MORPHINE USE FOR PAIN RELIEF

LEARNING OBJECTIVE:

Explain morphine dosage, administration routes, indications, contraindications, and casualty marking procedures.

A HM may be issued morphine for the control of shock through the relief of severe pain. This controlled drug is issued 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 series, Morphia Dosage and Casualty Marking.

MORPHINE ADMINISTRATION

Morphine is the most effective of all pain-relieving drugs. It is most commonly available in pre-measured 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 the HM 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 morphine be administered

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

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• 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
• 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 semipermanent 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.

SOFT TISSUE INJURIES

LEARNING OBJECTIVES:

Describe the different types of wounds.

Determine management and treatment procedures for open and internal soft-tissue injuries.

The most common injuries seen by HMs 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 necessary 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 casualty 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 the impaled object to prevent further injury and minimize bleeding. Impaled objects should be surgically removed.

LACERATIONS—These wounds are torn, rather than cut. They have ragged, irregular edges and masses of torn tissue underneath. These wounds are typically 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 typically 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.

**AVULSIONS**—An avulsion is the tearing away of tissue from a body part. Bleeding is normally 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 casualty 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 non-surgical 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 casualty. 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 (Kinematics of Trauma)**

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 the HM 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 wartime setting is the velocity of wound-causing missiles (bullets or shrapnel). A low-velocity missile damages only the tissues with which it comes into contact. 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 HM 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 casualty.

**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 casualty for shock, and 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 significant amounts of blood from the vessels of the circulatory system. The average adult body contains about 5-6 liters of blood. Five hundred milliliters of blood, the amount given by blood donors, can normally 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 normally dark 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, it can be difficult to decide whether bleeding is venous or arterial, but the distinction is not important. The important thing to know is that all bleeding must be controlled as quickly as possible.

External hemorrhage is of greatest importance 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 and the use of Tourniquets

In the past, emphasis has been placed on elevation of an extremity and compression on a pressure point (proximal to the bleeding site) as intermediate steps in hemorrhage control. No research has been published on whether or not elevation of an extremity slows hemorrhage. If the extremity is fractured, this maneuver could potentially result in converting a closed fracture to an open one or in causing increased internal hemorrhage. Similarly, the use of pressure points for hemorrhage control has not been studied. Thus, in the absence of compelling data, these interventions can no longer be recommended for situations where direct pressure or a pressure dressing has failed to control hemorrhage.

If external bleeding from an extremity cannot be controlled by pressure, application of a tourniquet is the reasonable next step in hemorrhage control.

APPLY A TOURNIQUET TO CONTROL BLEEDING

Scenario

The HM has encountered a casualty who is bleeding profusely from an extremity and needs a tourniquet to control the bleeding. All other more serious injuries have been assessed and treated.

Objective

Control the bleeding from the extremity without causing further harm to the casualty.

Performance Steps

<table>
<thead>
<tr>
<th>NOTE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take Body Substance Isolation (BSI) precautions.</td>
</tr>
</tbody>
</table>

1. Determine if the bleeding is life-threatening.
2. Apply a tourniquet if direct pressure and the emergency bandage fail to control the bleeding.

CAUTION:
Under combat conditions, while under effective enemy fire, a temporary tourniquet may often be the primary means to control bleeding.

A properly applied tourniquet will quickly control life-threatening hemorrhage until the casualty can be moved away from the effective fire.

a. Improvised tourniquet.
   i. Don BSI
   ii. Apply pressure to pressure point above the wound.
   iii. Prepare equipment.
   iv. Expose the wound.
   v. Place the prepared cravat and windlass 2-3 inches above the wound (not over a joint) and secure the cravat tightly against the extremity with a full non-slip knot.
   vi. Twist the windlass until the bleeding stops.
   vii. While holding tension on the windlass, place the windlass inside the half knot of the second cravat proximal to the tourniquet (if possible).
viii. Tighten the second cravat around windlass and secure the second cravat to the extremity with a full non-slip knot.

ix. Assess for the absence of a distal pulse (not indicated for amputations).

x. Place a "T" and the time of application on the casualty.

xi. Secure the tourniquet in place with tape.

b. C-A-T®:
   i. Don BSI.
   ii. Apply pressure to pressure point above the wound.
   iii. Expose the wound enough to ensure the tourniquet is placed above the injury.
   iv. Place C-A-T® between the heart and the wound on the injured extremity, 2-3 inches above the wound.
   v. Pull the free end of the self adhering band through the buckle and route through the friction adapter buckle (it is not necessary to route through friction adapter on an arm wound).
   vi. Pull the self adhering band tight around the extremity and fasten it back on itself.
   vii. Twist the windlass until the bleeding stops.
   viii. Lock the windlass in place within the windlass clip.

ix. Secure the windlass with the windlass strap.

x. Assess for the absence of a distal pulse (not indicated for amputations).

xi. Place a "T" and the time of application on the casualty.

xii. Secure the C-A-T® in place with tape.

3. Record the treatment.

4. Reassess the injury to ensure bleeding has been controlled.

5. If the source of bleeding was due to a traumatic amputation.
   a. Wrap the amputated part in a clean cloth or sterile dressing (if available).
   b. Wrap or bag the amputated part in plastic.
   c. Label the plastic bag with the casualty's information.
   d. Transport the amputated part in a cool container (if available) with the casualty.

   CAUTION:

   Do not place the amputated part directly in contact with ice.

   Do not submerge the part directly in water.

   Do not allow the part to freeze.

6. Evacuate the casualty.

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)
- Ecchymosis (pooling of the blood near the skin surface)

Other Signs and Symptoms

More often than not, however, there will be no visible signs of injury, and the HM 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
- Syncpe
- Dehydration and thirst
- Yawning and air hunger
- Anxiety, with a feeling of impending doom

Immediate Treatment

There is little that the HM can do to correct internal soft-tissue injuries since they are almost always surgical problems. The goal must be to obtain the greatest benefit from the casualty’s remaining blood supply.

INITIATE TREATMENT FOR HYPOVOLEMIC SHOCK\textsuperscript{23}

Scenario

The HM in the field is assessing a casualty who is suffering from significant blood loss.

Objective

Initiate treatment for hypovolemic shock, stabilize the casualty, minimize the effect of shock, and prepare for immediate evacuation without further injury to the casualty.

Performance Steps

**NOTE:**
Take Body Substance Isolation (BSI) precautions.

1. Control bleeding.
2. Maintain the airway.

**NOTE:**
Administer oxygen, if available.

3. Reassure the casualty to reduce anxiety.

**NOTE:**
Anxiety increases the heart rate, which worsens the casualty’s condition. Anyone who has just been shot or who has experienced detonation of explosives nearby will have tachycardia.

4. Initiate one large bore (18 gauge) IV.
5. Maintain the IV flow with Hextend®.
   a. Continue the flow until the systolic blood pressure stabilizes at greater than 80mm Hg.
      i. The usual amount is 500 ml; repeat the dose of 500 ml one time. A total of 1000 ml maximum amount of Hextend® can be used for hypovolemia.
      ii. A palpable radial pulse typically indicates that the casualty has a systolic blood pressure of 80 mm Hg.
6. Elevate the casualty's legs.
   a. Elevate the casualty's legs above chest level, without lowering the head below chest level.

   **NOTE:**
   Split leg or ankle fractures before elevating the legs, if necessary.

   b. If the casualty is on a litter, elevate the foot of the litter.


8. Monitor the casualty.

   **NOTE:**
   Give nothing by mouth. Moisten the casualty's lips with a wet cloth.

   a. Check vital signs every 5 minutes until they return to normal, and then check every 15 minutes.

   b. Check the casualty's level of consciousness.

   **NOTE:**
   If the blood pressure's unstable or drops, the pneumatic anti-shock garment (PASG) should be applied by qualified personnel.

9. Record the procedure.

10. Evacuate the casualty.

### WOUND CLOSURE

#### LEARNING OBJECTIVES:

*Discuss the different types of suture material and their uses.*

*Explain topical, local infiltration and nerve-block anesthetic administration procedures.*

*Explain 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 HMs 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, he or she 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
  - This aids 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 un-sutured. 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 typically involved
  - Only a surgeon should attempt to close this type of wound

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 unhindered.

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 HM will work. The HM should wear a cap and mask, scrub 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: non-absorbable sutures and absorbable sutures.

**Non-Absorbable 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; however, there is a 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 are 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 21-4.

<table>
<thead>
<tr>
<th>Type of Gut</th>
<th>Absorption Time</th>
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<tbody>
<tr>
<td>A: Plain</td>
<td>10 days</td>
</tr>
<tr>
<td>B: Mild</td>
<td>20 days</td>
</tr>
<tr>
<td>C: Medium</td>
<td>30 days</td>
</tr>
<tr>
<td>D: Extra</td>
<td>40 days</td>
</tr>
</tbody>
</table>

Table 21-4.—Absorption Times of Various Types of Surgical Gut

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 (atraioc, 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 casualty, 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.
   b. Position the patient securely so that access to the wound and suture tray is optimal. It is normally 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%, and 2%) and with or without epinephrine. Injectables containing epinephrine must never be used on the fingers, toes, ears, nose, or any other appendage with small vessels because of the vasoconstricting effect of the epinephrine which would eliminate blood flow causing tissue death in these areas. 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 nurse anesthetist for the surgical patient. For EMs, 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 innervate the fingers or toes are anesthetized. The most common method of anesthesia used by HMs 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 if the patient can distinguish a sharp sensation or pain when a sharp object is gently applied to the skin.

Administering local anesthesia is similar except the HM is anesthetizing nerves immediately adjacent to where the work will be done 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 ½ 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 ml 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 arc like 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 unsafe 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 21-4 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) wick 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 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 21-5 provides guidance as to the best suture to use in selected circumstances.
<table>
<thead>
<tr>
<th>Suture Size</th>
<th>Suture Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-0</td>
<td>Can be used to suture in G-Tube or Chest Tube</td>
</tr>
<tr>
<td>3-0</td>
<td>Skin: Foot&lt;br&gt;Deep: Chest, Abdomen, Back</td>
</tr>
<tr>
<td>4-0</td>
<td>Skin: Scalp, Chest, Abdomen, Foot, Extremity&lt;br&gt;Deep: Scalp, Extremity, Foot</td>
</tr>
<tr>
<td>5-0</td>
<td>Skin: Scalp, Brow, Oral, Chest, Abdomen, Hand, Penis</td>
</tr>
<tr>
<td>6-0</td>
<td>Skin: Ear, Lid, Brow, Nose, Lip, Face, Penis</td>
</tr>
<tr>
<td>7-0</td>
<td>Skin: Eyelid, L.p, Face</td>
</tr>
</tbody>
</table>

Table 21-5.—Suture Size by Location

10. When cutting sutures, subcutaneous catgut should have a 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 ¼-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.

MANAGEMENT OF MUSCULOSKELETAL INJURIES

LEARNING OBJECTIVE:

Select the appropriate stabilization and treatment procedure for the management of bone injuries.

BONE INJURIES

A break in the bone is known as 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.

Open fractures are more serious than closed fractures. They typically 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 casualty.

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 wobbly movements if the bone is broken clear through.

It may be difficult or impossible for the casualty 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 casualty 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, the HM might see the external wound but fail to recognize the broken bone.

**General Guidelines**

If required to give first aid to a person who has suffered a fracture, 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 casualty to a definitive care facility at the first possible opportunity. All fractures require medical treatment.
- Do not move the casualty 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 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 casualty is to be transported only a short distance, or if treatment by a medical officer will not be delayed, it is best to leave the clothing on and place emergency splinting over it.
  - If the casualty 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 to apply well padded splints directly to the injured part.
  - 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 casualty 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
  - Take care of the wound before dealing 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 were discussed in the section on wounds of this chapter. Use a tourniquet as a last resort.
  - After the bleeding has been stopped, treat the fracture.

Now that the general rules for treating fractures have been reviewed, please read on regarding 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 may appear 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 21-5. The hand should be raised about 4 inches above the level of the elbow. Treat the casualty for shock and evacuate as soon as possible.

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 (Fig. 21-6).

![Figure 21-5.—Treating a Forearm Fracture](image)

*Photograph provided by HMCS (SS/SW) Christopher Santee of Naval Medicine Manpower Personnel Education and Training Command, Bethesda, MD.*

**Upper Arm Fracture**

The signs of fracture of the upper arm include pain, tenderness, swelling, and a wobbly motion at the point of fracture. If the fracture is near the elbow, the arm is likely to be straight with no bend at the elbow.

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 using 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 casualty.
If the fracture is at or near the elbow, the arm may be either bent or straight. No matter in what position the arm is found, DO NOT ATTEMPT TO STRAIGHTEN IT OR MOVE IT IN ANY WAY. Splint the arm as carefully as possible in the position in which found. 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 casualty for shock and get him under the care of a medical officer as soon as possible.

Femur 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 may assume 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 femoral 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. 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 casualty is moved. Manufactured splints, such as the Hare or the Thomas half-ring traction splints are best, but improvised splints may be used. Remember, DO NOT MOVE THE CASUALTY UNTIL THE INJURED LEG HAS BEEN IMMOBILIZED. Treat the casualty 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 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 (Fig. 21-7). Be sure that the splints are well padded, particularly under the knee and at the bones on each side of the ankle.

Figure 21-7.—Splinting a Leg

Photograph provided by HMI Stephen J. Oreski, Biomedical Photography Department of Navy Medicine Support Command, Bethesda, MD.
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 casualty for shock and evacuate as soon as possible. When available, use the Hare or Thomas half-ring traction splints.

Kneecap Fracture

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. 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 casualty for shock and evacuate as soon as possible.

Clavicle Fracture

A person with a fractured clavicle shows definite symptoms. When the casualty stands, the injured shoulder is lower than the uninjured one. The casualty 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, it may be possible 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. Bend the casualty’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 casualty’s arm to the body. A figure-eight bandage may also be used for a fractured clavicle. Treat the casualty for shock and evacuate to a definitive care facility as soon as possible.

Rib Fracture

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

The common finding in all casualties 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, the location of the injury can be determined. There may or may not be a rib deformity, chest wall contusion, or laceration of the area. Deep breathing, coughing, or movement is 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 casualty 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 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 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 casualty for shock and evacuate as soon as possible.

**Nose Fracture**

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

Stop the nosebleed. Have the casualty sit quietly, with the head tipped slightly backward. Tell the casualty 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 casualty for shock. Ensure the casualty 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, jaw thrust position.

Apply a four-tailed bandage (also known as a Barton bandage). 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 casualty’s throat.

Be sure that the casualty has scissors or a knife to cut the bandage in case of vomiting.

Treat the casualty 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 may 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. 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 casualty has sustained a blow to the head. Sometimes the skull is depressed (caved in) at the point of impact. If the fracture is open, there may be glass, shrapnel, or other objects penetrating the skull.
- The casualty may be conscious or unconscious. If conscious, the casualty 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 or cerebrospinal fluid (CSF) leakage from the ears, nose, or mouth.
- The casualty may vomit.
• The casualty may be restless and perhaps confused and disoriented
• The arms, legs, face, or other parts of the body may be partially paralyzed
• The casualty’s face may be very pale, or it may be unusually flushed
• The casualty 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 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 casualty lying down. If the face is flushed, raise the head and shoulders slightly. If the face is pale, have the casualty lie so that the head is level with, or slightly lower than, the body. Watch carefully for vomiting. If the casualty 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 casualty. Move the casualty no more than is necessary. If transportation is necessary, keep the casualty 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 casualty is kept comfortably warm, but not too warm
• Do not give the casualty anything to drink. DO NOT GIVE ANY MEDICATIONS. See that the casualty 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 casualty 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 normally 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 casualty 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 casualty 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 casualty comfortably warm. Do not attempt to keep the casualty in the position ordinarily used for the treatment of shock, because it might cause further damage to the spinal cord. Just keep the casualty lying flat and do NOT attempt to lower the head.
To avoid further damage to the spinal cord, **DO NOT MOVE THE CASUALTY UNLESS IT IS ABSOLUTELY ESSENTIAL!** If the casualty’s life is threatened in the present location or transportation is necessary to receive medical attention, then, of course, the HM must move the casualty. However, if movement is necessary, be sure that the HMs do it in a way that will cause the least possible damage.

- **DO NOT BEND OR TWIST THE CASUALTY’S BODY**
- **DO NOT MOVE THE HEAD FORWARD, BACKWARD, OR SIDEWAYS**
- **DO NOT UNDER ANY CIRCUMSTANCES ALLOW THE CASUALTY TO SIT UP**

If it is necessary to transport a person who has suffered a spinal fracture, has a suspected spinal fracture, or the MOI indicates a high IOS of spinal fracture follow these general rules:

- Assume that the patient has a cervical fracture which has the most potential for negative outcomes (i.e. quadriplegic on a ventilator)
- Transport patient 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**
- No matter where the spine is broken, use a firm support in transporting the casualty; use a rigid stretcher, or a door, shutter, wide board, etc.
- Pad the support carefully, and put blankets both under and over the casualty
- Use cravat bandages or strips of cloth to secure the casualty firmly to the support

- When placing the casualty on a spine board, one of two acceptable methods may be used
  - **DO NOT ATTEMPT TO LIFT/ROLL THE CASUALTY UNLESS ADEQUATE ASSISTANCE IS AVAILABLE**
  - Remember: Any bending or twisting of the body is almost sure to cause serious damage to the spinal cord
  - One person lifts and supports the head while two other persons each lift at the shoulders and hips, respectively
  - A fourth person aligns the spine board next to the patient
  - The casualty is log rolled as a single unit towards the rescuers. It is **critical** that the head is kept aligned with the neck and the rest of the body
  - The spine board is positioned, the casualty is rolled back onto the spine board and both are lowered gently to the ground, and then the patient is secured in place
  - If there are at least four (preferably six) people present to help lift/roll the casualty, they can accomplish the job without too much movement of the casualty’s body
  - **NEVER** attempt to lift/roll the casualty, however, with fewer than four people
- Evacuate the casualty 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 casualty is unable to sit or stand. If the casualty is conscious, there may be a sensation of "coming apart." If the bladder is injured, the casualty’s urine may be bloody.

**Do not move the casualty unless ABSOLUTELY necessary.** The casualty should be treated for shock and kept warm but should not be moved into the position ordinarily used for the treatment of shock.

If the HM must transport the casualty to another place, do it with the utmost care. Use a rigid stretcher, a padded door, or a wide board. Keep the casualty supine. In some cases, the casualty will be more comfortable if the legs are straight, while in other cases the casualty will be more comfortable with the knees bent and the legs drawn up.

When the casualty is 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 and using cravats, roller bandages, or straps to hold the legs together, or through the use of MAST garments. Then, fasten the casualty securely to the stretcher or improvised support, and evacuate very carefully.

**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 a 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:

- **Dislocations**
- **Sprains**
- **Strains**
- **Contusions (bruises)**

**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 typically 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 stiff and immobile, with marked deformation at the joint, will help to 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 do not attempt to reduce a dislocation, to put a dislocated bone back into place, unless it is known 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, HMs should leave this treatment to specially trained medical personnel and concentrate their efforts on making the casualty 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 casualty 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 casualty comfortable.
4. Treat the casualty for shock.
5. Get medical help as soon as possible.

HMs should NEVER attempt to reduce the more serious dislocations, such as those of the hip. However, if it is probable that the casualty cannot be treated by a medical officer within a reasonable time, the HM 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 casualty to a definitive care facility.

**DISLOCATION OF THE JAW.**—When the lower jaw is dislocated, the casualty cannot speak or close the mouth. Dislocation of the jaw is typically 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 protection, wrap the thumbs with a handkerchief or bandage. While facing the casualty, the HM should press the thumbs down just behind the last lower molars and, at the same time, lift the chin up with the fingers. The jaw should snap into place at once. The HM will have to remove the thumbs quickly to avoid being bitten. No further treatment is required, but warn the casualty to keep the mouth closed as much as possible during the next few hours.

**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. 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 casualty in a supine position. After putting the heel of a foot in the casualty’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 casualty’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 involves a momentary dislocation, with the bone slipping back into place of its own accord. Although any joint may 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 casualty 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 may be very tender.
As a rule, slight bruises do not require treatment. However, if the casualty has severe bruises, treat for shock. Immobilize the injured part, keep it at rest, and protect it from further injury. Sometimes the casualty 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.

SPECIAL WOUNDS AND THEIR TREATMENT

LEARNING OBJECTIVE:

Describe medical precautions and wound-treatment procedures for the following list of wounds: eye wounds, head wounds, chest wounds, abdominal wounds, crushing injuries, animal bites, and the removal of foreign objects.

The HM 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.

TREAT FOREIGN BODIES OF THE EYE

Scenario

The HM has a casualty with a foreign body in the eye. All other more serious injuries have been assessed and treated.

Objective

Treat foreign bodies of the eye, minimizing the effects of the injury, without causing additional injury to the eye.

Performance Steps

NOTE:
Take Body Substance Isolation (BSI) precautions.

1. Perform visual acuity testing.
2. Assess eyes: pupils, equal and round, regular in size, and react to light (PEARL).
3. Locate the foreign body.
   a. Method one.
      i. Pull the lower lid down.
      ii. Tell the casualty to look up and to both sides and check for foreign bodies.
      iii. Pull the upper lid up.
      iv. Tell the casualty to look down and to both sides and check for foreign bodies.
   b. Method two.
      i. Tell the casualty to look down.
      ii. Grasp the casualty's upper eyelashes and gently pull the eyelid away from the eyeball.
      iii. Place a cotton-tipped swab horizontally along the outer surface of the upper lid and fold the lid back over the swab.
      iv. Look for the foreign bodies or damage on the globe.

CAUTION:
If the foreign bodies cannot be located, bandage both eyes and seek further medical aid immediately.
4. Remove the foreign body.

   CAUTION:
   Do not put pressure on the globe.

   a. Small foreign body on an anterior surface.
      i. Hold the casualty's eye open.
      ii. Irrigate the eye.

   b. Foreign body stuck to the cornea or lying under the upper or lower eyelid.
      i. For a foreign body under the lower eyelid, pull the lower lid down.
      ii. For a foreign body under the upper eyelid, pull the upper lid up.
      iii. Remove the foreign body with a moistened, sterile cotton-tipped swab.

   CAUTION:
   Bandage both eyes if foreign bodies are not easily removed by these methods or if there is pain or loss of vision in the eye. Seek further medical aid immediately.

   NOTE:
   In hazardous conditions, leave the good eye uncovered long enough to ensure the casualty's safety.

   c. Foreign body stuck or impaled in the eye.

   CAUTION:
   Do not attempt to remove a foreign body stuck to or sticking into the eyeball. A medical officer must remove such objects.

      i. Apply dry sterile dressings to build around and support the object.

   NOTE:
   This will help prevent further contamination and minimize movement of the object.

      ii. Cover the injured eye with a paper cup or cardboard cone.

   iii. Cover the uninjured eye with a dry dressing or eye patch.

   iv. Reassure the casualty by explaining why both eyes are being covered.

   NOTE:
   The eyes move together. If the casualty uses (moves) the uninjured eye, the injured eye will move as well.

   Covering both eyes will keep them still and will prevent undue movement on the injured side.

   In hazardous conditions, leave the good eye uncovered long enough to ensure the casualty's safety.

   d. Seek further medical aid immediately.

5. Obtain details about the injury.

   a. Source and type of the foreign bodies.
   b. Whether the foreign bodies were wind-blown or high velocity.
   c. Time of onset and length of discomfort.
   d. Any previous injuries to the eye.

6. Record the procedure

7. Do not cause additional injury to the eye.

   a. Do not probe for foreign bodies.
   b. Do not put pressure on the globe.
   c. Do not remove an impaled object.

8. Evacuate the casualty, as required.
CRUSH SYNDROME

When a casualty is crushed or trapped with compression on the extremities for a prolonged time, there is the possibility for crush syndrome (CS), characterized by ischemia and muscle damage (rhabdomyolysis). With rhabdomyolysis there is an efflux of potassium, nephrotoxic metabolites, myoglobin, purines, and phosphorous into the circulation, resulting in cardiac and renal dysfunction.

1. Recognition.
   a. History.
      i. Suspect in patients in whom there is a history of being trapped (e.g., urban operations, mountain operations, earthquakes, or bombings) for a prolonged period (from hours to days).
      ii. Clear history is not always available in combat, and the syndrome may appear insidiously in patients who initially appear well.
   b. Physical findings.
      i. A thorough examination must be done with attention to extremities, trunk, and buttocks. The physical findings depend on the duration of entrapment, treatment rendered, and time since the casualty’s release.
      ii. Extremities.
         1. May initially appear normal just after extrication.
         2. Edema develops and the extremity becomes swollen, cool, and tense.
         3. May have severe pain out of proportion to examination.
         4. Anesthesia and paralysis of the extremities, which can mimic a spinal cord injury with flaccid paralysis, but there will be normal bowel and bladder function.
      iii. Trunk/buttocks: may have severe pain out of proportion to examination.

   THERAPY.—On scene while still trapped. The primary goal of therapy is to prevent acute renal failure in crush syndrome. Suspect, recognize, and treat rhabdomyolysis early in casualties of entrapment. Therapy should be initiated as soon as possible, preferably in the field, while the casualty is still trapped. Ideally it is recommended to establish IV access in a free arm or leg vein.

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. HMs should never attempt to remove bullets, but they should try to find out whether the bullet remains in the casualty. Look for both entrance and exit wounds. The general rule to remember is this:

NOTE:
Remove foreign objects from a wound when it can be done 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 three or four times.

3. Grasping the object at the end, remove it. Tweezers, small pincers, or forceps may be used for this purpose. (Whatever instrument used 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, HMs 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 21-8 shows one method of removing a fishhook that has become embedded in the flesh. As illustrated in Figure 21-8A, the barb on the hook prevents its direct removal. However, if the HM pushes the hook forward through the skin, as shown in Figure 21-8B, then the HM can clip off the barb with a wire cutter or similar tool, as shown in Figure 21-8C. The remainder of the fishhook can then be withdrawn in the manner indicated in Figure 21-8D.

![Figure 21-8.—Removing a Fishhook](image)

**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 normally 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 6220.8 series, *Streptococcal Infection Control Program*. 

21-86
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 casualty’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 any exposed skin while providing patient care.

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.

ENVIRONMENTAL INJURIES

LEARNING OBJECTIVES:

Explain the classification and evaluation process for burns.

Determine the appropriate treatment for each type of burn.

Under the broad category of environmental injuries, HM’s 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 overpowers 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 casualty, and other medical complications.

Classification of Severity

Burns are classified according to their depth as first-, second-, and third-degree burns (Fig. 21-9).
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 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 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) will be painful.

Tissue color will range from white (scalds) to black (charring burns). Although the wound is typically 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 21-10 shows how the rule is applied to adults.
The Lund and Browder chart for accurate assessment of the % BSA

Figure 21-10.—Rule of Nines
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. The HM must take all these factors into consideration when evaluating the condition of the burn casualty, especially in a triage situation.

First Aid

1. After the casualty has been removed from the source of the thermal injury, first aid should be kept to a minimum.
2. Maintain an open airway.
3. Control hemorrhage, and treat for shock.
4. Remove constricting jewelry and articles of clothing.
5. Protect the burn area from contamination by covering it with clean sheets or dry dressings. DO NOT remove clothing adhering to a wound.
6. Splint fractures.
7. 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.
8. Maintain intravenous treatment during transportation.

   a. Pain resulting from small burns may be relieved with an anesthetic ointment if the skin is not broken.
   b. Relieve mild pain (as with first degree burns) with aspirin. Relieve moderate pain with cool, wet compresses or ice water immersion (for burns of less than 20 percent BSA).
   c. Severe pain may be relieved with morphine or Demerol® injections.

Aid Station Care

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

1. Continue to monitor for airway patency, hemorrhage, and shock.
2. 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.
3. Monitor urine output (UOP); at least 30cc/kg/hr is minimal output.
   a. Shave body hair well back from the burned area.
   b. Cleanse the area gently with disinfectant soap and warm water.
   c. Remove dirt, grease, and nonviable tissue.
   d. Apply a sterile dressing of dry gauze.
   e. Place bulky dressings around the burned parts to absorb serous exudates.
5. All major burn casualties 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.
6. 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.
   a. Gently spread a 1/16-inch thickness of or Silvadene Cream® over the burn area.
   b. Repeat the application after 12 hours, and then after daily debridement.
   c. 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 casualty 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 (Fig. 21-11).

Before treatment is started, ensure that the casualty is no longer in contact with a live electrical source. Shut the power off or use a non-conducting rope or stick to move the casualty away from the line or the line away from the casualty.

HMs can do little for these casualties other than monitoring the basic life functions; delivering CPR, treating for shock, covering the entrance and exit wounds with a dry, sterile dressing; and transporting the casualty to a medical treatment facility. Due to the nature of the injury, the patient may require defibrillation with an AED or cardiac defibrillator in order to re-set the electric circuits in the heart so that a normal cardiac rhythm can return. AEDs are the device of choice for HMs; follow the manufacturer’s directions for use.

CHEMICAL BURNS

When acids, alkalis, or other chemicals come in contact with the skin or other body membranes, they 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 more serious than acid burns because alkalis penetrate deeper and burn longer.

*Figure 21-11.—Electrical Burns

Photograph provided by HMCS (SS/SW) Christopher Santée of Naval Medical Manpower Personnel Education and Training Command, Bethesda, MD.*
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.
   a. Do not apply water too forcefully.
   b. Flood the area while the clothing (including shoes and socks) is being removed and continue flushing the skin after removal of all clothing.

   **NOTE:**
   There are two exceptions to the above:

   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.

   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 HMs 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.

   a. For acid burns, make a solution of 1 teaspoon of baking soda to a pint of water and flush it over the affected area.
   b. 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 sterile gauze. Do not rub the area.

4. Transport the casualty 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 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 casualty 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 casualty'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 casualty 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 casualty 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 phosphate 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:

Describe 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 casualty to a cool place. Since heat cramps are caused by loss of salt and water, give the casualty 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 casualty 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 casualty to experience weakness, dizziness, headache, nausea, and loss of appetite. The casualty 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 casualty will appear ashen gray, the skin cool, moist, and clammy and the pupils may be dilated. The vital signs usually are normal; however, the casualty may have a weak pulse, together with rapid and shallow breathing. Body temperature may be below normal.

Treat heat exhaustion as if the casualty were in shock. Move the casualty to a cool or air-conditioned area. Loosen the clothing, apply cool wet cloths to the head, maxilla, groin, and ankles, and fan the casualty. Do not allow the casualty to become chilled. (If this does occur, cover with a light blanket and move into a warmer area.) If the casualty is conscious, give a solution of 1 teaspoon of salt dissolved in a liter of cool water. If the casualty vomits, do not give any more fluids. Transport the casualty 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 casualty suffers a breakdown of the sweating mechanism and is unable to eliminate excessive body heat buildup while exercising. If the body temperature raises too high, the brain, kidneys, and liver may be permanently damaged.

Sometimes the casualty may have preliminary symptoms such as headache, nausea, dizziness, or weakness. Breathing will be deep and rapid at first, later shallow and almost absent. The casualty will be flushed, very dry, and very hot. The pupils will be constricted (pinpoint) and the pulse fast and strong. 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 casualty 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 casualty to the coolest place available and remove as much clothing as possible. Maintain an open airway. Place the casualty 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 casualty to a fan or air conditioner, since drafts will promote cooling. Immersing the casualty in a cold water bath is also very effective. If the casualty 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 casualty to a medical facility as soon as possible. Cooling measures must be continued while the casualty is being transported. Intravenous fluid infusion may be necessary for effective fluid and electrolyte replacement to combat shock.