CHAPTER 9

ORTHOPEDICS

9-1. FRACTURES.

a. A fracture is a break in a bone. The break does not need to be complete to be considered a fracture; the bone may only be cracked, or in the case of stress fractures the bone tissue itself may only be torn.

b. To diagnose a fracture without X rays requires the utmost use of history and physical examination. If there is any doubt, treat as a fracture. Fractures may be suspected by one or more of the following:

(1) The patient feels or hears the bone break.

(2) Partial or complete loss of motion.

(3) Crepitus or grating.

(4) Deformity.

(5) Swelling and discoloration.

(6) Abnormal motion at fracture site (arm bending but not at the elbow).

(7) Point tenderness.

(8) Muscle spasm.

c. The main objective in fracture treatment is to prevent broken bones from moving, thus preventing further damage to tissue, nerves, and blood vessels. The basic principles of treating fractures are:

(1) Check and maintain airway (if appropriate).

(2) Determine extent of injury.

(3) Control hemorrhage.

(4) Start IV (if appropriate):

(a) Massive tissue damage.

(b) Fracture of femur.

(c) Any open fracture.

(5) Dress wounds.

(6) Immobilize (splint) fractures.

(a) Splint them where they lie. (Gross deformities may be gently corrected to alleviate circulatory inhibition if present.)

(b) Immobilize the joint above and the joint below the fracture.

(c) Pad the splint to prevent further injury or discomfort. Add extra padding over bony prominences.

(d) Traction is required on most fractures of long bones to overcome muscle contractions.

(7) Under conditions where patient cannot be evacuated, reduce fractures as soon as possible.

(a) Use anesthetics for reduction p.r.n. Fracture reduction can usually be accomplished by injecting local anesthesia into the hematoma of the fracture. An adjunct (e.g., morphine, Demerol) can be used for very painful procedures.

(b) Pad areas of pressure.

(c) Cast or splint in position of function.

(d) Bivalve all casts to allow for swelling and hold in place with ace wrap until swelling subsides (about 3 days), then replace with plaster wrap.

(e) Elevate and cool fractured extremities.

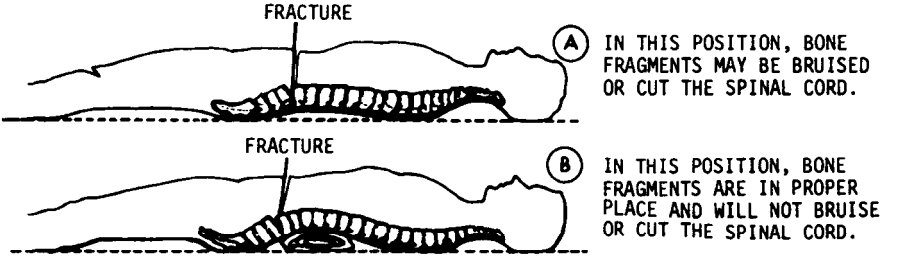
(f) Check extremities frequently for circulation loss.

d. Spinal column injuries. Any injury to the spinal column is potentially dangerous. Although a patient may have no apparent injury, moving him without proper precautions may result in spinal cord injury, causing paralysis.

(1) Fractured lower spine.

(a) Pain, tenderness, muscle spasm, deformity, paralysis, loss of bladder and/or bowel control may be present.

(b) If patient is conscious, place the patient in a swayback position (illustrated below) to avoid flexing the spine. (Flexing the spine can cause bone fragments to lacerate or compress the spinal cord.) If patient is unconscious transport in prone position with head rotated to side (be certain patient does not also have a neck injury).



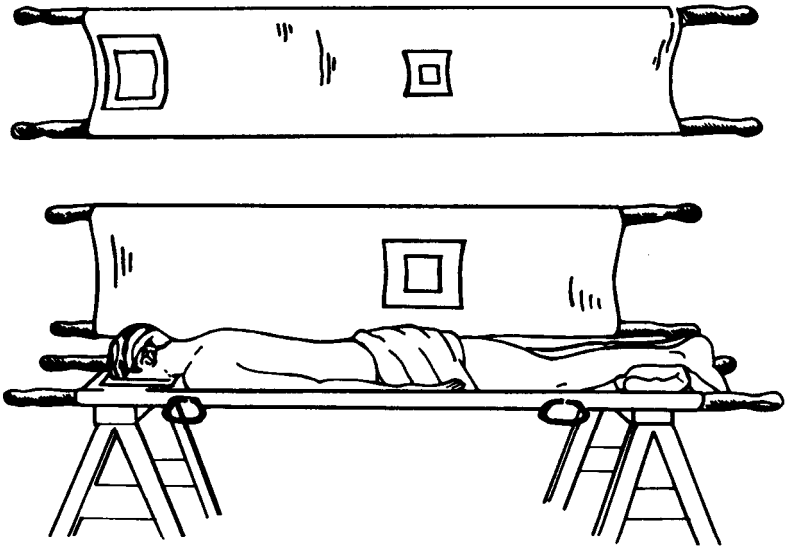
PATIENT PLACED IN A SWAYBACK POSITION.

If the patient is lying in a face-up position, place a folded blanket under the small of his back. If the patient is lying face down, place a folded blanket under his chest. This will keep the spinal column properly aligned and in a swayback position.

(c) Always move the entire vertebral column as a nonflexible unit.

(d) Use rigid litter or board longer than the patient is tall for transportation.

(e) Improvise some type of reversible bed so that the patient can be turned every 2 hours to prevent bed sores. (See illustration below.)



(f) An indwelling catheter must be used, and the patient should receive an enema daily.

(g) Patient must remain immobilized for 8-10 weeks.

(2) Fractured cervical spine.

(a) Signs and symptoms are similar to lower spinal column injury, but paralysis may include arms and upper body, even making the patient unable to breath. Any movement can cause further permanent damage.

(b) Make a thorough examination of the patient without moving his head.

(c) If patient is conscious, the first question should be, "Where do you hurt?" Suspect cervical spine injury if patient complains of severe occipital, shoulder, and arm pain, motor weakness, and numbness in arms and legs.

(d) To transport the patient. With the help of another person--

1. Hold the patient so his head and body are aligned.

2. Place the patient onto a firm surface (door or rigid stretcher). (If he is lying on his face, roll him onto the surface so he is lying on his back.) Be careful to hold the head in a neutral position.

3. Place a small rolled towel or sheet under the neck.

4. Place sandbags or boots filled with sand or dirt on either side of the head to stabilize it, or have someone hold the head in a neutral position while transporting the patient.

(e) Definitive treatment.

1. Fit into a head halter with padding to chin and apply traction in a straight line using a 10-15 lb weight. (A head halter can be improvised, but remember the patient will be in traction for at least 3 weeks. Think of his comfort when improvising.)

2. If there is no evidence of damage to the cord, place the patient on a foam mattress or a firm air mattress.

3. Patients with spinal cord damage must be placed on a turning frame (as with lower back injuries).

4. Commonly with cervical spine injuries, some sensory loss or paralysis may appear due to swelling, transection, or compression of spinal cord. Some or all of this paralysis may disappear as the swelling goes down.

5. Meticulous skin care must be maintained to prevent pressure sores.

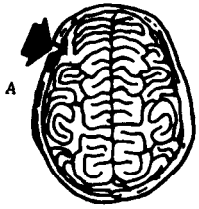
6. Place patient N.P.O., giving only IV fluids for the first few days until there is evidence of audible peristalsis.

7. Catheterize patient using indwelling Foley catheter.

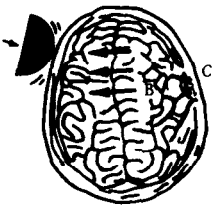
8. Usually after 3 weeks of traction, a cervical collar can be applied in cases where there is no cord damage (a collar can be made using a very well padded wire ladder splint). This should be worn for 8-12 weeks.

e. Craniocerebral injuries.

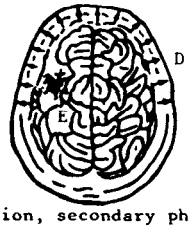
(1) Head injuries result either from penetration or impact. The damage may result from direct injury or may be secondary to compression, tension, or shearing forces caused by the injury. Note illustrations below.



A blow to the skull (direct injury) may result in fracture (A)



Or, in the absence of fracture, it may cause sufficient movement of the brain (B) to result in tearing some of the veins bridging from the cortical surface to the dura (C) with consequent development of subdural hematoma



In addition, secondary phenomena may result from the injury. Ischemia and particularly cerebral edema may ensue. Elevation of intracranial pressure secondary to ischemia cerebral edema (D), a mass lesion (E), or combination of these processes may occur and affect the outcome.

(2) Head injuries are classified as either closed or open.

(a) Closed injuries. Except for a possible bruise or contusion, there is no obvious external damage. Injury may be to the brain itself or to the pia or arachnoid meninges. Rupture of the blood vessels of the pia is particularly important in closed injuries. Blood spilled onto brain cells is a foreign substance and disturbs the functioning of these tissues. Blood collecting within the cranium exerts pressure against the brain. If there is no fracture of the skull, or if skull fracture is such that the integrity of the dura is not disturbed, the cranium is unyielding. If the skull is depressed or displaced inwardly, it may exert direct pressure on the brain even without formation of a hematoma (blood pool).

(b) Open wound. In an open wound there is obvious external damage. Open wounds of the head are subclassified according to whether or not the integrity of the dural is disturbed.

1. Nonperforated dura mater. The wound may be no more than a laceration of the scalp that, although not to be taken lightly, may not be serious. There may be one or more fractures of the skull, but the dura is not perforated. In either case, the possible internal damage is likely to be or become more serious than that of the scalp and skull. If the skull is fractured, it will hold in the same manner as a closed injury against the pressure of any hemorrhage that may occur within the cranium.

2. Perforated dura mater. With the skull and dura opened, the meninges are exposed to the open air and to pathogenic invasion. If the delicate meninges are opened, the brain itself is exposed. If the skull is fractured in such a way that it is no longer a

closed vault, part of it may be torn away, and brain tissue may be extruding through the opening.

(3) All head injuries are potentially dangerous, not only because of the immediate tissue damage and increased susceptibility to infection, but also because of the probability that some vital area or special sense is or will become involved. For these reasons, it is extremely important that all signs and symptoms referable to the nervous system be carefully noted and recorded with the time of their occurrence or observation.

(a) State of consciousness. The following descriptive adjectives should be used, as appropriate, to define the state of consciousness observed.

Conscious. Patient is alert and oriented in time and space.

Confused. Patient is alert but disoriented and excited. (For purposes of taking fluids by mouth, patient is conscious.) The disorientation and excitement, which are not in keeping with the total situation, may be temporary and have a psychological basis in addition to or instead of brain injury.

Somnolent. Patient is excessively drowsy or sleepy, but responds to stimulation.

Semicomatose. Patient responds to painful stimuli but makes no spontaneous movements. (For purposes of taking fluid by mouth, patient is considered unconscious.)

Comatose. Patient does not respond to any applied stimulus; he is unconscious in the usual sense.

(b) Pupil size. Normally, pupils of the eyes tend to become very small in the presence of strong light and to dilate as the light fades. Dilation in the presence of strong light indicates central nervous system impairment. Normally, the pupils are equal in size. When neither eye is obviously injured and the pupils are of unequal size, brain impairment should be assumed and is an ominous sign.

(c) Muscles. The musculature on one or both sides of the face may droop due to lack of stimulation from the brain through the cranial nerves serving the facial muscles. There may be loss or impairment of speech. Paralysis and lack of tone in the muscle mass of any part of the body when there is no damage to the area nor suspicion of spinal cord damage is presumptive evidence of impairment of the brain area controlling movement of those muscles.

(d) Vital signs. The vital signs--temperature, blood pressure, respiration--are especially important in head injuries since changes in these indices frequently indicate the onset of complications.

(e) Headache, nausea, dizziness, and loss of consciousness (which may be brief, intermittent, or extended) may accompany a closed head injury, depending upon the particular injury and its severity. If injury is from impact with a blunt surface, an elevated contusion (bruise) forms when blood and other fluids collect in a pocket in the subcutaneous tissue between the dermis and the skull; there may be fracture in which part of

the skull is displaced inwardly. In the more severe injuries, vomiting and paralysis of some muscle group may occur. The patient may bleed from the nose, mouth, or ears in the absence of obvious injury to these parts. Cerebrospinal fluid coming from the nose or ears indicates a grave injury. Normally a clear liquid, cerebrospinal fluid becomes cloudy when mixed with small quantities of blood. Signs of increasing intracranial pressure include: elevated blood pressure, slow pulse, restlessness, dilation of one or both pupils, decreased respiration, cyanosis, delirium or irritability, and paralysis. Unless a qualified person is available to relieve the pressure by opening the skull, increased respiratory failure, heart failure, and death may be expected.

(4) Closed head injuries may be difficult to diagnose. What may initially appear to be a minor injury with no complications may develop. (within 24 hours to 2 weeks or longer) into a life threatening problem due to gradually increasing intracranial pressure. It is important in head injuries to get a good history at the time of injury and do a complete neurological exam (see Chapter 1, Section VII, Nervous System). If there was any period of unconsciousness, the patient should be placed under observation for at least 24 hours with frequent neurological examinations. You should compare these examinations to determine if there is any deterioration in the neurologic findings.

(5) *Emergency medical treatment of head wound.*

(a) Assure an open airway. Clear the air passage of any vomitus, mucus, or debris as necessary; place the patient in coma position; turn the semicomatose or comatose patient from one side to the other every 20 minutes. As the patient's condition stabilizes, turning him every hour may be sufficient. Maintaining an open airway is usually not a problem for patients who have only scalp lacerations; the first consideration with these patients is to control the profuse bleeding.

(b) Control bleeding and protect wound. Place a sterile pressure dressing over the wound; do not remove or disturb any foreign material that may be in the wound; leave any protruding brain tissue as it is, and apply the dressing over this tissue.

(c) Prevent or treat shock. Apply measures for prevention or treatment of shock, with the following exceptions and modifications:

Do not put patient in head-low position.

Do not give morphine.

Give necessary fluids by mouth if possible (patient must be conscious and not nauseated). If required, give them very slowly.

(d) Observe patient. Observe the seriously injured patient for hours or until he can be transported to surgery. Take and record vital signs (which include pulse, respiration, and blood pressure) periodically. When possible, seek help from professional medical personnel if symptoms indicating intracranial injury or increased intracranial pressure appear.

f. Fracture of the femur.

(1) Usually there is a marked displacement of the fragments due to contraction of the large muscles in the thigh. This usually carries

varying degrees of shock due to trauma to the bone and soft tissue and loss of blood.

(2) First treat the patient as a whole; restore lost blood and fluid, treat for shock, relieve pain, and always make a search for associated injuries.

(3) If the fracture is an open one, it should be cleaned, debrided, and converted to a closed fracture as soon as the patient's condition permits.

(4) Traction must be used along with immobilization for all fractures of the femur. Use Thomas leg splint or improvise a traction splint of some type.

(5) Union takes at least 12-14 weeks. If there is any doubt, continue the immobilization with reduced traction for 4-8 more weeks.

(6) When union is sound, remove traction and have patient exercise the limb and joints freely in bed for several days, then allow the patient to walk using crutches until you are sure the union is sound.

g. Fracture of the lower jaw (see Chapter 19, Dental Emergencies and Treatment).

h. Fracture of the clavicle.

(1) Pain in shoulder, injured shoulder usually lower than uninjured shoulder, patient cannot raise his arm above his shoulder, patient usually supports the elbow on the affected side with opposite hand, and the fractured ends can usually be felt under the skin.

(2) Pad axillae and over the shoulder.

(3) Use two belts, strips of cloth, cravats, or roller bandages in a figure eight fashion to bring the shoulders up and back.

(4) Support the forearm with a sling and secure it to the body to reduce movement.

(5) Figure eight bandage must remain in place for 4-6 weeks.

i. Rib fracture.

(1) Pain in breathing and coughing. Pain and tenderness at fracture site are produced by hand pressure on the sternum. Sometimes the fracture can be felt. Patient usually holds his hand tightly over the break. If lung is punctured, the patient may cough up bright red frothy blood.

(2) Treat any penetrating chest wounds, hemothorax or pneumothorax (see Chapter 16, Emergency War Surgery).

(3) Control pain and apprehension, but avoid drugs that depress the respiratory and cough reflex centers. Pain is best relieved by intercostal blocks (repeated as necessary).

(a) Injection of one rib may be effective, but usually the

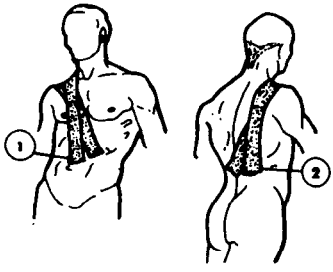
ribs above and below must also be injected to attain relief.

(b) Inject at least 5 cc. of lidocaine a hand's width proximal (toward the spine) under the margin of the rib after aspirating to insure you are not in a blood vessel.

(4) For fractures of upper ribs--

(a) Cleanse the skin and paint with tincture of benzoin.

(b) Have patient hold his breath following expiration while you apply two long 3" adhesive strips across the shoulder of the injured side. Strips should extend well down on the abdomen in the front and to the lower back in the rear (illustration below).

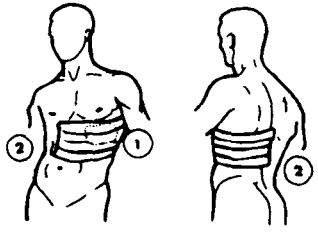


STRAPPING UPPER RIBS.

(5) For fractures of lower ribs--

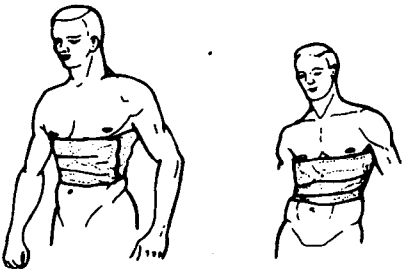
(a) Apply a piece of felt or foam rubber 1-2" thick over the fracture.

(b) Have patient hold his breath following expiration while you apply 3" adhesive strips extending beyond the midline anteriorly and posteriorly (illustration below).



STRAPPING LOWER RIB FRACTURES.

(6) An alternate method for fractures of upper and lower ribs is to apply a 6-8" elastic bandage encircling the trunk from below the costal cage to just below the level of the nipples. (See illustration below.)



STRAPPING WITH ELASTIC BANDAGE OR MUSLIN DRESSING.

(7) Union takes 4-6 weeks.

j. Fractures of fingers or toes.

(1) Manually manipulate fracture into position.

(2) Tape fractured finger or toe to adjacent finger or toe.

(3) Union takes 2-6 weeks.

9-2. SPRAINS.

a. A sprain is caused when a joint is stretched beyond its normal range of motion causing a stretching of the joint capsule and the ligaments surrounding the capsule--some fibers tear but the continuity of the structure remains intact. The amount of tearing of the ligaments determines the severity of the sprain.

b. Symptoms are very sharp pain at the time of injury accompanied by a sensation of no support in that particular joint. In addition, there is rapid swelling and loss or decrease of function in the joint.

c. Treatment.

(1) Sprains should be immobilized either by cast or taping depending on their severity.

(a) Hematomas around the sprained joint usually denote a severe sprain and should be splinted or put in a cast for at least 3 weeks.

(b) Minor sprains should be taped to support the ligaments and give them time to heal.

(2) Keep the joint at rest and elevate the part if possible.

(3) Apply cold compresses immediately after the injury and for the first 24 hours, then apply heat to relieve pain and promote circulation.

9-3. DISLOCATION.

a. A dislocation starts the same as a sprain but continues until the ligaments are torn and the bone pulls out of the joint capsule. This displacement of bone may be either partial or complete. Dislocations are

frequently accompanied by fractures, and structures such as blood vessels, nerves, and soft tissue surrounding the joint may be injured.

b. Symptoms are pain, deformity, swelling, discoloration, and usually a loss of motion. In severe cases, shock may be present.

c. Treatment.

(1) Dislocations should be reduced as soon as possible. Muscles surrounding the joint suffer a shock and you have a period of little or no pain, but as the muscles recover, they try to pull the bone back into the joint by contracting. The longer the bone is out of joint the stronger the contractions and the more damage is done to the surrounding tissue. By the same token, the stronger the contractions the more severe the pain and the harder it is to reduce the dislocation.

(a) Morphine or Demerol should be used in major dislocations to relieve pain and relax the muscles.

(b) The principle to follow in the reduction of dislocations is to pull the bone straight out and away from the joint and allow the muscles to pull the bone back into the joint by gradually releasing the pressure exerted.

(c) Once the dislocation has been reduced, the patient should feel immediate relief.

(d) Check distal capillary filling of the nail beds, blanching, pulse (pulse may or may not be present), color (look for cyanosis or pallor), and warmth of extremity to insure adequate peripheral circulation.

1. If circulation is insufficient, you will have severe pain in the flexor muscles, swelling, coldness, cyanosis or pallor, and paralysis and/or impairment of sensations.

2. Treatment should be started immediately. Treat symptomatically. Relieve anything that may cause circulatory impairment. Apply traction and ice packs (to relieve swelling). If after 2 hours circulatory impairment is not relieved, make S-shaped incision over the joint and extending distally. Incise the fascia and remove the hematoma. This may be sufficient to allow the collateral blood supply to relieve the circulatory insufficiency. (If it is necessary to repair arteries, see Chapter 16, Emergency War Surgery.)

(e) After dislocation has been reduced and blood supply is adaquate, immobilize the joint for at least 3 weeks.

9-4. STRAINS.

a. Strains are due to overstretching or overexerting a muscle or tendon, causing a tearing or rupture.

b. Symptoms are a sharp pain and cramps immediately upon injury, swelling, redness, heat, and loss of function.

c. Treatment.

(1) Place patient in a comfortable position that lessens tension and reduces pressure on the injured muscle or tendon.

(2) Apply heat.

(3) Strap injured area with adhesive tape to immobilize the area.

CHAPTER 10

BURNS AND BLAST INJURIES

10-1. BURNS.

a. How to manage situations causing burns.

(1) Patient with clothes on fire: Since flames ascend, get the patient flat on the floor, forcibly if necessary, with flames uppermost, then smother flames with coat, rug, or blanket.

(2) Scalds: Immediately rip off affected clothes so as to reduce time of application of hot fluid to skin.

(3) Patient in a burning room: Rescuer first hyperventilates, ties a wet cloth around his face and enters room, holding breath and staying low. Give oxygen to patient immediately upon rescue.

(4) Electrical: Push patient off the conductor with a nonconductor or pull him off by his belt. Do not touch his body while he is in contact with the conductor unless you are wearing insulated gloves. First check for heartbeat or pulse. If there is none, start CPR until heart resumes beating and patient is breathing on his own, or is pronounced dead or for a maximum of 3 hours.

b. Calculation of depth (degree) of burn.

(1) First degree:

(a) Examples: Sunburn, low intensity flash.

(b) Only the outer layer (epidermis) is burned.

(c) Symptoms: Tingling, painful, hyperesthetic (extremely sensitive to touch).

(d) Signs: Reddened, blanches with pressure, minimal or no edema.

(e) Course: Peeling and complete recovery within seven days.

(f) Treatment: Noxzema cream or mild analgesics.

(2) Second degree:

(a) Examples: Scalds, flash flame.

(b) Most but not all of the thickness of the skin is burned. Capillary walls are damaged with leakage of plasma into the tissues.

(c) Symptoms: Very painful; sensation to pin prick normal or slightly decreased.

(d) Signs: Blisters either intact or broken; weeping surface; mild edema.

(e) Course: Heals with no scarring or minimal scarring in 2-3 weeks. Infection may convert to third degree.

(3) Third degree:

(a) Example: Fire burns.

(b) The full thickness of the skin is destroyed. Edema is greatest.

(c) Symptoms: Painless to pin prick. Symptoms of shock may appear if edema is great enough.

(d) Signs: Skin is dry, pale white, or charred. Edema is present.

(e) Course: A scab will form and slough in about three weeks. Skin grafting will be necessary since scar, not skin, will cover the burn.

c. Treatment.

(1) First aid for all burns involves the following items:

(a) Relieve pain. (Morphine is the most active way to reach pain in severe burns. IV injection 8 to 10 mg. may bring relief).

(b) Prevent or treat shock.

(c) Prevent infection through strict asepsis.

(d) In burns due to electricity or severely swollen membranes in mouth and throat, the burn may have to be ignored while resuscitative measures are carried out, or CPR instituted to restore the heartbeat.

(2) Remove all clothing except that which is stuck.

(3) Treat chemical burns: Local treatment of chemical burns varies with the burning agents. Wash the burn with large quantities of water; acid burns should be neutralized by washing with a dilute sodium bicarbonate solution, and alkali burns with vinegar or dilute acetic solution. Otherwise the treatment is the same as for thermal burns.

(4) Examination of patient: Make careful initial evaluation combined with an accurate diagnosis.

(a) History and type of burning agent.

(b) Duration of exposure to heat.

(c) Careful examination of the depth of burn. Although burns are classified in degrees, the important factor from a therapeutic and prognostic viewpoint is whether the full thickness of the skin is affected. This may be checked in the following manner:

1. Areas of full thickness of skin loss show insensitivity to pin prick and loss of light touch.

2. If hair can be picked out with little resistance or no pain, the burn is a deep one.

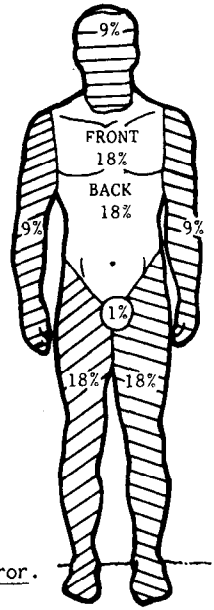
(d) Careful evaluation of the extent of the burn (percent of the body surface area burned). This may be accomplished by the "Rule of Nines" method.

d. Calculating the area of the burn.

(1) No one can treat a burn intelligently unless he is able to correctly observe and record the area of the burn expressed in percent of total body surface.

(2) RULE OF NINES:

Each upper extremity	9%
Head and neck	9%
Anterior trunk	18%
Posterior trunk	18%
Each thigh	9%
Each lower leg	9%
Perineum	1%



CAUTION: Do not overestimate percentage. Common error.

e. Classification of burns by severity.

(1) Critical burns.

(a) Second degree over 30% area.

(b) Third degree over 10% area.

(c) Third degree of hands, feet, or face.

(d) Any burn complicated by respiratory injury or other injury such as fractures or major soft tissue injury.

(2) Moderate burns.

(a) Second degree of 15-30% area.

(b) Third degree of 4-10% not involving hands, feet, or face.

(3) Minor burns.

(a) Second degree less than 15% area.

(b) Third degree less than 4% area not involving hands, feet, or face.

f. General principles of burn treatment.

(1) Cleansing: The cleaning of burned areas should be accomplished by gentle washing with pHisoHex and sterile saline when the burn is fresh. Wash away all trash, dirt, and bits of clothing. After danger of infection is past, burned area may be washed with ordinary soap and tap water.

(2) Blisters: What should be done about blisters? Leave intact blisters alone until they break themselves, then cut away with iris scissors. Any intact blister showing evidence of infection within it (purulent contents or surrounding lymphangitis) should be immediately opened and debrided in a sterile manner.

(3) All second degree or more burns should receive a tetanus booster.

(4) Ointments: There is no proven evidence that any antibiotic ointment applied to a burned surface is any more advantageous than plain vaseline or no ointment at all. However, it has been the personal experience of others that routine light application of Furacin ointment or Silvadene Cream to all second and third degree burns decreases the incidence of infection, and may prevent a deep second degree from going to a third degree burn. A very rare patient may exhibit a sensitivity to Furacin ointment or Silvadene Cream, but the benefit far outweighs the risk.

(5) Bandaging: Numerous papers variously supporting the "open method" and the "closed method" exist. You cannot go wrong by following this rule:

(a) All burns of the head, neck, and perineum should be left open.

(b) All burns of the hands, joints, and circumferential burns of the trunk and extremities should be bandaged.

(c) For burns involving a single aspect of the trunk or extremity, either method is fine.

Use own judgment, depending on the circumstances. If in doubt, bandage.

CAUTION: Extensive bandaging of a patient hospitalized in a warm room may cause hyperpyrexia.

(d) When bandaging, a nonadherent material should be placed next to the burn to prevent granulation tissue growing into the gauze only to be ripped off at the next dressing change. An ideal such material is

parachute nylon obtained from a surplus parachute. Cut it up in small pieces, package and autoclave it, and that will make an ideal nonadherent material to place next to the burn. If such is not available, use the finest mesh gauze that is available.

(e) Burns of the hand should be bandaged using a bulky dressing with the hand in the position of function (slight extension at the wrist and all fingers moderately flexed). If the fingers are burned, place bandaging between the fingers. The tips of the fingers should be exposed to allow for circulation to be checked and to preserve the patient's sense of touch.

(f) Burn bandages should be bulky so as to absorb exudate. Change the original burn bandage at 5 to 7 days if there are no complications. Change the dressing earlier if it is stained from the inside out, if there is malodor, if there is an increased pain or unexplained elevation of the patient's temperature.

(6) Burn over joints: Immobilize the joint to allow healing.

(7) Antibiotics: No systemic antibiotics are indicated for burns less than 15%. For second or third degree burns over 15%, give procaine penicillin 1.8 million units and streptomycin 1.0 gram daily in divided doses for 5 days. Thereafter, rely on sensitivity disc if infection is apparent in the wound.

(8) Pain: Small second degree burns can usually be managed with oral codeine, 1/2 grains from 1 to every 3 hours. Second degree burns over 20% usually require parenteral narcotic analgesics. The drug of choice is morphine; the second choice is Demerol.

NOTE: If hypotension or shock exist, which is possible if the burn is over 20%, give the analgesic intravenously in 1/3 to 1/2 of the IM doses. The reason for this is that subcutaneous or IM medications are not picked up by the patient in shock because of decreased blood flow. Therefore, the medications will not give pain relief even if repeated and will accumulate in the extravascular spaces until such time as the shock is corrected. Then they will pick medication up into the circulation all at once and constitute an overdose.

(9) Environmental temperature: The ideal environmental temperature for treatment of a large burn is 75 degrees to 80 degrees F.

(10) Burns of the genitalia: The urethra may close off from excessive edema in one-half hour, therefore place a Foley catheter as early as possible.

(11) Transportation of burned patients: If transportation to a hospital requires less than one-half hour, the only treatment required is about 1/8 grain morphine intravenously. If transportation is expected to require more than one-half hour, start an IV of Ringer's lactate or Saline. The patient does not tolerate prolonged transportation as well after 48 hours as he does before that time.

(12) Establishment of intravenous lifeline: All patients with burn over 20% must have an 18-gage needle (or preferably an intravenous catheter) placed and anchored securely in a vein as soon as the diagnosis is made because intravenous fluids and whole blood will be required. The

most practical site for a corpsman to do a cutdown is the greater saphenous vein just anterior to the medial malleolus of either ankle.

(13) Oral intake: Burned patients are usually quite thirsty and demand large quantities of water. Fluid replacement in burns less than 15% can usually be administered entirely by mouth. In more extensive burns, paralytic ileus and vomiting are quite common during the first few days. In an extensively burned patient, all oral intake is withheld and the entire replacement therapy is intravenous.

(14) Respiratory tract burns: A burn of the trachea or bronchi is a very serious complication of a burn injury. It is most apt to occur in flame burns about the face, or if the burn was sustained in a close-fire explosion, or if live steam is involved. Edema of any of the upper respiratory passages after such a burn may quickly cause death. As soon as the burned patient is seen, determine if respiratory tract damage has occurred.

(a) The symptoms of respiratory tract burns are hoarseness, coughing, rapid respiration, or cyanosis. Redness in the posterior pharynx may be present. Rales or rhonchi in the lung may be or may not be present. If a respiratory tract burn exists, a tracheostomy should be performed as soon as pain is relieved and replacement therapy has been started (fluids or whole blood). Give oxygen.

(b) Recent evidence clearly shows that a tracheotomy should not be done in burn patients unless there is a clear indication for it. The concept of "prophylactic tracheotomy" in the burned patient should be abandoned. If the tracheotomy is done, be sure it is done into the second or third tracheal rings, located just below the cricoid cartilage and above the isthmus of the thyroid gland. A "low" tracheotomy below the fourth ring is dangerous; the endotracheal cannula may rest on the carina or enter a main stem bronchus.

g. Treatment of pulmonary edema.

(1) Semi-Fowler position (sitting up).

(2) Morphine grains 1/6, IM or IV.

(3) Oxygen in high concentration (8-9 liters per minute).

(4) Aminophylline 250-500 mg. IV slowly.

(5) Reduction in the blood volume by venesection (300-500 ml.) or tourniquets on two of the four extremities applied with sufficient pressure to obstruct venous but not arterial flow. Rotate every 15 minutes.

h. Pathologic physiology.

(1) Edema inevitably follows burning. Heat causes capillary injury, resulting in vasodilation and increased capillary permeability.

(2) A burn is a three-dimensional wound consisting of length and width (area) and depth. Depth cannot be visualized and is difficult to determine accurately, but is an extremely important factor affecting the volume of edema that will occur. Examples: In a first degree burn,

vasodilation is the only change that occurs, and edema is minimal. A second degree burn, being deeper, involves a large volume of tissue plus more extensive capillary damage so that edema occurs. Although there is no edema in the charred eschar of a third degree burn, the volume of edema around and under it is greater than the volume of edema in a second degree burn of comparable area. Remember that the greatest fluid losses occur deep in the wound, hence appearance is misleading.

i. Edema time factors.

(1) The rate of edema formation (intravascular fluid loss) is greatest in the first 8 hours after burning. Edema continues to form, but at a less rapid rate, until about 36 to 48 hours after burning, at which time the total edema is maximal.

(2) Resorption of edema then occurs and proceeds slowly over 5 to 7 days, but burn edema may persist for 2 or 3 weeks.

(3) From the above statement it is apparent that the danger of shock is greatest in the first 24 hours after burning and is almost never a problem after 36 to 48 hours, if adequate fluid replacement therapy has been given. After the possibility of respiratory tract burn has been considered, all efforts in therapy are then directed towards proper fluid therapy to replace the fluid extravasated into the tissues as edema.

j. Fluid replacement in minor burns.

(1) In general, there is not a significant danger of shock in burns less than 20% and these can be handled with an oral fluid replacement therapy consisting of a solution of 1/2 teaspoon of salt and 1/2 teaspoon baking soda in one quart of water.

(2) The solution should be thoroughly chilled for optimal patient tolerance. If vomiting occurs, discontinue oral intake and use the intravenous route.

(3) In a disaster, when IV fluids may not be available, oral electrolyte replacement solution may be a lifesaving measure for all patients with burns up to 35%. The recommendation limiting the use of oral therapy to patients with less than 20% burns is conservative and assumes availability of IV fluids.

(4) If both IV and oral fluids are given, the oral intake must be included in the calculated 24-hour fluid replacement plan.

k. Calculation of fluid replacement therapy in moderate or serious burns.

(1) Fluid replacement requirements are governed by many complex variables and it is impossible to state in a formula exact replacement requirements. The burn formula below is a very practical and valuable as an initial rough estimate fluid replacement guide.

(2) Brooke formula:

(a) Ml. of fluid to be given in the first 24 hours = (% body burn) x (wt. in kilograms) x (0.5 cc.) colloid plus (% body burn) x (wt. in kilograms) x (1.5 ml.) Ringer's lactate solution plus 2,000 ml. 5%

dextrose in water.

(b) Expressed in terms of pounds instead of kilograms, the formula becomes: ml. first 24 hours = (% burn) x (wt. in pounds) x 0.23 ml. colloid + (% burn) x (wt. in pounds) x (0.67 ml.) Ringer's lactate solution plus 2,000 ml. of 5% dextrose in water.

(c) Give one-half of the total calculated 24-hour requirement in the first 8 hours after the burn, starting from the time the burn occurred. Give the remainder evenly over the remaining 16 hours.

(d) In applying the formula to burns over 50%, calculate as though only 50% had been burned.

(e) Do not count first degree burns in computing the fluid requirement.

(f) During the second 24 hours, give one-half of the volume of colloid and Ringer's lactate as calculated for the first 24 hours, plus 2,000 ml. of 5% dextrose in water.

Problem: A 150-lb man sustains a total body burn of 35% consisting of 20% first degree, 25% second degree, and 10% third degree. Plan fluid therapy. Assume you have dextran.

Ml. first 24 hours = 35 x 150 x 0.23 ml. colloid + 35 x 150 x 0.67 ml. Ringer's lactate plus 2,000 cc. 5% dextrose in water which equals 1,207 ml. dextran plus 3,517 ml. Ringer's lactate plus 2,000 ml. dextrose in water.

The total volume of fluids to be given in the first 24 hours after the burn is 6,724 ml. One half of this amount, or about 3,500 ml., should be given in the first 8 hours after the burn. Therefore, appropriate fluids for the first 8 hours after the burn would be 2,000 ml. of Ringer's lactate, then 500 ml. Dextran, then 1,000 ml. dextrose 5% in water. If IV fluids are started late and you are trying to catch up, you can give as much as 200 ml. in 1 hour (300 drops per minute) without overloading the circulation. Or if treatment has been delayed and the patient is already in shock, fluid administration by two separate veins may be necessary.

(g) By far the most accurate guide to adequacy of administered fluids is the rate of urinary output. Therefore, all patients receiving prolonged therapy should have a Foley catheter in place and urinary output measured at least hourly. A urinary output of 25 to 40 ml. per hour is adequate. A rate much over this indicates fluids are being given too rapidly.

1. Oliguria (very low rate of urine output).

(1) A special problem is posed by the severely burned patient who has oliguria or anuria even after fluid therapy has been started, since acute renal failure is a rare complication of severe burns. Should the case be considered one of renal failure or should it be assumed that fluid therapy has been insufficient? This question is crucial since the accepted method of treatment for renal failure is rigid fluid restriction, a plan that would be disastrous if in fact the oliguria is due to inadequate fluids. In this circumstance the correct course of action is intensive therapy with whatever fluid appears to be deficient on the assumption that oliguria is caused by inadequate fluids. If oliguria persists, then he has

a renal shutdown and you stop the flow of IV fluids after 1,000 ml. of colloid and 1,000 ml. of electrolyte solution have been given rapidly (150-300 drops per minute), then renal failure due to organic changes is likely to be present.

(2) Oliguria is often encountered in extensive second degree burns, while anuria is more commonly a complication of extensive third degree burns.

m. Other care in the first 24 hours.

(1) Record the urine output, pulse, and blood pressure at least hourly. It is preferable not to give anything by mouth for the first 48 hours in severely burned patients. If there is severe thirst, small amounts of water may be given, but the amount must be recorded and subtracted from the total allowance.

2. Since acute gastric dilation is a common complication, examine the abdomen frequently for distention. It may be necessary to pass a nasogastric tube.

n. The second 24-hour period.

(1) The fluid regimen consists of 1/2 of the colloid and electrolyte solutions given during the first 24 hours, plus 2,000 ml. 5% dextrose in water.

(2) Fever of 101-102°F. (orally) is not uncommon even in the absence of infection.

o. Treatment after 48 hours. By 48 hours, edema is maximal but its production has ceased. The physiology of electrolyte imbalance that may occur after 48 hours is too complicated to be considered in this manual. A general rule is to give only 5% dextrose and water in order to dilute the large amount of sodium being immobilized from the burn edema.

p. Outline of immediate treatment plan.

(1) Relieve pain.

(2) Obtain history, including weight of patient.

(3) Map area and degree of burn.

(4) Determine need for tracheotomy.

(5) Start Ringer's lactate of dextran, using a large-bore needle (an 18-gage is preferable).

(6) Do cut down if necessary.

(7) Insert Foley catheter.

(8) Initiate local care, like cleansing and dressing.

(9) Give penicillin and streptomycin if indicated.

(10) Give tetanus toxoid.

(11) Plan fluid replacement requirement.

10-2. BLAST INJURIES.

a. General information. The human body is not constructed to tolerate very marked or sudden increases in pressure. This is obvious from our past experiences in wars and from the experiences of deep-sea divers. The effects of a blast depend upon the wave length and the substance this blast or "shock" waves are transmitted by. Long slow waves are very low pitched and do very little damage since usually only one or two waves pass through the body. A sudden increase of 7 psi may rupture the tympanic membrane; however, it will take a sudden increase in excess of 30 psi to injure the hollow organs or cavities of the body.

b. Types of blast.

(1) Air. The waves travel slowest in air and do not do as much damage to the human body. Most injuries from an air blast are not true blast injuries but are caused by flying debris, etc.

(2) Water. Blast waves travel much faster in water than in air and will cause damage at greater distances. The human body has essentially the same density as sea water, which allows blast waves to pass through solid tissue without injury. Most of the damage from a water blast occurs to the hollow viscera, lungs, abdomen, and gas-filled cavities.

(3) Solid. Blast waves travel fastest through solid objects. The denser the substance, the faster they travel. These waves traveling through the deck of ships, etc., produce breaks in major blood vessels often without a break in the skin.

c. Classification of blast injuries.

(1) Primary. Injuries caused by the effect of blast waves on the body such as ruptured tympanic membranes, damage to hollow viscera, etc.

(2) Secondary. Injuries caused by flying debris such as shrapnel, bricks, chunks of plaster, etc. This classification also covers those who were trapped and injured in a building that was blown up around them.

(3) Tertiary. Injuries caused by the blast picking up the body and hurling it through the air striking some other object.

NOTE: It is frequently very hard to determine just which classification is proper and there are many times when more than one classification of injury will coexist in the same patient.

d. Common blast injuries. It is necessary to suspect blast injuries after any incident that would cause them. With no external marks or visible symptoms, the victim might be required to do something that could prove fatal to him. If there are no visible signs of injury and the patient is developing shock, it is a good indication of blast injury. Victims are often treated as "walking wounded" and only when shock, dyspnea, apprehension, tremulousness, and fear are apparent, is the correct diagnosis made.

(1) Ruptured tympanic membrane. As previously noted, this is the most common blast injury and occurs when there is as little as 7 psi sudden increase in pressure.

(a) Symptoms: A sudden, severe, lancinating pain in the ear. There may be bleeding from the affected ear and various degrees of hearing loss.

(b) Treatment: Clean the opening or meatus gently then "leave it alone." Do not pack, syringe, or instill any medication.

(2) Blast lung. When the symptoms of pain and clinical signs are first in and remain localized in the upper abdomen, the chances are very good that the blast injury is thoracic.

(a) Symptoms: In addition to the routine blast symptoms there is usually cyanosis, rapid pulse, and pain in the chest and upper abdomen with moderate abdominal rigidity. The patient may be coughing with ineffective expectoration of bloody, frothy mucous. There are usually multiple hematomas along the anterior costal lines.

(b) Treatment: Move as little as possible and it is best to stabilize patient for 48 hours before even evacuating him if possible. Administer oxygen for relief of cyanosis and dyspnea. Always suspect pulmonary edema from alveolar hemorrhage, and if it is mandatory to use IV fluids, use with extreme caution and run at slow rate. Atropine sulfate may be given in small doses to help diminish secretions. Avoid any ether or gaseous anesthetic agents. Antibiotics are useful for serious blast lung cases.

(3) Blast abdomen. Many persons describe the sudden onset of pain as a "kick in the belly," followed by a remission then by a recurrence. When clinical signs occur first in the upper abdomen then spread to the lower abdomen, then abdominal blast injury is most certain. When clinical signs remain from the onset in the lower abdomen, there is little doubt of intraperitoneal damage.

(a) Symptoms: Sudden occurrence of abdominal pain, a brief period of remission, then reoccurrence of severe, unremitting, and most of all increasing pain. Frequent bowel evacuations with difficulty in urination. Melena or frank passage of bright red blood in the stool.

(b) Treatment: The serious cases can be treated only with surgery. Place them high on the evacuation list. If hemorrhage or perforation is suspected with good reason, then request advice on dosage of antibiotics to sterilize the bowel. Keep N.P.O., insert nasogastric (NG) tube, catheterize with indwelling catheter, and consider pain relief. Withhold morphine until a careful assessment is made of the injury and treatment schedule. For example, do not give morphine if he will be on anesthesia and surgery within the following 1 to 2 hours.

(4) Other blast injuries. For fractures and other tissue trauma, treat the same as at any other time. Contusions of the scrotum and testicular pain are common; treat with adequate support. The transient paresis of the limbs that has been described in association with blast injuries is probably due to minor vascular disturbances in the spinal cord.

CHAPTER 11

HEAT AND COLD INJURIES

11-1. HEAT INJURIES.

a. Factors that govern heat injuries.

(1) Water.

(a) The human body is absolutely dependent upon water to cool itself in hot environments. In severe heat it is possible for a person to lose a quart of water each hour. Water lost must be replaced or an individual can become a heat injury. The activity will determine the amount of water necessary to maintain proper body functions, as illustrated below.

ACTIVITY	ILLUSTRATIVE DUTIES	Quarts per man per day for drinking purposes (a guide for planning only) WBGT or WD index* Less than 80°	Greater than 80°
Light	Desk	6	10
Moderate ...	Route march	7	11
Heavy	Forced marches; stevedoring; entrenching; or route marches with heavy loads or in CBR protective clothing.	9	13

*80° wet bulb globe temperature (WBGT) or WD index is approximately equivalent to a dry bulb temperature of 85° in a jungle or 105° in a desert environment.

Water requirements.

(b) The myth that humans can be taught to adjust to decreased water intake has been disproven. When water is in short supply, significant water economy can be accomplished only by limiting physical activity to the coolest part of the day or night.

(2) Salt.

(a) Ordinarily one's normal food intake will contain adequate salt; however, in heat stress situations, unacclimatized persons may require additional intake.

(b) Unless one is sweating continuously or repeatedly, salt tablets will not be required. Extra salt in the cooking, at the table, and in the water is all that is required.

(c) Older people and acclimatized persons tend to have less acute needs for salt replacement.

(d) A convenient way to provide adequate salt is to salt the drinking water 0.1%, in amounts shown below.

Salt	Diluting Water
2 ten-grain salt tablets	dissolved in 1-quart canteen
4 ten-grain salt tablets	dissolved in 2-quart canteen
1 1/3 level mess kit spoons salt	dissolved in 5-gallon can
9 level mess kit spoons salt	dissolved in lister bag
1 level canteen cup salt	dissolved in 250-gallon water trailer

Preparation of 0.1 percent salt solution.

(3) Acclimatization. It takes a period of about 2 weeks to become acclimatized, regardless of the physical condition. An acclimatization program should consist of a person being exposed to progressively increasing heat and physical exertion in a new climate condition. Careful and fully developed acclimatization increases resistance, but it does not give complete protection from the ill effects of heat.

(4) Physical conditioning has a significant bearing on the reaction to heat stress.

(a) Debilitating diseases and injuries enhance the likelihood of heat injuries.

(b) Overweight personnel have a much higher incidence of heat injuries.

(5) Environmental factors.

(a) Although heat injuries can occur at temperatures below 0°F., e.g., overexerting and overdressing, most heat injuries occur during periods of high temperature and humidity. As the temperature rises, physical activity should be curtailed, as shown in heat categories below.

GUIDELINES FOR PHYSICAL ACTIVITY

CATEGORY	WBGT INDEX	NONACCLIMATED PERSONNEL	ACCLIMATED PERSONNEL
I	82-84.9°F.	Use discretion in planning intense physical activity. Limit intensity of work and exposure to sun. Provide constant supervision.	Normal duties.
II	85-87.9°F.	Strenuous exercises such as close order drill and physical training will be canceled. Outdoor classes in the sun will be canceled.	Use discretion in planning intense physical activity. Limit intensity of work and exposure to sun. Provide constant supervision.
III	88-89.9°F.	All physical training, strenuous activities, and parades will be canceled.	Strenuous outdoor activities will be minimized for all personnel with less than 12 weeks

			training in hot weather.
IV	90°F. and above	Strenuous activities and nonessential duty be canceled.	Strenuous activities and nonessential duty will be canceled.

Heat categories.

(b) The four basic factors that determine the degree of heat stress exerted by the environment are air temperature, relative humidity, air movement, and heat radiation. These factors can be measured by using a WBGT Index. The WBGT Index is computed as follows:

WBGT = 0.7 x wet bulb temperature

+ 0.2 x black globe temperature

+ 0.1 x dry bulb temperature.

(c) To make a WBGT apparatus, see sketch on following page.

b. Heat cramps. Caused by excessive salt loss from the body.

S. Painful cramps of the voluntary muscles usually in paroxysms lasting from 3-10 minutes with periods of relative comfort between the spasms. Patient may be grimacing and thrashing about with arms and legs drawn up. Skin is usually hot and moist.

O. Blood pressure and temperature will usually be normal. The pulse may be slightly elevated.

A. Heat cramps. Differential diagnosis: Heat exhaustion.

P. Remove to shaded area and give salt in any form to balance loss. IV normal saline 500-1,000 cc. in acute cases, 0.1% salt solution in cool water orally will afford both relief and continued protection. Massaging of cramped muscles will usually help afford immediate relief.

Do not use hot packs on the cramped muscles; that will only make it worse. Do not use saline enemas as that only draws more salt and water from the tissue.

c. Heat exhaustion. Caused by failure of peripheral circulation due to salt loss and dehydration.

S. Profuse sweating (diaphoresis) with cold, wet, and pale skin. Headache, mental confusion, vertigo, incoordination, drowsiness, extreme weakness, anorexia, nausea and vomiting, with visual disturbances. Occasionally, cramps of the extremities or abdominal muscles occur.

O. Temperature taken orally may be subnormal or slightly elevated, rectal temperature is usually elevated (100-101°F.), rapid pulse (140-200) with blood pressure usually lowered.

A. Heat exhaustion. Differential diagnosis: Heat cramps,

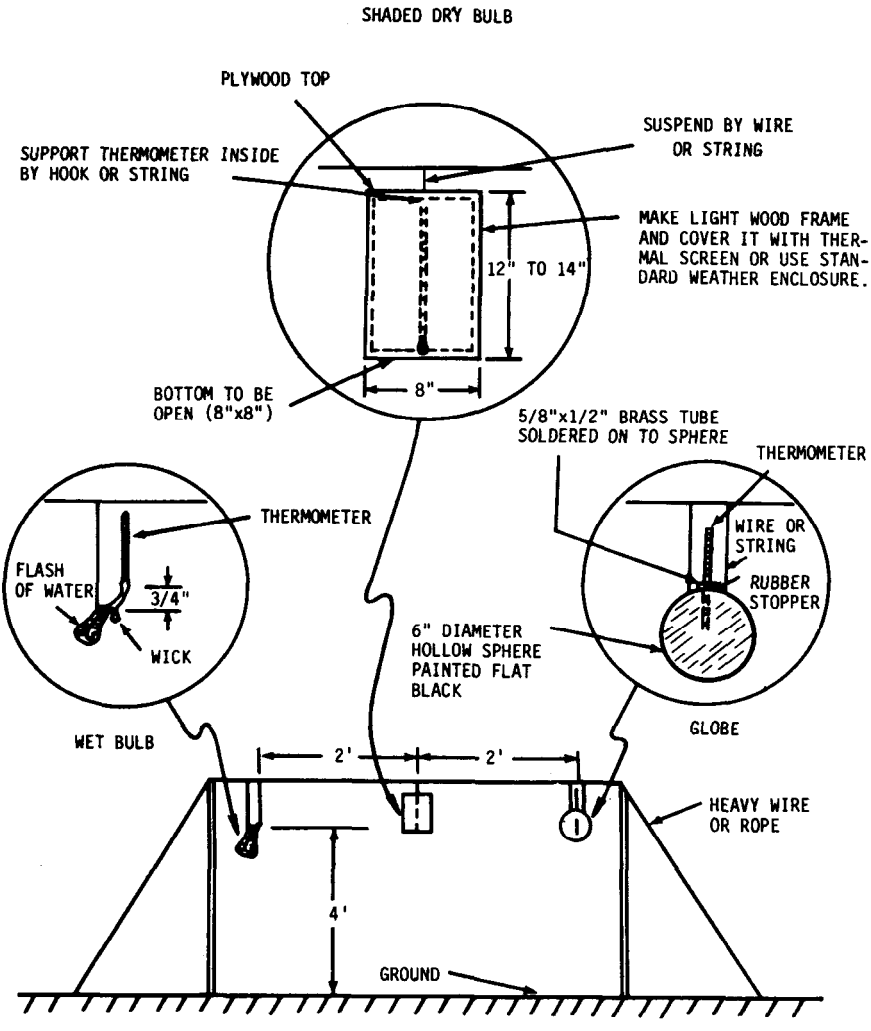


FIGURE 1. WBGT Index of-field apparatus.

heatstroke.

P. Remove patient to a cool, shaded area. Replace fluids and salt by giving patient cool water with 0.1% salt solution; or if he cannot take by mouth, give 1,000 to 1,500 cc. 5% dextrose in normal saline or a normal saline IV (an IV should be started in any case). Stimulation may be required such as tea, coke, coffee (caffeine) or even IM injection of .3 to .5 cc. of 1:1,000 epinephrine. Avoid immediate reexposure to heat.

d. Heatstroke. Caused by a breakdown of the body heat regulating mechanism.

S-O. There may be early symptoms of headache, dizziness, mental confusion, weakness, nausea, involuntary urination, and diminished or absent sweating. There may even be a false sense of exhilaration. Usually, however, the onset is dramatically sudden with collapse and loss of consciousness. Convulsions may occur. The skin is hot, red, and dry. The pulse is full and rapid, with blood pressure normal or elevated. Respirations are rapid and deep. The body temperature is markedly elevated (106-110oF.). As the patient's condition worsens, cyanosis is usually noted. The breathing becomes shallow and irregular. Pulmonary edema, involuntary urination and defecation, vomiting, hemorrhagic tendencies, disturbances of muscle tone, and jaundice and meningitislike symptoms to include tetanuslike body arching. Death may come very rapidly, but if patient survives until the second day, recovery usually occurs. Severe relapses may occur.

A. Heat stroke.

P. Lower the patient's body temperature as rapidly as possible. The longer the body temperature is high the greater the threat of permanent damage or death. Remove the patient's clothes and immerse him in cold water (tub of ice water, if possible). If not available, wet patient down with ice, water, or alcohol and fan him. Rub patient's extremities and trunk briskly to increase circulation to the skin. Temperature must be monitored closely and when temperature drops to 102oF. stop cooling, dry patient off, and wrap him in blankets or place him on heating pads. Usually the temperature will continue to fall, and sometimes will reach as low as 94oF. before it starts to rise again. If the patient's temperature falls below 97oF. be prepared to start the cooling process again when his temperature rises to 97oF. Constantly monitor the patient's body temperature and alternate heating and cooling until his temperature stabilizes. Continue monitoring the temperature every 10 minutes for the next 48 hours.

Care must be used in giving heatstroke patients medication. Sedative drugs disturb the heat regulating center and should be avoided if possible. When sedatives are necessary (as with convulsions), a short acting barbiturate such as sodium Pentothal IV is the drug of choice. If a longer acting drug is needed, phenobarbital should be administered IM. Epinephrine, sodium amytal, and morphine are contraindicated. Atropine or other drugs that may interfere with sweating are also contraindicated. An IV of normal saline or as second choice Ringer's lactate should be started and 1,000-2,000 cc. should be given initially. Subsequent IV infusion is determined by hourly urinary output and serum electrolyte determinations. It is important to recognize that the heat regulating centers may not function correctly for many weeks after an attack. This means the patient must be kept in a fairly controlled environment during this period and

monitored at regular intervals. One attack of heatstroke predisposes an individual to further attacks.

11-2. COLD INJURIES.

a. Factors governing cold injuries.

(1) Weather, temperature, humidity, precipitation, and wind modify the rate of body heat loss. Low temperatures and low humidity favor frostbite, whereas higher temperatures together with moisture are usually associated with trench foot. Wind velocity accelerates body heat loss under both wet and cold conditions. (See chart.)

Cooling Power of Wind on Exposed Flesh Expressed as an Equivalent Temperature (under calm conditions)

Estimated wind speed (in mph)	Actual Thermometer Reading (°F.)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	EQUIVALENT TEMPERATURE (F.)											
calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-21	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-36	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-124
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-49	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(wind speeds greater than 40 mph have little additional effect)	LITTLE DANGER (for properly clothed person)				INCREASING DANGER			GREAT DANGER				
	Danger from freezing of exposed flesh											

Trench foot and immersion foot may occur at any point on this chart.

(2) Clothing should be worn loose and in layers. Loose layers of clothing with air space between them worn under an outer wind- and water-resistant garment provide maximum protection. The loose inner layers can and must be removed during periods of strenuous physical exertion to prevent overheating and accumulation of perspiration. Wet clothing loses much of its insulation value.

(3) The very young and very old are more susceptible to cold injuries.

(4) Previous cold injuries definitely increase the risk of subsequent cold injury, not necessarily involving the part previously injured.

(5) Fatigue may cause apathy leading to neglect of acts vital to

survival.

(6) Other injuries resulting in significant blood loss or shock reduce blood flow to extremities and predispose the extremities to cold injury.

(7) Studies show blacks are more vulnerable than whites to cold injuries.

(8) Starvation or semistarvation predisposes to cold injury.

(9) Any drug or medication that affects peripheral circulation or sweating can lead to cold injury.

(10) Alcohol dilates the peripheral blood vessels causing body heat loss, which increases the dangers of hypothermia and frostbite.

(11) Heat injuries, as strange as it sounds, may occur even in extreme cold due to overdressing and overexertion. When this happens, the body temperature regulating mechanism is damaged and the patient can rapidly develop hypothermia leading to death.

b. Clinical manifestations.

(1) Symptoms during exposure.

(a) The lack of warning symptoms emphasizes the insidious nature of cold injury.

(b) There may be tingling, stinging, or at most a dull aching of the affected part followed by numbness.

(c) The skin briefly may appear red and then becomes pale or waxy white. At this stage the part may feel "like a block of wood." If freezing has occurred, the tissue appears "dead white" and is hard or even brittle with complete lack of sensation and movement.

(2) Differentiation. Terms such as chilblain, trench foot (immersion foot), and frostbite are only used to describe how the injury occurred. After rewarming, the tissue injury, which is largely the result of vascular damage, is similar in all forms of cold injury. The major variable is the degree (severity) of injury. Early evaluation of the degree of cold injury is extremely difficult even to the most experienced doctor. Definitive classification of severity into first, second, third, and fourth degree is possible only in retrospect.

(a) First degree. After rewarming, the skin becomes mottled, red, hot, and dry. The skin blanches poorly on pressure and capillary filling is sluggish or absent. There is frequently intense itching or burning and a later deep-seated ache. Swelling begins within 3 hours and may persist for 10 days or more if patient remains on duty, but usually disappears in less than 5 days if patient is kept at bed rest. Peeling of the superficial layers of the skin may begin within 5-10 days after the injury and last for a month.

(b) Second degree. After rewarming, the skin becomes deep red, hot, and dry. Light touch and position sense are frequently absent. Blisters and even huge blebs may appear within 6-12 hours and may extend

nearly to the tips of the involved digits. These blebs are a valuable sign identifying the injury as second degree. They dry forming black eschars within 10-24 days; the eschars gradually separate revealing intact skin that is thin, soft, poorly keratinized, and easily traumatized. During rewarming there may be a tingling and burning sensation that increases in intensity to a deep aching and burning sensation. This pain may increase to the point the patient will require medication.

(c) Third degree. Necrosis of skin and cutaneous tissue. Vesicles may be present but they contain blood, are smaller, and do not extend to the tip of the involved digits. Edema of the entire involved area (entire hand or foot) usually appears in an average of 6 days. Most patients have a period of anesthesia lasting from 5-17 days followed by burning, aching, throbbing, or shooting pains lasting for months and recurring during exposure to cold sometimes for the rest of their lives. The skin overlaying the injury forms a black, hard, dry eschar that eventually separates exposing underlying granulation tissue. Healing occurs in an average of 68 days. Trauma and infection due to injury other than cold may result in extensive tissue loss, systemic infection, and even wet gangrene requiring emergency amputation of the affected part.

(d) Fourth degree. Complete necrosis of the entire thickness of the part including bone, resulting in loss of the entire injured part. Upon rewarming the skin may turn deep red, purple, or mottled and cyanotic. In some cases edema develops rapidly reaching a maximum within 6-12 hours; the area may show no significant increase in volume, but rapidly progresses to dry gangrene and mummification. In other cases edema develops slowly and is more pronounced, and the eschar formation is not evident until 2-3 weeks after rewarming. The line of demarcation becomes apparent in an average of 36 days but it takes 60-80 days to extend down to the bone. Usually there is no feeling in the injured area for 3-13 days, then ghost pain begins that may become severe.

(3) Early diagnosis and prognostic signs. As previously pointed out, classification of cold injuries as to degree is a retrospective diagnosis. In the early stages (first 48-72 hours) after rewarming, you can only differentiate between superficial (loss of skin or less) or deep (loss of skin and tissue) cold injuries.

(a) Signs of superficial cold injury.

1. Early development of large, clear blebs extending to tips of the digits.

2. Rapid return of sensations.

3. Return of normal (warm) temperature in injured area.

4. Pink or mildly erythematous skin color that blanches rapidly.

(b) Signs of deep cold injury.

1. Hard, white, cold, and insensitive.

2. Absence of edema.

3. Dark hemorrhagic blebs or lack of blebs or blisters.

4. Early mummification.

5. Systemic signs of tissue necrosis (fever, tachycardia, prostration).

6. Superimposed trauma.

7. Cyanotic or dark red skin color that does not blanch on pressure.

c. Treatment. Because of the progressive nature of cold injuries, the earlier they are detected and treatment started the better.

(1) Individual. A fairly reliable symptom of incipient frostbite of fingers, toes, and exposed skin is the sudden and complete cessation of the sensation of cold or discomfort in the part, often followed by a pleasant feeling of warmth. Prompt and immediate care will usually prevent the development of a more serious cold injury. The part must be rewarmed immediately. To rewarm an ear, nose, or cheek, remove your glove and hold (do not rub) your warm hand against the part until it is rewarmed, then protect the area with a scarf or ear flaps, etc. Fingers can be warmed by placing them under the clothes against the skin of the abdomen or the armpit. Toes can be rewarmed by holding them against a companion's chest or abdomen under his outer clothing.

(2) Initial or emergency treatment. The patient should be restricted from his usual duties or activities until the severity of the injury can be evaluated. All constricting items of clothing (boots, socks, gloves) should be removed from the injury site, and the area must be protected from further cold injury by blankets or available loose clothing. Smoking, drinking of alcohol, and use of medications (salves, ointments) on affected area are prohibited. Do not drain blisters; cover them with loose dry dressing. Give plenty of hot liquids to the patient (soup, coffee, tea, etc.). If a lower extremity is involved, treat the patient as a litter patient with the affected limb level or slightly elevated. If travel by foot is the only means of evacuation, do not thaw frostbitten feet until the patient reaches an aid station and medical help. Once the patient has reached an area of shelter (aid station, hospital) if freezing has occurred and the affected tissue is still frozen, it should be thawed as rapidly as possible in water 104-109°F. (40-42°C.). Thawing is determined by return of sensations (usually), return of color (frequently dark red or purple), and the observation that the tissue is soft. Under no circumstances should snow, ice water, grease, massage, walking, or dry heat be used. Warming above 98°F. (37°C.) is not recommended for nonfreezing cold injuries. Cold injury is no contraindication for narcotics or other pain medications, but accompanying injuries may govern the choice of medications. Tetanus toxoid booster should be given. Prophylatic antibiotics should not be used, but if an infection develops, suitable antibiotics should be started.

(3) Definitive treatment. Absolute bed rest is mandatory for any cold injury involving the feet. Debridement should be postponed until the eschar is completely formed, which in fourth degree cold injuries can take 60-80 days to extend to the bone. Patience, understanding, and constant encouragement are essential to good results.

d. Hypothermia--lowering of the body temperature below normal.

(1) Usually caused by exposure (atmospheric or immersion) to prolonged or extreme cold. Immersion in water 48°F. for 1 hour will usually lower body temperature enough to cause death, but hypothermia in cold environments can be caused by unconsiousness due to wounds, disease, alcohol, etc., in individuals who are inadequately protected.

(2) When the internal body temperature is about 95°F., there is a breakdown of the temperature control centers and the body cannot produce enough heat to maintain temperature balance. Further decline of body temperature is quite rapid. Death usually occurs by the time the internal body temperature has reached 80°F.

(3) Symptoms.

(a) As the body temperature drops, the patient may become delirious, drowsy, or comatose; the skin is pale and cold. Respirations may be markedly reduced in frequency and so shallow that casual observation may fail to note any respiratory movement. The pulse and blood pressure become difficult to take or even unobtainable. Pupils become unreactive to light but usually not dilated, and the patient becomes unresponsive to painful stimuli. The tissue becomes semirigid and passive movements are difficult. Death usually follows due to cardiac arrest or ventricular fibrillation.

(4) Treatment. The primary intent is to raise the body temperature.

(a) First aid. If patient is wet, strip and dry him. Heat him by a fire or by stripping and bundling in blankets or sleeping bag to share body heat. If patient is conscious, give plenty of hot fluids (tea, coffee, soup).

(b) Definitive treatment. Patients with moderate or severe hypothermia (core temperature of less than 32°C. (89.6°F.)) often require aggressive rewarming with individualized supportive care. Either heated blankets or warm baths may be used. Bath should be 40-42°C. (104-107.6°F.) with a rate of rewarming of 1-2°C. per hour. The patient must be closely monitored as active external warming may cause marked peripheral dilatation that predisposes to ventricular fibrillation and hypovolemic shock. CPR may be required. An IV should be initiated as soon as possible and urinary output closely monitored. Metabolic acidosis, pneumonia, renal failure, and ventricular fibrillation may occur even several days after an apparently successful resuscitation and restoration of body temperature. Because of this the patient's vital signs should be closely monitored for several days after rewarming. With proper early care 50-70 percent of moderate to severe hypothermia cases can be saved.

e. Snowblindness.

(1) Cause/definition. The eye is sensitive to ultraviolet radiation just as the skin is. In areas of unbroken ice or snow, approximately 75 percent of the incident ultraviolet radiation is reflected so that the eyes are exposed to reflected as well as direct rays from the sun. The eyes can be exposed to excessive ultraviolet radiation even on grey, overcast days or in forested areas. Such excessive exposure can result in sunburn of the tissues comprising the surface of the eye, as well

as the retina, producing snowblindness.

(2) Signs/symptoms.

(a) Symptoms may not be apparent until as much as 8 to 12 hours after exposure.

(b) Initially, the eyes feel irritated and dry, but as time passes, the eyes feel as though they are full of sand. Blinking and moving the eyes becomes extremely painful, and even exposure to light may cause discomfort. Redness of eyes and excessive tearing may occur. The eyelids are usually red, swollen, and difficult to open.

(3) Complications. A mild case of snowblindness may completely disable an individual for several days; however, in the more severe cases, the damage to the eye may be permanent.

(4) Treatment.

(a) A mild case of snowblindness will heal spontaneously in a few days; however, the pain may be quite severe if the injury is not treated.

(b) Cold compresses and a lightproof bandage should be applied in order to relieve pain.

(c) If available, an opthalmic ointment should be applied hourly, not only to provide relief from pain but also to lessen the inflammatory reaction and course of the injury.

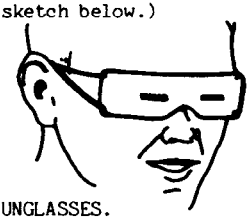
(d) The individual SHOULD NOT rub his eyes.

(e) Local anesthetic agents SHOULD NOT be used. These agents rapidly lose their effectiveness when applied to the eyes, and they may further damage the eye surface.

(5) Prevention.

(a) Snowblindness can be prevented by the consistent use of proper goggles or sunglasses when in areas of unbroken ice or snow. These glasses should be large and curved or have side covers to block reflected light coming from below and from the sides.

(b) If sunglasses or goggles are broken or lost, an emergency pair should be made from a thin piece of leather, cardboard, or other material that is cut the width of the face and provided with horizontal slits over the eyes. The improvised eye protectors can be held in place with string attached to the sides and tied at the back of the head. (See sketch below.)



IMPROVISED SUNGLASSES.