there until the “all clear” signal is given.

In the absence of specially constructed shelters during a nuclear explosion ashore, you can get some protection in a foxhole, a dugout, or on the lowest floor or basement of a reinforced concrete or steel-framed building. Generally, the safest place is in the basement near walls. The next best place is on the lowest floor in an interior room, passageway, or hall, away from the windows and, if possible, near a supporting column. Avoid wooden buildings when possible. If you have no choice, take shelter under a table or bed rather than going out into the open. If you have time, draw the shades and blinds to keep out most of the heat from the blast. Only those people in the direct line of sight of thermal emission will be burn casualties; that is, anything that casts a shadow will afford protection. Tunnels, storm drains, and subways can also provide effective shelter.

In the event of a surprise attack, no matter where you are—out in the open on the deck of a ship, in a ship compartment, out in the open ashore, or inside a building—drop to a prone position in a doorway or against a bulkhead or wall. If you have a protective mask with you, put it on. Otherwise, hold or tie a handkerchief over your mouth and nose. Cover yourself with anything at hand, being especially sure to cover the exposed portions of the skin, such as the face, neck, and hands. If this can be done within a second of seeing the bright light of a nuclear explosion, some of the heat radiation may be avoided. Ducking under a table, desk, or bench indoors, or into a trench, ditch, or vehicle outdoors, with the face away from the light, will provide added protection.

Treatment of Nuclear Casualties

Most injuries resulting from the detonation of a nuclear device are likely to be mechanical wounds resulting from collapsing buildings and flying debris, and burns caused by heat and light liberated at the time of detonation.

A burn is a burn, regardless of whether it is caused by a nuclear explosion or by napalm, and its management remains the same. This is also true of fractures, lacerations, mechanical injuries, and shock. In none of these is the treatment dictated by the cause. For most of the conventional injuries, standard first-aid procedures should be followed.

The following word of caution should be considered when you are treating wounds and burns: Dressings for wounds and burns should follow a closed-dressed principle, with application of an adequate sterile dressing using aseptic techniques. Make no attempt to close the wound, regardless of its size, unless authorized by a physician. If signs of infection and fever develop, give antibiotics. When a physician is not available to direct treatment, the Corpsman should select an antibiotic on the basis of availability and appropriateness, and administer **three times** the recommended amount. If the antibiotic does not control the fever, switch to another. If the fever recurs, switch to still another. Overwhelming infection can develop rapidly in the patients due to burns or damage from radiation. Whenever a broad-spectrum antibiotic is given, administer oral antifungal agents.

To date, there is no specific therapy for injuries produced by lethal or sublethal doses of ionizing radiation. This does not mean that all treatment is futile. Good nursing care and aseptic control of all procedures is a must. Casualties should get plenty of rest, light sedation if they are restless or anxious, and a bland, nonresidue diet.

DECONTAMINATION

If you suspect that you are contaminated, or if detection equipment indicates you are, report to a personnel decontamination facility as soon as possible.

Facilities

In a large-scale nuclear catastrophe, there may be numerous casualties suffering not only from mechanical injuries and thermal burns, but from radiation injuries and psychological reactions as well.

The medical facility should consist of a personnel monitoring station, both clean and contaminated emergency treatment stations, a decontamination station, a sorting station, and various treatment stations. It should be set up so that personnel must pass through a monitoring station prior to sorting for medical care. If there is a need for decontamination, the casualty should be routed through the decontamination station on the way to the sorting station. The physical layout should be arranged so that no casualty can bypass the monitoring station and go directly to a treatment station. Also, casualties who are contaminated should be unable to enter clean areas without first passing through a decontamination station. The medical facility flow chart shown in figure 8-3 illustrates an appropriate schema for handling those exposed to nuclear radiation.

TEAMS.—Patients brought in by the rescue teams or arriving on their own should first proceed through the monitoring station to determine whether or not they are contaminated with radioactive material. No medical treatment should be instituted in the monitoring station. Only personnel who have had training and experience as members of Radiological Safety/Decontamination teams or as members of Damage Control parties should be assigned to the monitoring station. Those operating the monitoring station should have a basic knowledge of and experience with radiac instruments. Of the personnel available to the treatment facility, several of those most experienced and knowledgeable in radiological safety and radiation protection should be assigned supervisory jobs in the decontamination station. Also, it is highly desirable to have some personnel with operating room experience to decontaminate patients with traumatic injuries. It is not necessary for the other personnel working in the decontamination station to have any appreciable training or experience other than that given when the medical facility is put into operation.

MONITORS.—After the patients are monitored, they are directed or taken down one of four avenues, depending upon their physical conditions. Those requiring immediate lifesaving measures should be considered contaminated and routed directly through the monitoring station to the contaminated emergency treatment station. Definitive monitoring for these individuals may be performed at the decontamination station. Both treatment stations are set up much the same and should have only those facilities necessary for immediate lifesaving forms of treatment. Personnel working in these stations should be better

versed in emergency first-aid care than those used for monitoring and for rescue teams, but they need not be trained in radiation monitoring.

SORTING.—After emergency lifesaving procedures have been attended to, casualties from the clean emergency treatment station should be taken directly to the sorting station, and those from the contaminated treatment station should be taken to the decontamination station. Casualties not requiring immediate emergency treatment should be taken or sent from the monitoring station directly to the sorting station or to the decontamination station, whichever is appropriate. The decontamination station should be set up to take, hold, and dispose of all contaminated clothing and to supply clean replacement clothing after the casualty has been decontaminated. Monitoring equipment will also be required, as will showering and washing facilities, and some capability for surgical (e.g., wound) decontamination when necessary.

Cleaning

Early removal of radioactive “contamination” will reduce radiation burns, radiation dosage, and the chances of inhaling or ingesting radioactive material. There are two rules to be remembered in the removal of radioactive contamination:

- Contamination is easily spread, so “spot” cleaning must be attended to before general decontamination procedures are started.
- Removal of radioactive contamination is best accomplished with soap and water.

SPOT CLEANING.—Cotton swabs or gauze may be used to decontaminate moist areas. Use gummed tapes to decontaminate dry areas. If, after the first cleansing, decontamination is inadequate, the process should be repeated three to five times. If contamination persists, a preparation consisting of a mixture of 50 percent detergent and 50 percent cornmeal, with enough water added to make a paste, should be tried. The contaminated area should be scrubbed (preferably with a soft-bristle surgical brush) for 5 minutes, then rinsed.

GENERAL CLEANING.—After the hot spots have been removed, the second step is to shower with soap and water. Scrub the entire body, including the hair and nails. After the shower, monitor again; if any contamination remains, repeat spot cleaning and shower procedures. If the hair is contaminated, shampoo it several times. If it becomes apparent that

shampooing has not removed the radioactive material, cut the hair as close to the scalp as necessary to remove the radioactive material.

If areas become tender from excessive washing, it may be necessary to restore some of the skin oils by gently rubbing in a small amount of lanolin or ordinary hand or face cream. This will soothe the skin and prepare it for further decontamination if additional steps are necessary. Decontamination should be continued until the radioactivity has been reduced to the “safe” level set by the responsible Medical Department representative. Wounds or body parts that resist decontamination may have to be covered and the patient referred to a higher-level medical treatment facility.

UNCONTAMINATED AREAS.—Protect any uncontaminated cut, scratch, or wound with an impermeable tape or other suitable material while decontaminating the rest of the body. If a wound is already contaminated, the simplest and least drastic decontamination method available should be tried first, always by trained medical personnel. First, the wound should be carefully bathed or flushed with sterile water, and a reasonable amount of bleeding should be encouraged. Following decontamination, standard triage procedures are used.

Additional information pertaining to the initial management of irradiated or radioactively contaminated individuals may be obtained from the current version of BUMEDINST 6470.10, *Initial Management of Irradiated or Radioactively Contaminated Personnel*.

Contaminated Material and Supplies

Radiological material may be removed but not destroyed. Water then becomes a special problem. Distillation frees water of radioactive material, providing emergency drinking water. Water coming from an underground source usually is free from radioactive materials and is therefore usable; however, water coming from a reservoir that has to depend upon a surface watershed for its source may not be usable. Fortunately, regular water-treatment processes that include coagulation, sedimentation, and filtration will remove most fallout material, and if the reservoir water can be properly treated, it will be usable again. But for safety’s sake, never drink untested water.

SUPPLIES AND FOOD.—Supplies and food can be protected from residual radiation by storage in dust-proof containers. Although the outside of the

containers may become contaminated, most of this radioactive material can be removed by washing. The container can then be opened and the contents removed and used without fear of causing significant contamination.

The outer wrappings on medical supplies and the peelings on fruit and vegetables also afford protection to their contents. After carefully removing the outer coverings and checking the contents, it may be found that these materials will be safe to use.

CLOTHING.—Contaminated clothing should be handled with care. Such clothing should never be casually placed on furniture, hung on walls, or dropped on floors, but, instead, should be stored in garbage cans or disposable containers. If these are not available, contaminated clothing should be placed on pieces of paper large enough to be rolled and secured. Grossly contaminated clothing should be properly disposed of by an authorized method, such as burial at sea or in

deep pits or trenches, whichever is appropriate. If clothing is in short supply, lightly contaminated clothing may be salvaged by special laundering. Three washings in hot water with detergent should be sufficient. To be sure that this procedure has freed the clothing from radioactive material, each article should be monitored before it is released for reuse. Rubber and plastic materials are readily decontaminated in a warm detergent wash.

SUMMARY

In this chapter we discussed the recognition and treatment of chemical, biological, and radiological (CBR) hazards, and the Medical Department's role in meeting the medical aspects of CBR defense. These included protection from CBR hazards, mass-casualty decontamination, decontamination stations, and supplies for decontamination.