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Trauma

Introduction

Trauma is one of the leading causes of death in the United States. Emergency trauma care basics include triage; assessing and maintaining airway, breathing, and circulation (the ABCs); protecting the cervical spine; assessing the level of consciousness (LOC); and, as needed, preparing the patient for transport and possibly surgery.

Common mechanisms of trauma include car, bicycle, and other vehicle accidents; car-pedestrian accidents, drowning, firearms, burns, and falls.

Triage: First things first

Triage is the setting of medical priorities for emergency care by making sound, rapid assessments. The need for triage usually arises at the scene of injury and continues in the emergency department. Following health care facility protocol, you'll decide which patient to treat first, which injury to treat first, how to best utilize other members of the medical team, and how to control patient and staff traffic.

In most cases, victims are assigned to the following categories:

- *emergent*—life-threatening or limb-threatening injury requiring treatment within a few minutes to prevent death or further injury; includes patients with moderate to severe respiratory distress, cardiopulmonary arrest, compensated or uncompensated shock, limb injury with neurovascular compromise, alteration in neurologic status, and patients who have attempted suicide
- *urgent*—serious, but not immediately life-threatening injury that should receive treatment within 2 hours; includes patients with mild wheezing and mild or no respiratory distress, mild to moderate dehydration, and suspected forearm fracture (These patients require periodic assessment because they can deteriorate and become emergent.)
- *nonurgent*—presence of minor or stable illness or injury that doesn't require treatment within 2 hours; includes patients with ear discomfort, minor or isolated soft tissue wounds, and sore throat.

During the assessment, if the patient is discovered to have a life-threatening condition, immediate intervention is needed. It may also be necessary to prioritize patients within the same triage category based on the severity of each patient's symptoms.

Trauma care is very stressful. Often, you must deal with patients and families who are upset, angry, belligerent, intoxicated, or frightened; some may speak only a foreign language. Thus, you must work calmly and rationally, employing crisis-intervention techniques. You can help the patient a great deal by talking to him. Be sure to tell him what you're going to do before you touch him. You must also handle difficult situations diplomatically and intelligently, recognize your limitations, and ask for help when you need it.

The ABCs

Begin your care of an injured patient with a quick primary assessment of the ABCs. Also assess for disability and neurologic status.

To assess airway patency, routinely check for respiratory distress or signs of obstruction, such as stridor, choking, or cyanosis. Be especially alert for respiratory distress in a patient who inhaled chemicals, was in a fire, or has upper body burns. If the airway is obstructed, remove vomitus, dentures, blood clots, or foreign bodies from the mouth.

In a semiconscious or unconscious patient, open the airway using a jaw-thrust maneuver. (Don't use the head-tilt maneuver for a trauma patient. Suspect cervical spine injury until X-rays rule it out.) Then insert an oropharyngeal or nasopharyngeal airway. A nasopharyngeal airway is contraindicated in patients with massive facial trauma and those with possible basal skull fractures. Assist with endotracheal tube insertion as necessary. If rescue personnel have inserted an esophageal obturator airway, leave it in place until the patient has been tracheally intubated. This will prevent him from vomiting and possibly aspirating.

Next, make sure the patient's breathing is adequate. Look, listen, and feel for respirations. If the patient isn't breathing, call

for help immediately, begin bag-valve-mask resuscitation, and prepare for intubation. Give supplemental oxygen; then draw samples for arterial blood gas measurement and calculate the supplemental oxygen's effects to establish a baseline for oxygen and acid-base therapy. Multiple injuries create a need for supplemental oxygen because of blood loss and significant physiologic stress. A conscious multipleinjury patient usually displays compensatory hyperventilation. If he doesn't, expect neurologic involvement or chest injury. Needle thoracentesis may be done to decompress tension pneumothorax.

To assess circulation, check for central and peripheral pulses, as well as capillary refill (which should be less than 2 seconds). If a carotid pulse is absent, institute cardiopulmonary resuscitation. If external hemorrhage is evident, apply direct pressure to the bleeding site and, if the wound is on a limb, elevate it above heart level if possible. Apply a tourniquet only if the hemorrhage is life-threatening.

Monitor the patient's vital signs even if he appears stable. Because vital signs can change rapidly, taking them serially can identify subtle and overt changes. Document baseline readings, and obtain new readings every 5 to 15 minutes until the patient is stable. Assess trends in vital sign readings to detect changes. Place him on a cardiac monitor and a pulse oximeter. Remember that the patient may have up to a 25% volume loss before it's reflected in vital sign readings.

Draw blood for type and crossmatch, complete blood count, prothrombin time, partial thromboplastin time, platelet count, and routine blood studies, including amylase levels. Begin at least two I.V. lines with 14G or 16G catheters for fluid resuscitation with normal saline or lactated Ringer's solution. Administer tetanus prophylaxis as needed. (See *Managing tetanus prophylaxis*.)

Immobilize the patient's head and neck with an immobilization device, sandbags, backboard, and tape, if this hasn't been done. Obtain cervical spine X-rays as appropriate and rule out cervical spine injury before moving the patient again. Presume spinal injury and take precautions to prevent further injury, such as logrolling and using adequate staff to move the patient, until spinal injury has been ruled out.

Proceed with assessment of the patient's disability; assess the patient's LOC and pupillary and motor response to check the patient's neurologic status. Attempt to establish the patient's Glasgow Coma Scale rating. Report decorticate or decerebrate responses immediately. The patient need not have a head injury to exhibit an abnormal neurologic response. Any injury that impairs ventilation or perfusion can cause cerebral edema and raise intracranial pressure.

Expose the patient for secondary assessment

Secondary assessment includes removal of the patient's clothes to enable a more thorough examination. The clothing is placed in bags, which are labeled with the patient's name and the date and time that he was brought to your facility. The bag will be given to the patient's family, or to the authorities if an investigation into the circumstances of the trauma is necessary. If the clothing must be given to the authorities, document having done so. Institute environmental controls by providing warming measures, such as warming blankets and units, warmed oxygen and I.V. solutions, and increased environmental temperature.

Assess the patient's vital signs, and inform the patient's family of his status. They can help to provide his history, especially his immunization status. Assess the need for comfort measures; pain medication may be given as appropriate, and other techniques may be used to make the patient comfortable.

Head-to-toe assessment

Secondary assessment also includes a thorough head-to-toe assessment of the patient. Quickly and carefully look for multiple injuries by systematically examining the patient. If you detect no spinal injury, carefully logroll the patient over to inspect his back for other wounds.

In chest trauma, assess for open wounds, tension pneumothorax, hemothorax, cardiac tamponade, bruises and hematomas,

flail chest, and fractured larynx. Cover open wounds, and apply direct pressure to the wound as necessary. Be ready to assist with insertion of chest tubes, pericardiocentesis, cricothyrotomy, or tracheotomy, as appropriate.

MANAGING TETANUS PROPHYLAXIS

History of tetanus immunization (number of doses)	Tetanus-prone wounds		Non-tetanus-prone wounds	
	Td*	TIG**	Td	TIG
Uncertain	Yes	Yes	Yes	No
0 to 1	Yes	Yes	Yes	No
2	Yes	Yes	Yes	No
3 or more	No (*yes* if more than 5 years since last dose)	No	No (*yes* if more than 10 years since last dose)	No

* Td = Tetanus and diphtheria toxoids adsorbed (for adult use), 0.5 ml

** TIG = Tetanus immune globulin (human), 250 units

Note: When Td and TIG are given concurrently, separate syringes and separate sites should be used.

Note: For children younger than age 7, tetanus and diphtheria toxoids and pertussis vaccine, adsorbed (DPT) are preferred over tetanus toxoid alone. If pertussis vaccine is contraindicated, administer tetanus and diphtheria toxoids, adsorbed (DT).

Insert an indwelling urinary catheter and a nasogastric tube, and give prophylactic antibiotics and immunizations, as indicated. Appropriate diagnostic studies—such as X-rays, computed tomography (CT) scans, peritoneal lavage, magnetic resonance imaging (MRI), and excretory urography—may be performed based on assessment findings and patient stabilization. Notify medical or surgical specialists, as appropriate.

Stabilize the patient

Because severe injuries commonly lead to shock, check skin temperature, color, and moisture. To control shock, administer I.V. fluids (lactated Ringer's or normal saline solution) followed by blood or blood products.

In all cases of massive external bleeding or suspected internal bleeding, watch for hypovolemia and estimate blood loss. Remember, however, that a blood loss of 500 to 1,000 ml might not change systolic blood pressure but may elevate the pulse rate. However, bradycardia may be an ominous sign and a late finding of hemorrhagic shock. Stay alert for signs of occult bleeding, which commonly occurs in the chest, abdomen, and thigh. Repeat abdominal examinations frequently to assess the patient for abdominal distention; this could be a sign of internal injuries and bleeding.

Increased diameter of the legs or abdomen usually means that blood has leaked into these tissues (as much as 4,000 ml into the abdomen, 3,000 ml into the chest, and 2,000 ml into a thigh). Such blood loss will induce signs of hypovolemic

shock (tachycardia, tachypnea, hypotension, restlessness, decreased urine output, delayed capillary refill, and cold, clammy skin).

If the patient has renal injuries or a fractured pelvis, look for the classic sign of retroperitoneal hematoma—numbness or pain in the leg on the affected side as a result of pressure on the lateral femoral cutaneous nerve in L1 to L3. Retroperitoneal bleeding may not cause abdominal tenderness. If the patient shows clinical signs of hypovolemia, immediately begin I.V. therapy with two or more large-bore catheters, and regulate fluids according to the hypovolemia's severity. Although the initial resuscitation fluids are crystalloids, significant hypovolemia caused by hemorrhage requires blood transfusion. Assist with insertion of a central venous pressure or pulmonary artery catheter to monitor circulating blood volume.

If spinal trauma is suspected, methylprednisolone may be given I.V. If head trauma is present, the patient may be given emergency medication such as mannitol and ventilation may be controlled. The patient may also require emergency surgery—either exploratory or lifesaving—to help with stabilization depending on the injury's type and extent.

Limb fractures can be a source of blood loss. Look for limb fractures and dislocations. Check circulation and neurovascular status distal to the injury by palpating pulses distal to the injury and looking for the classic signs of arterial insufficiency: decreased or absent pulse, pallor, paresthesia, pain, and paralysis. Splint and apply traction as needed.

The patient will require X-rays, a CT scan, or an MRI to determine the extent of injury to the limb, so prepare the patient for transport. Use special care in suspected cervical spinal injury. If necessary, after splinting the injury site, also splint the areas above and below it to prevent further soft-tissue and neurovascular damage and to minimize pain. For example, if the forearm is injured, splint the wrist and elbow, too.

Types of splints include:

- *air splint*—an inflatable splint
- *hard splint*—a rigid splint with a firm surface, such as a long or short board, an aluminum ladder splint, or a cardboard splint
- *soft splint*—a nonrigid splint, such as a pillow or blanket
- *traction splint*—a splint that uses traction to decrease angulation and reduce pain.

Tips on applying a splint

- Splint most injuries “as they lie,” except when the patient's neurovascular status is compromised.

- Whenever possible, have one person support the injured part while another applies padding and the splint.
- Secure the splint with straps or gauze, *not* an elastic bandage.
- To apply an air splint, slide the splint backward over your arm and grasp the distal portion of the injured limb. Then slip the splint from your arm onto the injured limb and inflate the splint. Don't apply the splint too tightly; be sure to reassess neuromuscular integrity often while the splint is in place.

Special considerations

After the patient is stabilized, he'll need ongoing care and assessment and, possibly, rehabilitation to ensure recovery. Specialists may be consulted for certain types of trauma.

- Regularly evaluate the patient's ABCs, as well as his neurologic status.
- Keep the patient's family informed about his condition and provide support as indicated.

Depending on the type of injury, the patient may be admitted to your facility or transferred to another facility.

HEAD

Concussion

By far the most common head injury, a concussion results from a blow to the head—a blow hard enough to jostle the brain and make it strike the skull, causing temporary neural dysfunction, but not hard enough to cause a cerebral contusion. Most concussion patients recover completely within 24 to 48 hours. Repeated concussions, however, exact a cumulative toll on the brain.

Causes and incidence

The blow that causes a concussion is usually sudden and forceful. It occurs when the head strikes a stationary object (as in a fall to the ground), or when a moving object strikes the head (as in a punch to the head). Such blows may also result from automobile accidents or child abuse. Significant jarring can lead to unconsciousness. Microscopic shearing of nerve fibers is thought to occur in the brain from sudden acceleration or deceleration from the head injury.

In 2001, death resulted in 5 of every 100,000 patients with trauma related to falls.

Complications

- Seizures
- Persistent vomiting

Signs and symptoms

A concussion may produce vomiting and a short-term loss of consciousness. The patient may also suffer from anterograde and retrograde amnesia, in which the patient not only can't recall what happened immediately after the injury, but also has difficulty recalling events that led up to the traumatic incident. The presence of anterograde amnesia and the duration of retrograde amnesia reliably correlate with the injury's severity. The length of the unconsciousness may also relate to the concussion's severity.

This type of injury commonly causes adults to be irritable or lethargic, to behave out of character, and to complain of dizziness, nausea, or severe headache. Some children have no apparent ill effects, but many grow lethargic and somnolent in a few hours. Postconcussion syndrome—characterized by headache, dizziness, vertigo, anxiety, and fatigue—may persist for several weeks after the injury.

Diagnosis

Differentiating between a concussion and more serious head injuries requires a thorough history of the injury and a neurologic examination. Such an examination must evaluate the patient's level of consciousness (LOC), mental status, cranial nerve and motor function, deep tendon reflexes, and orientation to time, place, and person. If no abnormalities are found and if a severe head injury appears unlikely, the patient should be observed for signs of more severe cerebral trauma. Observation provides a baseline for gauging any deterioration in the patient's condition. Whenever you suspect a severe head injury, obtain a computed tomography scan or magnetic resonance imaging to rule out fractures and more serious injuries. A neurosurgeon should be consulted immediately.

Treatment

Treatment for concussion varies according to the type of injury. Supportive care may include application of an ice pack to the site of injury, analgesics for mild headache, and sutures or steri-strips for lacerations.

If the neurologic examination revealed no abnormalities, observe the patient in the emergency department. Check vital signs, LOC, and pupil size every 15 minutes. The patient who remains stable after 4 or more hours of observation can be discharged in the care of a responsible adult.

Special considerations

ALERT

Before discharge, provide a head injury instruction sheet and advise the patient to be alert for vomiting, worsening of headache, and signs of an earbleed or cerebrospinal fluid leak.

- Instruct the family or caregiver to wake the patient every few hours at night for observation of his mental state and for medication administration. Tell them they should follow these precautions for at least 3 days. Review the head injury instruction sheet and ensure that the family or caregiver is aware of signs necessitating a return to the emergency department.

HEMORRHAGE, HEMATOMA, AND TENTORIAL HERNIATION

Among the most serious consequences of a head injury are hemorrhage, hematoma, and tentorial herniation. An epidural hematoma results from a rapid accumulation of blood between the skull and the dura mater; a subdural hematoma results from a slow accumulation of blood between the dura mater and the subarachnoid membrane. Intracerebral hemorrhage occurs within the cerebrum itself. Tentorial herniation occurs when injured brain tissue swells and squeezes through the tentorial notch, constricting the brain stem.

Epidural hemorrhage or hematoma can cause immediate loss of consciousness, followed by a lucid interval lasting minutes to hours, which eventually gives way to a rapidly progressive decrease in the level of consciousness. Other effects are contralateral hemiparesis, progressively severe headache, ipsilateral pupillary dilation, and signs of increased intracranial pressure (ICP).

With a subacute or chronic subdural hemorrhage or hematoma, blood accumulates slowly, so symptoms may not occur until days after the injury. In an acute subdural hematoma, symptoms appear within 24 hours of the injury. Loss of consciousness occurs, commonly with weakness or paralysis. Intracerebral hemorrhage usually causes nuchal rigidity, photophobia, nausea, vomiting, dizziness, seizures, decreased respiratory rate, and progressive obtundation.

Tentorial herniation causes drowsiness, confusion, dilation of one or both pupils, hyperventilation, nuchal rigidity, bradycardia, and decorticate or decerebrate posturing. Irreversible brain damage or death can occur rapidly.

Intracranial hemorrhage may require a craniotomy to locate and control bleeding and to aspirate blood. Increased ICP may be controlled with I.V. mannitol, steroids, hyperventilation, or induced coma, but emergency surgery is usually required.

Cerebral contusion

A cerebral contusion is a bruising of brain tissue as a result of a severe blow to the head. More serious than a concussion, a contusion disrupts normal nerve function in the bruised area and may cause loss of consciousness, hemorrhage, edema, and even death.

Causes and incidence

A cerebral contusion results from coupcontrecoup or acceleration-deceleration injuries. Such injuries can occur directly beneath the site of impact when the brain rebounds against the skull from the force of a blow (such as in a beating with a blunt instrument), when the force of the blow drives the brain against the opposite side of the skull, or when the head is hurled forward and stopped abruptly (as in an automobile accident when a driver's head strikes the windshield). The brain continues moving and slaps against the skull (acceleration) and then rebounds (deceleration). These injuries can also cause the brain to strike against bony prominences inside the skull (especially the sphenoidal ridges), causing intracranial hemorrhage or hematoma that may result in tentorial herniation. (See *Hemorrhage, hematoma, and tentorial herniation*.)

Signs and symptoms

The patient with a cerebral contusion may have severe scalp wounds and labored respirations. He may lose consciousness for a few minutes or longer. If conscious, he may be drowsy, confused, disoriented, agitated, or even violent. He may display hemiparesis, unequal pupillary response, and decorticate or decerebrate posturing. Eventually, he should return to a relatively alert state, perhaps with temporary aphasia, slight

hemiparesis, or unilateral numbness. A lucid period followed by rapid deterioration suggests epidural hematoma.

Diagnosis

An accurate history of the injury and a neurologic examination are the principal diagnostic tools. A computed tomography (CT) scan or magnetic resonance imaging shows ischemic tissue, hematomas, and fractures. Intracranial hemorrhage contraindicates lumbar puncture.

Treatment

Treatment of a cerebral contusion focuses on establishing a patent airway and performing regular evaluations of the patient's level of consciousness (LOC), motor responses, and intracranial pressure. If needed, assist with a tracheotomy or endotracheal intubation. Start an I.V. fluid infusion with lactated Ringer's or normal saline solution. Mannitol I.V. may be given in consultation with a neurosurgeon to reduce cerebral edema.

Special considerations

- Verify that a head CT scan has been performed to assess for a basilar skull fracture.
- Restrict total fluid intake to 1,200 to 1,500 ml/day to reduce volume and intracerebral swelling.
- If spinal injury is ruled out, elevate the bed's head 30 degrees. Enforce bed rest.
- If the patient is intubated, use mild hyperventilation until his partial pressure of arterial carbon dioxide reaches 30 to 35 mm Hg.
- Type and crossmatch blood for a patient suspected of having an intracerebral hemorrhage. Such a patient may need a blood transfusion, and possibly a craniotomy, to control bleeding and to aspirate blood.
- Insert an indwelling urinary catheter as ordered and monitor intake and output. If the patient is unconscious, insert a nasogastric tube to prevent aspiration.
- Observe carefully for leakage of cerebrospinal fluid (CSF) from the nostrils and ear canals. If you detect blood in the canal and aren't sure whether CSF is mixed in, place a drop on a white sheet or a piece of filter paper and check for a central spot of blood surrounded by a lighter ring (halo sign). If CSF leakage develops, raise the bed's head 30 degrees. If you detect CSF leaking from the nose, place a gauze pad under the nostrils. Be sure to tell the patient not to blow his nose, but to wipe it instead. If CSF leaks from the ear, position the patient so that the ear drains naturally, and don't pack the ear or nose.
- Monitor the patient's vital signs and respirations regularly (usually every 15 minutes). Abnormal respirations could indicate a breakdown in the respiratory center in the brain stem and, possibly, impending tentorial herniation—a critical neurologic emergency.
- Check his neurologic status frequently. Assess for restlessness, LOC, and orientation.
- After the patient is stabilized, clean and dress any superficial scalp wounds. (If the skin has been broken, tetanus prophylaxis may be in order.) Assist with suturing if necessary.

Fractured skull

Because of possible brain damage, a skull fracture is considered a neurosurgical condition. Skull fractures may be classified as simple (closed) or compound (open) and may displace bone fragments. Skull fractures are further described as linear, comminuted, or depressed. A linear fracture is a common hairline break, without displacement of structures; a comminuted fracture splinters or crushes the bone into several fragments; a depressed fracture pushes the bone toward the brain.

In children, the skull's thinness and elasticity allow a depression without a fracture. (A linear fracture across a suture line increases the possibility of epidural hematoma.) Skull fractures are also classified according to location, such as cranial vault fracture and basilar fractures. Because of the danger of grave cranial complications and meningitis, basilar fractures are usually far more serious than cranial vault fractures.

Causes and incidence

Skull fractures invariably result from a traumatic blow to the head. Motor vehicle

accidents, bad falls, sports injuries, and physical assaults top the list of causes. The brain can be directly affected by damage to the nervous system and by bleeding.

Closed head injuries occur in 200 out of every 100,000 patients. Severe head trauma carries a 30% mortality rate.

Complications

- Infection
- Intracerebral hemorrhage
- Hematoma
- Brain abscess
- Increased intracranial pressure

Signs and symptoms

Many skull fractures are accompanied by scalp wounds—abrasions, contusions, lacerations, or avulsions. If the scalp has been lacerated or torn away, bleeding may be profuse because the scalp contains many blood vessels. Occasionally, bleeding may be heavy enough to induce hypovolemic shock. The patient may also be in shock from other injuries or from medullary failure in severe head injuries.

Linear fractures that are associated only with concussion don't produce loss of consciousness. They require evaluation, but not definitive treatment. A fracture that results in a cerebral contusion or laceration, however, may cause the classic signs of brain injury: agitation and irritability, loss of consciousness, changes in respiratory pattern (labored respirations), abnormal deep tendon reflexes, and altered pupillary and motor responses.

If the patient with a skull fracture remains conscious, he is apt to complain of a persistent, localized headache. A skull fracture may also result in cerebral edema, which may cause compression of the reticular activating system. This cuts off the normal flow of impulses to the brain and results in possible respiratory distress. The patient may experience alterations in level of consciousness (LOC), progressing to unconsciousness or even death.

When jagged bone fragments pierce the dura mater or the cerebral cortex, skull fractures may cause subdural, epidural, or intracerebral hemorrhage or hematoma. With the resulting space-occupying lesions, clinical findings may include hemiparesis, unequal pupils, dizziness, seizures, projectile vomiting, progressive unresponsiveness, and decreased pulse and respiratory rates. Sphenoidal fractures may also damage the optic nerve, causing blindness, whereas temporal fractures may cause unilateral deafness or facial paralysis. Symptoms reflect the head injury's severity and extent. However, some elderly patients may have cortical brain atrophy, with more space for brain swelling under the cranium, and consequently may not show signs of increased intracranial pressure (ICP) until it's very high.

Vault fractures commonly produce soft-tissue swelling near the fracture, making it difficult to detect without a computed tomography (CT) scan.

Basilar fractures commonly produce a hemorrhage from the nose, pharynx, or ears; blood under the periorbital skin (raccoon eyes) and under the conjunctiva; and Battle's sign (supramastoid ecchymosis), sometimes with bleeding behind the eardrum (hemotympanum). This type of fracture may also cause cerebrospinal fluid (CSF) or even brain tissue to leak from the nose or ears.

Depending on the extent of brain damage, the patient with a skull fracture may suffer residual effects, such as seizures, hydrocephalus, and organic brain syndrome. Children may develop headaches, giddiness, easy fatigability, neuroses, and behavior disorders.

Diagnosis

Suspect brain injury in all patients with a skull fracture until clinical evaluation proves otherwise. Consequently, you'll need to obtain a thorough injury history and magnetic resonance imaging (MRI) or a CT scan (to locate the fracture) for every suspected skull injury. (Keep in mind that many vault fractures aren't visible or palpable.)

A fracture also requires a neurologic examination to check cerebral function (mental status and orientation to time, place, and person), LOC, pupillary response, motor function, and deep tendon reflexes.

Using reagent strips, test the draining nasal or ear fluid for CSF. The tape will turn blue in the presence of CSF but will remain the same in the presence of blood alone. However, the tape will also turn blue if the patient is hyperglycemic. Also check the patient's bedsheets for the halo sign—a blood-tinged spot surrounded by a lighter ring—from leakage of CSF.

Brain damage can be assessed by a CT scan and MRI, which reveal intracranial hemorrhage from ruptured blood vessels and swelling. Expanding lesions contraindicate a lumbar puncture.

Treatment

Although occasionally even a simple linear skull fracture can tear an underlying blood vessel or cause a CSF leak, linear fractures generally require only supportive treatment, including mild analgesics such as acetaminophen, and cleaning, debridement, and repair of any wounds after injection of a local anesthetic.

If the patient with a skull fracture hasn't lost consciousness, observe him in the emergency department for at least 4 hours. Following this observation period, if his vital signs are stable and if the neurosurgeon concurs, you can discharge him. Before discharge, give the patient an instruction sheet to follow for 24 to 48 hours of observation at home.

More severe vault fractures, especially depressed fractures, usually require a craniotomy to elevate or remove fragments that have been driven into the brain and to extract foreign bodies and necrotic tissue. This reduces the risk of infection and further brain damage. Other treatments for severe vault fractures include antibiotic therapy and, in profound hemorrhage, blood transfusions.

Basilar fractures call for immediate prophylactic antibiotics to prevent the onset of meningitis from CSF leaks as well as close observation for secondary hematomas and hemorrhages. Surgery may be necessary.

Special considerations

- Establish and maintain a patent airway; nasal airways are contraindicated in patients who may have a basilar skull fracture. Intubation may be necessary. Suction the patient through the mouth, not the nose, to prevent introducing bacteria if a CSF leak is present.
- Be sure to obtain a complete history of the traumatic injury from the patient, family members, any eyewitnesses, and emergency medical services personnel. Ask whether the patient lost consciousness and, if so, for how long.
- Assist with diagnostic tests, including a complete neurologic examination, CT scan, and other studies.
- Check for abnormal reflexes such as Babinski's reflex.
- Look for CSF draining from the patient's ears, nose, or mouth. Check pillowcases and linens for CSF leaks and look for a halo sign. If the patient's nose is draining CSF, wipe it—*don't let him blow it*. If an ear is draining, cover it lightly with sterile gauze—*don't pack it*.

- Position the patient with a head injury so that secretions can drain properly. Elevate the bed's head 30 degrees if intracerebral injury is suspected.
- Cover scalp wounds carefully with a sterile dressing; control any bleeding as necessary.
- Take seizure precautions, but don't restrain the patient. Agitated behavior may be due to hypoxia or increased ICP, so check for these symptoms. Speak in a calm, reassuring voice, and touch the patient gently. Don't make any sudden, unexpected moves.
- Don't give the patient opioids or sedatives because they may depress respirations, increase carbon dioxide levels, lead to increased ICP, and mask changes in neurologic status. Give acetaminophen or another mild analgesic for pain as ordered.

If a skull fracture requires surgery, proceed as follows:

- Obtain consent, as needed, to shave the patient's head. Explain that you're performing this procedure to provide a clean area for surgery. Type and crossmatch blood. Obtain baseline laboratory studies, such as a complete blood count, serum electrolyte studies, prothrombin time, partial thromboplastin time, and urinalysis.

- After surgery, monitor the patient's vital signs and neurologic status frequently (usually every 5 minutes until the patient is stable and then every 15 minutes for 1 hour), and note any changes in LOC. Because skull fractures and brain injuries heal slowly, don't expect dramatic postoperative improvement.
- Monitor intake and output frequently, and maintain the patency of the indwelling urinary catheter. Monitor fluid intake carefully. Because hypotonic fluids (such as dextrose 5% in water) can increase cerebral edema, give fluids only as indicated.
- If the patient is unconscious, provide parenteral nutrition. (Remember, the patient may regurgitate and aspirate food if you use a nasogastric tube for feedings.)

If the fracture doesn't require surgery, proceed as follows:

- Wear sterile gloves to examine the scalp laceration. With your finger, probe the wound for foreign bodies and a palpable fracture. Gently clean lacerations and the surrounding area; cover them with sterile gauze. The wound should be sutured if necessary.
- Provide emotional support for the patient and his family. Explain the need for procedures to reduce the risk of brain injury.
- Before discharge, instruct the patient's family to watch closely for changes in mental status, LOC, or respirations and to give the patient acetaminophen for a headache. Tell them to return him to the hospital immediately if his LOC decreases, if his headache persists after several doses of mild analgesics, if he vomits more than once, or if he develops weakness in his arms or legs.
- Teach the patient and his family how to care for his scalp wound. Emphasize the need to return for suture removal and follow-up evaluation.

Fractured nose

The most common facial fracture, a fractured nose usually results from blunt injury and may be associated with other facial fractures. The fracture's severity depends on the direction, force, and type of the blow. A severe, comminuted fracture may cause extreme swelling or bleeding that may partially obstruct the airway. Inadequate or delayed treatment may cause permanent nasal displacement, septal deviation, and obstruction.

Causes and incidence

Nasal bone fractures usually result from direct trauma. The causative injury may be relatively minor, such as a fall, or more severe, such as a car accident.

Complications

- Deviated septum
- Airway obstruction
- Septal hematoma
- Cerebrospinal leakage
- Intracranial air penetration

Signs and symptoms

Immediately after injury, a nosebleed may occur, and soft-tissue swelling may quickly obscure the break. After several hours, pain, periorbital ecchymoses, and nasal displacement and deformity are prominent. Possible complications include septal hematoma, which may lead to abscess formation, resulting in avascular septal necrosis and saddle nose deformity.

Diagnosis

CONFIRMING DIAGNOSIS

Palpation, X-rays, and clinical findings such as a deviated septum confirm a nasal fracture.

Diagnosis also requires a complete patient history, including the injury's cause and the amount of nasal bleeding. Watch for clear fluid drainage, which may suggest a cerebrospinal fluid (CSF) leak and a basilar skull fracture. If the patient is pregnant, a computed tomography (CT) scan is necessary.

Treatment

Treatment restores normal facial appearance and re-establishes bilateral nasal passage after swelling subsides. Reduction of the fracture corrects alignment; immobilization (intranasal packing and an external splint shaped to the nose and taped) maintains

it. Reduction is best accomplished in the operating room under local anesthesia for adults and general anesthesia for children. Severe swelling may delay treatment. CSF leakage calls for close observation, a CT scan of the basilar skull, and antibiotic therapy; septal hematoma requires incision and drainage to prevent necrosis.

Start treatment immediately. While waiting for X-rays, apply ice packs to the nose to minimize swelling. Wrap the ice packs in a light towel to prevent ice from directly contacting the skin. To control anterior bleeding, gently apply local pressure. Posterior bleeding is rare and requires an internal tamponade applied in the emergency department.

Special considerations

- Because the patient will find breathing more difficult as swelling increases, instruct him to breathe slowly through his mouth. To warm the inhaled air during cold weather, tell him to cover his mouth with a handkerchief or scarf. To prevent subcutaneous emphysema or intracranial air penetration (and potential meningitis), warn him not to blow his nose.
- After packing and splinting, apply ice in a plastic bag.
- Before discharge, tell the patient that ecchymoses should fade after about 2 weeks.

Dislocated or fractured jaw

Dislocation of the jaw is a displacement of the temporomandibular joint. A jaw fracture is a break in one or both of the two maxillae (upper jawbones) or the mandible (lower jawbone). Treatment can usually restore jaw alignment and function.

Causes and incidence

Simple fractures or dislocations are usually caused by a manual blow along the jawline; more serious compound fractures commonly result from automobile accidents. Other causes include industrial accidents, recreational or sports injuries, assaults, or other trauma. Recurrence of a dislocated jaw is common.

Complications

- Infection
- Sublingual hematoma
- Trauma to nerves of jaw and face

Signs and symptoms

Malocclusion is the most obvious sign of a dislocation or fracture. Other signs include mandibular pain, swelling, ecchymosis, loss of function, and asymmetry. In addition, mandibular fractures that damage the alveolar nerve produce paresthesia or anesthesia of the chin and lower lip. Maxillary fractures produce infraorbital paresthesia and commonly accompany fractures of the nasal and orbital complex.

Diagnosis

CONFIRMING DIAGNOSIS

Abnormal maxillary or mandibular mobility during the physical examination and a history of traumatic injury suggest a fracture or dislocation; X-rays confirm it.

Treatment

As in all traumatic injuries, check first for a patent airway, adequate ventilation, and pulses; then control hemorrhage and check for other injuries. As necessary, maintain a patent airway with an oropharyngeal airway, nasotracheal intubation, or a cricothyrotomy. Relieve pain with analgesics as needed.

After the patient stabilizes, surgical reduction and fixation by wiring restores mandibular and maxillary alignment. Maxillary fractures may also require reconstruction and repair of soft-tissue injuries. Teeth and bones are never removed during surgery unless unavoidable. If the patient has lost teeth from trauma, the surgeon will decide whether they can be reimplanted. If they can, he'll reimplant them within 6 hours, while they're still viable. Viability is increased if the tooth is placed in milk, saliva, or normal saline solution. Dislocations are usually reduced manually under anesthesia.

Special considerations

After reconstructive surgery, perform the following:

- Position the patient on his side with his head slightly elevated. He'll usually have a nasogastric tube in place, with low suction to remove gastric contents and prevent nausea, vomiting, and aspiration of vomitus. As necessary, suction the nasopharynx through the nose or by pulling the cheek away from the teeth and inserting a small suction catheter through any natural gap between teeth.
- If the patient isn't intubated, provide nourishment through a straw. If he has a natural gap between his teeth, insert the straw there; if not, one or two teeth may have to be extracted. After the patient can tolerate clear liquids, offer milkshakes, broth, juices, pureed foods, and nutritional supplements.
- If the patient can't tolerate oral fluids, I.V. therapy can maintain hydration postoperatively.
- Administer antiemetics as indicated to minimize nausea and prevent aspiration of vomitus (a real danger in a patient whose jaw is wired). Keep a pair of wire cutters at the bedside to snip the wires should the patient vomit.
- A dental water-pulsator may be used for mouth care while the wires are intact.
- Because the patient will have difficulty talking while his jaw is wired, provide a Magic Slate or pencil and paper and suggest appropriate diversionary activities.

Perforated eardrum

Perforation of the eardrum is a rupture of the tympanic membrane that may cause otitis media and hearing loss.

Causes and incidence

The usual cause of perforated eardrum is trauma, such as the deliberate or accidental insertion of foreign objects (cotton swabs or bobby pins) or sudden excessive changes in pressure (explosion, a blow to the head, flying, or diving). The injury may also result from untreated otitis media and, in children, from acute otitis media.

Complications

- Mastoiditis
- Meningitis
- Permanent hearing loss

Signs and symptoms

Sudden onset of a severe earache and bleeding from the ear are the first signs of a perforated eardrum. Other symptoms include hearing loss, tinnitus, and vertigo. Purulent otorrhea within 24 to 48 hours of injury signals infection.

Diagnosis

ALERT

A severe earache and bleeding from the ear with a history of trauma strongly suggest a perforated eardrum; direct visualization of the perforated tympanic membrane with an otoscope confirms it.

Additional diagnostic measures include audiometric testing and a check of voluntary facial movements to rule out facial nerve damage.

Treatment

If you detect bleeding from the ear, use a sterile, cotton-tipped applicator to absorb the blood, and check for purulent drainage or evidence of cerebrospinal fluid leakage. A culture of the specimen may be appropriate.

ALERT
Irrigation of the ear is absolutely contraindicated in a patient with perforation of the eardrum.

Apply a sterile dressing over the outer ear, and refer the patient to an ear specialist. A large perforation with uncontrolled bleeding may require immediate surgery to approximate the ruptured edges. Other measures may include administration of a mild analgesic, a sedative to decrease anxiety, and an oral antibiotic.

Special considerations

- Before discharge, tell the patient not to blow his nose or get water in his ear canal until the perforation heals.
- Advise the patient to follow up with an ear specialist, as appropriate.
- Instruct the patient and his family to notify the physician if he develops signs of infection, such as fever, increasing discomfort, and continued or purulent drainage.
- Inform the authorities if child abuse is suspected as the cause of injuries.

NECK AND SPINE

Acceleration-deceleration cervical injuries

Acceleration-deceleration cervical injuries (commonly known as whiplash) result from sharp hyperextension and flexion of the neck that damages muscles, ligaments, disks, and nerve tissue. The prognosis for this type of injury is excellent; symptoms usually subside with treatment.

Causes and incidence

Whiplash commonly results from rear-end automobile accidents. A seat belt keeps a person's body from being thrown forward, but the head may snap forward, then backward, causing a whiplash injury to the neck. Other causes include roller coasters or other amusement park rides, sports injuries, or punches or shoves.

Signs and symptoms

Although symptoms may develop immediately, they're often delayed 12 to 24 hours if the injury is mild. Whiplash produces moderate to severe anterior and posterior neck pain. Within several days, the anterior pain diminishes, but the posterior pain persists or even intensifies, causing patients to seek medical attention if they didn't do so before. Whiplash may also cause dizziness, gait disturbances, vomiting, headache, nuchal rigidity, neck muscle asymmetry, and rigidity or numbness in the arms.

Diagnosis

Full cervical spine X-rays are required to rule out cervical fractures. If the X-rays are negative, the physical examination focuses on motor ability and sensation below the cervical spine to detect signs of nerve root compression. If the patient's cervical spine continues to be tender to examination, an MRI may be required to rule out ligamentous injury.

Treatment

Treatment aims to control symptoms and includes:

- a mild analgesic—such as aspirin with codeine or ibuprofen—and possibly a muscle relaxant—such as diazepam, cyclobenzaprine, or chlorzoxazone with acetaminophen
- ice or cool compresses to the neck to relieve pain
- immobilization with a soft, padded cervical collar for several days or weeks
- in severe muscle spasms, short-term cervical traction.

Most whiplash patients are discharged immediately.

Special considerations

ALERT

In all suspected spinal injuries, assume that the spine is injured until proven otherwise. Until an X-ray rules out a cervical fracture, move the patient as little as possible. Before the X-ray is taken, remove any ear and neck jewelry carefully. Don't undress the patient; cut clothes away if necessary. Caution him to avoid making movements that could injure his spine.

- Teach the patient to watch for possible adverse drug effects; to avoid alcohol if he's taking diazepam, opioids, or muscle relaxants; and to rest for a few days and avoid lifting heavy objects.
- Instruct the patient to return to the hospital immediately if he experiences persistent pain or develops numbness, tingling, or weakness on one or both sides.

Spinal injuries

Spinal injuries (without cord damage) include fractures, contusions, and compressions of the vertebral column, usually as a result of head or neck trauma. The real danger lies in possible spinal cord damage. Spinal fractures most commonly occur in the 5th, 6th, and 7th cervical, 12th thoracic, and 1st lumbar vertebrae.

Causes and incidence

Most serious spinal injuries result from motor vehicle accidents, falls, dives into shallow water, and gunshot wounds. Less serious injuries result from heavy object lifting and minor falls. Spinal dysfunction

may also result from hyperparathyroidism and neoplastic lesions.

Spinal cord injuries occur in 12,000 to 15,000 people per year in the United States. About 10,000 of these injuries cause permanent paralysis; many other patients die as a result of these injuries. Most spinal cord injuries occur in males between the ages of 15 to 35 years; about 5% occur in children. Mortality is higher in pediatric spinal cord injuries.

Complications

- Spinal cord injury
- Autonomic dysreflexia
- Spinal shock

- Neurogenic shock

Signs and symptoms

The most obvious symptoms of spinal injury are muscle spasm and back pain that worsen with movement. In cervical fractures, pain may produce point tenderness; in dorsal and lumbar fractures, it may radiate to other body areas such as the legs. After mild injuries, symptoms may be delayed for several days or weeks. If the injury damages the spinal cord, clinical effects range from mild paresthesia to quadriplegia and shock.

Diagnosis

The diagnosis is typically based on the patient's history, physical examination, X-rays, computed tomography (CT) scan, and magnetic resonance imaging (MRI).

The patient history may reveal a traumatic injury, a metastatic lesion, an infection that could produce a spinal abscess, or an endocrine disorder. The physical examination (including a neurologic evaluation) locates the level of injury and detects cord damage.

Spinal X-rays, the most important diagnostic measure, locate the fracture. In spinal compression, a lumbar puncture may show increased cerebrospinal fluid pressure from a lesion or trauma; a CT scan or MRI can locate a spinal mass.

Treatment

The primary treatment after a spinal injury is immediate immobilization to stabilize the spine and prevent cord damage; other measures are supportive. Cervical injuries require immobilization, using a type of cervical immobilization device (CID) on both sides of the patient's head, a hard cervical collar, or skeletal traction with skull tongs or a halo device.

Treatment of stable lumbar and dorsal fractures consists of bed rest on firm support (such as a bed board), analgesics, and muscle relaxants until the fracture stabilizes (usually in 10 to 12 weeks). Later measures include exercises to strengthen the back muscles and use of a back brace or other device to provide support while walking.

An unstable dorsal or lumbar fracture requires a plaster cast, a turning frame and, in severe fracture, a laminectomy and spinal fusion.

When the spinal injury results in compression of the spinal column, neurosurgery may relieve the pressure. If the cause of compression is a metastatic lesion, chemotherapy and radiation may relieve it. Surface wounds accompanying the spinal injury require tetanus prophylaxis unless the patient has been immunized recently.

Special considerations

In all spinal injuries, suspect cord damage until proven otherwise.

- During the initial assessment and X-ray studies, immobilize the patient on a firm surface, with sandbags or CID on both sides of his head. Tell him not to move, and avoid moving him yourself because hyper-flexion can damage the cord. If you must move the patient, get at least three other members of the staff to help you logroll him to avoid disturbing body alignment.
- Throughout assessment, offer comfort and reassurance. Remember, the fear of possible paralysis will be overwhelming. Talk to the patient quietly and calmly. Allow a family member who isn't too distraught to accompany him.
- If the injury requires surgery, administer prophylactic antibiotics as ordered. Catheterize the patient as ordered to avoid urine retention, and monitor bowel elimination patterns to avoid impaction.

- Explain traction methods to the patient and his family. Reassure them that traction devices don't penetrate the brain. If the

  patient has a halo or skull-tong traction device, clean pin sites daily, trim hair short, and provide analgesics for persistent headaches. During traction, turn the patient often to prevent pneumonia, embolism, and skin breakdown; perform passive range-of-motion exercises to maintain muscle tone. If available, use a CircOlectric bed or Stryker frame to facilitate turning and to avoid spinal cord injury.
- Turn the patient on his side during feedings to prevent aspiration. Create a relaxed atmosphere at mealtimes.
- Suggest appropriate diversionary activities to fill the patient's hours of immobility.
- Watch closely for neurologic changes. Immediately report changes in skin sensation and loss of muscle strength—either of which might indicate pressure on the spinal cord, possibly as a result of edema or shifting bone fragments.
- Help the patient walk as soon as the physician allows; he'll probably need to wear a back brace.
- Before discharge, instruct the patient about continuing analgesics or other medication, and stress the importance of regular follow-up examinations.
- To help prevent a spinal injury from becoming a spinal *cord* injury, educate firemen, policemen, paramedics, and the general public about the proper way to handle such injuries.

THORAX

Blunt chest injuries

Chest injuries, including blunt chest injuries, consist of myocardial contusion as well as rib and sternal fractures that may be simple, multiple, displaced, or jagged. Such fractures may cause potentially fatal complications, such as hemothorax, pneumothorax, hemorrhagic shock, and diaphragmatic rupture.

Causes and incidence

Motor vehicle accidents cause two-thirds of major chest injuries in the United States. Other common causes include sports and blast injuries and cardiopulmonary resuscitation. About 50% of these injuries affect the chest wall; 80% of those with significant blunt chest trauma also have extrathoracic injuries.

Chest injuries account for 70% of all trauma-related deaths in the United States.

Complications

- Hemothorax
- Hemorrhagic shock
- Pneumothorax
- Tension pneumothorax
- Diaphragmatic rupture
- Liver laceration
- Myocardial tears
- Cardiac tamponade

- Pulmonary artery tears
- Ventricular rupture
- Rupture of the aorta
- Bronchial, tracheal, or esophageal tears

Signs and symptoms

Rib fractures produce tenderness, slight edema over the fracture site, and pain that worsens with deep breathing and movement; this painful breathing causes the patient to display shallow, splinted respirations that may lead to hypoventilation. Sternal fractures, which are usually transverse and located in the middle or upper sternum, produce persistent chest pains, even at rest. If a fractured rib tears the pleura and punctures a lung, it causes pneumothorax. This usually produces severe dyspnea, cyanosis, agitation, extreme pain and, when air escapes into chest tissue, subcutaneous emphysema.

Multiple rib fractures within two or more places may cause flail chest, in which a portion of the chest wall "caves in," causing a loss of chest wall integrity and preventing adequate lung inflation. (See *Flail chest: Paradoxical breathing*, page 1056.)

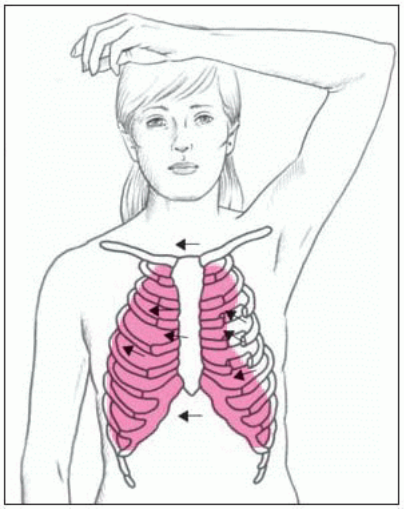
Signs and symptoms of flail chest include bruised skin, extreme pain caused by rib fracture and disfigurement, paradoxical chest movements, tachycardia, hypotension, respiratory acidosis, cyanosis, and rapid, shallow respirations. Flail chest can also cause tension pneumothorax, a condition in which air enters the chest but can't be ejected during exhalation. This life-threatening thoracic pressure buildup causes lung collapse and subsequent mediastinal shift. The cardinal symptoms of tension pneumothorax include severe dyspnea, absent breath sounds (on the affected side), agitation, jugular vein distention, tracheal deviation (away from the affected side), cyanosis, and shock.

FLAIL CHEST: PARADOXICAL BREATHING

A patient with a blunt chest injury may develop flail chest, in which a portion of the chest "caves in." This results in paradoxical breathing, described below.

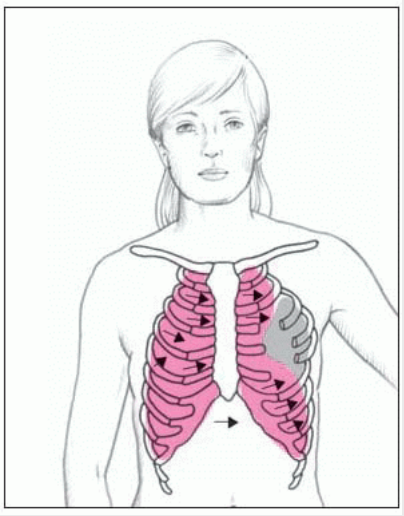
Inhalation

- Injured chest wall collapses in.
- Uninjured chest wall moves out.



Exhalation

- Injured chest wall moves out.
- Uninjured chest wall moves in.



Hemothorax occurs when a rib lacerates lung tissue or an intercostal artery, causing blood to collect in the pleural cavity, thereby compressing the lung and limiting respiratory capacity. It can also result from rupture of large or small pulmonary vessels.

Massive hemothorax is the most common cause of shock after a chest injury. Although slight bleeding occurs even with mild pneumothorax, such bleeding resolves very quickly, usually without changing the patient's condition. Rib fractures may also cause pulmonary contusion (resulting in hemoptysis, hypoxia, dyspnea, and possible obstruction), large myocardial tears (which can be rapidly fatal), and small myocardial tears (which can cause pericardial effusion).

Myocardial contusions—actual bruising of the heart muscle—produce electrocardiographic (ECG) abnormalities. Laceration or rupture of the aorta is almost always immediately fatal. Because aortic laceration may develop 24 hours after blunt injury, patient observation is critical. Diaphragmatic rupture (usually on the left side) causes severe respiratory distress. Unless treated early, abdominal viscera may herniate through the rupture into the thorax (with resulting bowel sounds in the chest), compromising both circulation and the lungs' vital capacity.

Other complications of blunt chest trauma may include cardiac tamponade, pulmonary artery tears, ventricular rupture, and bronchial, tracheal, or esophageal tears or rupture.

Diagnosis

A history of trauma with dyspnea, chest pain, and other typical clinical features suggest a blunt chest injury. To determine its extent, a physical examination and diagnostic tests are needed.

- In hemothorax, percussion reveals dullness. In tension pneumothorax, it reveals tympany. Auscultation may reveal a change in position of the loudest heart sound.
- Chest X-rays may confirm rib and sternal fractures, pneumothorax, flail chest, pulmonary contusions, lacerated or ruptured aorta, tension pneumothorax, diaphragmatic rupture, lung compression, or atelectasis with hemothorax.
- With cardiac damage, the ECG may show abnormalities, including unexplained tachycardias, atrial fibrillation, bundlebranch block (usually right), ST-segment changes, and ventricular arrhythmias such as multiple premature ventricular contractions.
- Serial aspartate aminotransferase, alanine aminotransferase, lactate dehydrogenase, creatine kinase (CK), and CK-MB levels are elevated. However, cardiac enzymes fail to detect up to 50% of patients with myocardial damage.
- Retrograde aortography, computed tomography angiography, and transesophageal echocardiography reveal aortic laceration or rupture.
- Contrast studies and liver and spleen scans 9detect diaphragmatic rupture.
- Echocardiography, computed tomography scans, and cardiac and lung scans show the injury's extent.

Treatment

Blunt chest injuries call for immediate physical assessment, control of bleeding, maintenance of a patent airway, adequate ventilation, and fluid and electrolyte balance.

Special considerations

- Check all pulses and level of consciousness. Evaluate skin color and temperature, depth of respiration, use of accessory muscles, and length of inhalation compared to exhalation.
- Check pulse oximetry values for adequate oxygenation.
- Observe tracheal position. Look for distended jugular veins and paradoxical chest motion. Listen to heart and breath sounds carefully; palpate for subcutaneous emphysema (crepitation) or a lack of structural integrity of the ribs.
- Obtain a history of the injury. Unless severe dyspnea is present, have the patient locate the pain, and ask if he's having trouble breathing. Obtain laboratory studies (arterial blood gas analysis, cardiac enzyme studies, complete blood count, type, and crossmatch).
- For simple rib fractures, have the patient cough and breathe deeply to mobilize secretions while splinting to decrease pain. Give adequate analgesics, encourage bed rest, and apply heat. Don't strap or tape the chest.
- More severe fractures may require administration of intercostal nerve blocks. (Obtain X-rays before and after the nerve blocks to rule out pneumothorax.) Intubate the patient with excessive bleeding or hemopneumothorax. Chest tubes may be inserted to treat hemothorax and to assess the need for

thoracotomy. To prevent atelectasis, turn the patient frequently and encourage coughing and deep-breathing exercises.

- Pneumothorax may require placement of a chest tube anterior to the midaxillary line at the fourth intercostal space to aspirate as much air as possible from the pleural cavity and to re-expand the lungs. When time permits, insert chest tubes attached to water-seal drainage and suction.
- For flail chest, place the patient in semi-Fowler's position. Re-expanding the lung is the first definitive care measure. Administer oxygen at a high flow rate under positive pressure. Suction the patient frequently, as completely as possible. Maintain acid-base balance. Observe carefully for signs of tension pneumothorax. Start I.V. therapy, using lactated Ringer's or normal saline solution. Beware of both excessive and insufficient fluid resuscitation.

ALERT

For hemothorax, treat shock with I.V. infusions of lactated Ringer's or normal saline solution. Administer packed red blood cells for blood losses greater than 1,500 ml or circulating blood volume losses exceeding 30%. Administer oxygen. The patient may need insertion of chest tubes in the fourth intercostal space anterior to the midaxillary line to remove blood. Monitor and document vital signs and blood loss. Watch for and respond immediately to falling blood pressure, rising pulse rate, and hemorrhage—all require a thoracotomy to stop bleeding.

- For a pulmonary contusion, give limited amounts of colloids (such as salt-poor albumin, whole blood, or plasma) as appropriate to replace volume and maintain oncotic pressure. Give analgesics as necessary. Monitor blood gas levels to ensure adequate ventilation; provide oxygen therapy, mechanical ventilation, and chest tube care.
- For suspected cardiac damage, close intensive care or telemetry may detect arrhythmias and prevent cardiogenic shock. Impose bed rest in semi-Fowler's position (unless the patient requires shock position); administer oxygen, analgesics, and supportive drugs to control heart failure or supraventricular arrhythmias as needed. Watch for cardiac tamponade, which calls for pericardiocentesis. (Provide essentially the same care as you would for a patient with a myocardial infarction.)

ALERT

For myocardial rupture, septal perforation, and other cardiac lacerations, immediate surgical repair is mandatory. Less severe ventricular wounds require use of a digital or balloon catheter; atrial wounds require a clamp or balloon catheter.

ALERT

For patients with aortic rupture or laceration, immediate surgery is mandatory, using synthetic grafts or anastomosis to repair the damage. Give large volumes of I.V. fluids (lactated Ringer's or normal saline solution) and whole blood, along with oxygen at very high flow rates; then transport the patient promptly to the operating room.

ALERT

For tension pneumothorax, the patient may need insertion of a 14G to 16G angiocatheter in the second intercostal space at the midclavicular line to release

pressure in the chest. After this, insert a chest tube to normalize pressure and re-expand the lung. Administer oxygen under positive pressure along with I.V. fluids.

- For a diaphragmatic rupture, insert a nasogastric tube to temporarily decompress the stomach, and prepare the patient for surgical repair.

Penetrating chest wounds

Depending on their size, penetrating chest wounds may cause varying degrees of damage to bones, soft tissue, blood vessels, and nerves. Mortality and morbidity from such wounds depend on the wound's size and severity. Gunshot wounds are usually more serious than stab wounds because they cause more severe wounds with rapid blood loss. Ricochet within a gunshot wound commonly damages large areas and multiple organs. Despite prompt, aggressive treatment, up to 90% of patients with penetrating chest wounds die.

Causes and incidence

Stab wounds from a knife or an ice pick are the most common penetrating chest wounds; gunshot wounds are a close second. Wartime explosions or firearms fired at close range are the usual sources of large, gaping wounds.

Penetrating chest injuries cause one in every four deaths in the United States. Many patients with this type of injury die after reaching the hospital.

Complications

- Arrhythmias
- Cardiac tamponade
- Mediastinitis
- Subcutaneous emphysema
- Bronchopleural fistula
- Myocardial rupture
- Pneumothorax
- Rib and sternal fractures
- Shock
- Tears and lacerations of the tracheobronchial tree

Signs and symptoms

In addition to the obvious chest injuries, penetrating chest wounds can also cause:

- a sucking sound as the diaphragm contracts and air enters the chest cavity through the opening in the chest wall
- tachycardia due to anxiety and blood loss
- weak, thready pulse due to massive blood loss and hypovolemic shock
- varying levels of consciousness, depending on the injury's extent. If the patient is awake and alert, the severe pain will make him splint his respirations, thereby reducing his vital capacity.

Penetrating chest wounds may also cause lung lacerations (bleeding and substantial air leakage through the chest wall), arterial lacerations (loss of more than 100 ml blood/hour through the chest tube), exsanguination, pneumothorax (air in pleural space causes loss of negative intrathoracic pressure and lung collapse), tension pneumothorax (intrapleural air accumulation causes potentially fatal mediastinal shift), and hemothorax. Other effects may include arrhythmias, cardiac tamponade, mediastinitis, subcutaneous emphysema, esophageal perforation, bronchopleural fistula, and tracheobronchial, abdominal, or diaphragmatic injuries.

Diagnosis

CONFIRMING DIAGNOSIS

An obvious chest wound and a sucking sound during breathing confirm the diagnosis of a penetrating chest wound. Consider any lower thoracic chest injury a thoracoabdominal injury until proven otherwise.

Baseline tests include:

- pulse oximetry and arterial blood gas analysis to assess respiratory status
- chest X-rays before and after chest tube placement to evaluate the injury and tube placement (However, in an emergency, don't wait for chest X-ray results before inserting the chest tube.)
- complete blood count, including hemoglobin (Hb) level, hematocrit (HCT), and differential (Low Hb level and HCT reflect severe blood loss; in early blood loss, these values may be normal.)
- palpation and auscultation of the chest and abdomen to evaluate damage to adjacent organs and structures.

Treatment

Penetrating chest wounds require immediate support of respiration and circulation, prompt surgical repair, and measures to prevent complications.

Special considerations

- Immediately assess airway, breathing, and circulation. Establish a patent airway, support ventilation, and monitor pulses frequently.
- Place an occlusive dressing over the sucking wound. Watch for signs of tension pneumothorax (respiratory distress, tachycardia, tachypnea, and diminished or absent breath sounds on the affected side [tracheal shift]); if tension pneumothorax develops, temporarily remove the occlusive dressing to create a simple pneumothorax.
- Control blood loss (remember to look *under* the patient to estimate loss), type and crossmatch blood, and replace blood and fluids as necessary.
- Assist with chest X-ray and placement of chest tubes (using water-seal drainage) to re-establish intrathoracic pressure and to drain blood in a hemothorax. A second X-ray will evaluate the position of tubes and their function.
- Emergency surgery may be needed to repair the damage caused by the wound.
- Throughout treatment, monitor central venous pressure and blood pressure to detect hypovolemia, and assess vital signs. Provide analgesics as appropriate. Tetanus and antibiotic prophylaxis may be necessary.
- Reassure the patient, especially if he's been the victim of a violent crime. Report the incident to the police in accordance with local laws. Help contact the patient's family, and offer them reassurance as well.

ABDOMEN

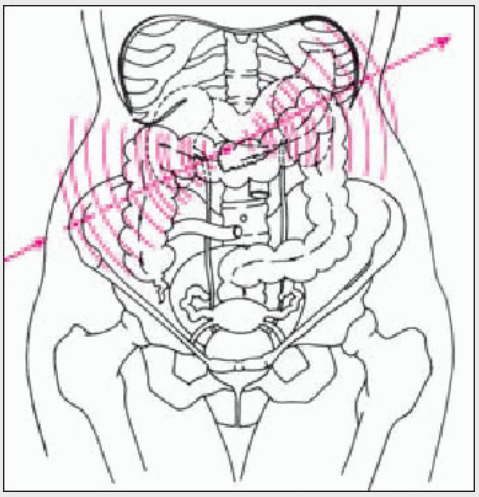
Blunt and penetrating abdominal injuries

Blunt and penetrating abdominal injuries may damage major blood vessels and internal organs. Their most immediate life-threatening consequences are hemorrhage and hypovolemic shock; later threats include infection. The prognosis depends on

the extent of the injury and the specific organs damaged, but it's usually improved by prompt diagnosis and surgical repair.

PROJECTILE PATHWAY

In a penetrating abdominal injury, you can estimate probable internal damage by determining the organs lying on the pathway between the entry and exit sites.



Causes and incidence

Blunt (nonpenetrating) abdominal injuries usually result from automobile accidents, falls from heights, or sports injuries; penetrating abdominal injuries, from stab and gunshot wounds.

The most commonly injured organs associated with penetrating abdominal trauma are the small intestine (29%), liver (28%), and colon (23%). Penetrating abdominal trauma affects 35% of those admitted to urban trauma centers and 1% to 12% of those admitted to suburban and rural centers.

Complications

- Hemorrhage
- Hypovolemic shock
- Infection
- Dysfunction of major organs such as liver, spleen, pancreas, and kidneys

Signs and symptoms

Symptoms vary with the degree of injury and the organs damaged. Penetrating abdominal injuries cause obvious wounds (gunshots commonly produce both entrance and exit wounds) with variable blood loss, pain, and tenderness. They commonly result in pallor, cyanosis, tachycardia, shortness of breath, and hypotension. (See *Projectile pathway*.) Blunt abdominal injuries cause severe pain (which may radiate beyond the abdomen to the shoulders), bruises, abrasions, contusions, or distention. They may also result in tenderness, abdominal splinting or rigidity, nausea, vomiting, pallor, cyanosis, tachycardia, and shortness of breath. Rib fractures commonly accompany blunt injuries. (See *Effects of blunt abdominal trauma*.)

In both blunt and penetrating injuries, massive blood loss may cause hypovolemic shock. Damage to solid abdominal organs (liver, spleen, pancreas, and kidneys) generally causes hemorrhage. Damage to hollow organs (stomach, intestine, gallbladder, and bladder) causes rupture and release of the organs' contents (including bacteria) into the abdomen, which in turn produces inflammation and, possibly, infection.

Diagnosis

CONFIRMING DIAGNOSIS

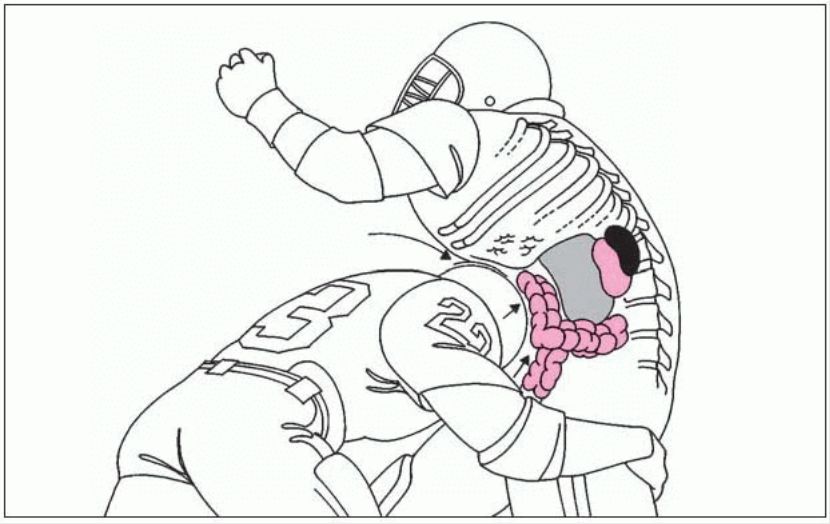
A history of abdominal trauma, clinical features, and laboratory test results confirm the diagnosis of blunt or penetrating abdominal injury and determine organ damage.

Consider any upper abdominal injury a thoracoabdominal injury until proven otherwise. Laboratory studies vary with the patient's condition but usually include:

- chest X-rays (preferably done with the patient upright to show free air)
- examination of stools and stomach aspirate for blood
- blood studies (Decreased hematocrit and hemoglobin levels point to blood loss; coagulation studies evaluate hemostasis; white blood cell count is usually elevated but doesn't necessarily point to infection; type and crossmatch to prepare for a blood transfusion.)
- arterial blood gas analysis to evaluate respiratory status

EFFECTS OF BLUNT ABDOMINAL TRAUMA

When a blunt object strikes a person's abdomen, it raises intra-abdominal pressure. Depending on the blow's force, the trauma can lacerate the liver and spleen, rupture the stomach, bruise the duodenum, and damage the kidneys.



- serum amylase levels, which may be elevated in pancreatic injury
- aspartate aminotransferase and alanine aminotransferase levels, which increase with tissue injury and cell death
- excretory urography and cystourethrography to detect renal and urinary tract damage
- angiography to detect specific injuries, especially to the kidneys
- computed tomography scan to detect abdominal, head, or other injuries
- exploratory laparotomy to detect specific injuries when other clinical evidence is incomplete
- other laboratory studies to rule out associated injuries
- peritoneal lavage with insertion of a lavage catheter to check for blood, GI content, vegetable fibers, and bile. In blunt trauma with equivocal abdominal findings, this procedure helps establish the need for exploratory surgery.

Treatment

Emergency treatment of abdominal injuries controls hemorrhage and prevents hypovolemic shock through the infusion of I.V. fluids and blood components. After stabilization, most abdominal injuries require surgical repair; some patients, however, require immediate surgery. Analgesics and antibiotics increase patient comfort and prevent infection. Most patients require hospitalization; if they're asymptomatic, they may require observation for only 6 to 24 hours.

Special considerations

Emergency care in patients with abdominal injuries supports vital functions by maintaining airway, breathing, and circulation. At admission, immediately evaluate respiratory and circulatory status and, if possible, obtain a history. Follow these guidelines:

- To maintain airway and breathing, intubate the patient and provide mechanical ventilation as necessary; otherwise, provide supplemental oxygen.

CLASSIFYING SPRAINS AND STRAINS

This guide will help you classify the severity of sprains and strains.

Sprains

- *Grade 1 (mild):* minor or partial ligament tear with normal joint stability and function
- *Grade 2 (moderate):* partial tear with mild joint laxity and some function loss
- *Grade 3 (severe):* complete tear or incomplete separation of ligament from bone, causing total joint laxity and function loss

Strains

- *Grade 1 (mild):* microscopic muscle or tendon tear (or both) with no loss of strength
- *Grade 2 (moderate):* incomplete tear with bleeding into muscle tissue and some loss of strength
- *Grade 3 (severe):* complete rupture, usually resulting from separation of muscle from muscle, muscle from tendon, or tendon from bone (This type of strain usually stems from sudden, violent movement or direct injury.)

- Using a large-bore needle, start two or more I.V. lines for rapid infusion of normal saline solution, lactated Ringer's solution, or blood. Then draw a blood sample for laboratory studies, and type and crossmatch blood. Also, insert a nasogastric tube and, if necessary, an indwelling urinary catheter. Monitor stomach aspirate and urine for blood.
- Obtain baseline vital signs, and continue to monitor them every 15 minutes.
- Apply a sterile dressing to open wounds. After assessing the patient, splint a suspected pelvic injury by tying the patient's legs together with a pillow between them. Mast trousers may be used to splint pelvic fractures. Try not to move the patient.
- Give analgesics as ordered. Opioids usually aren't recommended, but if the pain is severe, give opioids in small, titrated I.V. doses.
- Give tetanus prophylaxis and prophylactic I.V. antibiotics as ordered.
- Prepare the patient for surgery. Have the patient or a responsible relative sign a consent form. Remove dentures.
- If the injury was caused by a motor vehicle accident, find out if the police were notified; if not, notify them. If the patient suffered a gunshot or stab wound, notify the police. Place the patient's clothes in a paper bag, labeled with the patient's name and the date and time he was brought to your facility; the police will require the clothing as part of their investigation into the circumstances surrounding the patient's injury. Document the number and sites of the wounds. Contact the patient's family and offer them reassurance.

EXTREMITIES

Sprains and strains

A sprain is a complete or incomplete tear in the supporting ligaments surrounding a joint that usually follows a sharp twist. A strain is an injury to a muscle or tendinous attachment. Both injuries usually heal without surgical repair. (See *Classifying sprains and strains.*)

Causes and incidence

Sprains and strains may result from accidental injury, various sports-related injuries, or from simple household or work-related tasks. More than 4 of 10 injuries resulting in time absent from work are due to sprains and strains, mostly affecting the back.

Complications

- Avulsion fracture
- Chronic strain

Signs and symptoms

A sprain causes local pain (especially during joint movement), swelling, loss of mobility (which may not occur until several hours after the injury), and a black-andblue discoloration from blood extravasating into surrounding tissues. A sprained ankle is the most common joint injury. (See *Muscle-tendon ruptures*.)

A strain may be acute (an immediate result of vigorous muscle overuse or overstress) or chronic (a result of repeated overuse). An acute strain causes a sharp, transient pain (the patient may report having heard a snapping noise) and rapid swelling. When severe pain subsides, the muscle is tender; after several days, ecchymoses appear. A chronic strain causes stiffness, soreness, and generalized tenderness several hours after the injury.

Diagnosis

A history of a recent injury or chronic overuse, clinical findings, and an X-ray to rule out fractures establish the diagnosis. (See *Sprains and strains: An inside view*, page 1064.)

Treatment

Treatment of sprains consists of controlling pain and swelling. Immediately after the injury, control swelling by elevating the joint above the level of the heart and by applying ice intermittently for 24 to 48 hours. To prevent a cold injury, place a towel between the ice pack and the skin.

Support the joint, using an elastic bandage. Place patient on weight-bearing as tolerated. Codeine or another analgesic may be necessary if the injury is severe. If the patient has a sprained ankle, he may need crutch gait training. Because patients with sprains seldom require hospitalization, provide patient teaching.

A sprain usually heals in 2 to 3 weeks, after which the patient can gradually resume normal activities. Occasionally, however, torn ligaments don't heal properly and cause recurrent dislocation, requiring surgical repair. Some athletes may request immediate surgical repair to hasten healing; to prevent sprains, they may tape their wrists and ankles before sports activities.

MUSCLE-TENDON RUPTURES

Perhaps the most serious muscle-tendon injury is a rupture of the muscle-tendon junction. This type of rupture may occur at any such junction, but it's most common at the Achilles tendon, extending from the posterior calf muscle to the foot. An Achilles tendon rupture produces a sudden, sharp pain and, until swelling begins, a palpable defect. Such a rupture typically occurs in men between ages 35 and 40, especially during such physical activities as jogging and tennis.

To distinguish an Achilles tendon rupture from other ankle injuries, the physician performs this simple test: With the patient prone and his feet hanging off the foot of the table, the physician squeezes the calf muscle. If this causes plantar flexion, the tendon is intact; if it causes ankle dorsiflexion, it's partially intact; if there's no flexion of any kind, the tendon is ruptured.

An Achilles tendon rupture usually requires surgical repair, followed first by a long leg cast for 4 weeks and then by a short cast for an additional 4 weeks.

Acute strains require analgesics and application of ice for up to 48 hours and then application of heat. Complete muscle rupture may require surgery. Chronic strains usually don't need treatment, but heat application, nonsteroidal anti-inflammatory drugs such as ibuprofen, or an analgesicmuscle relaxant can relieve discomfort.

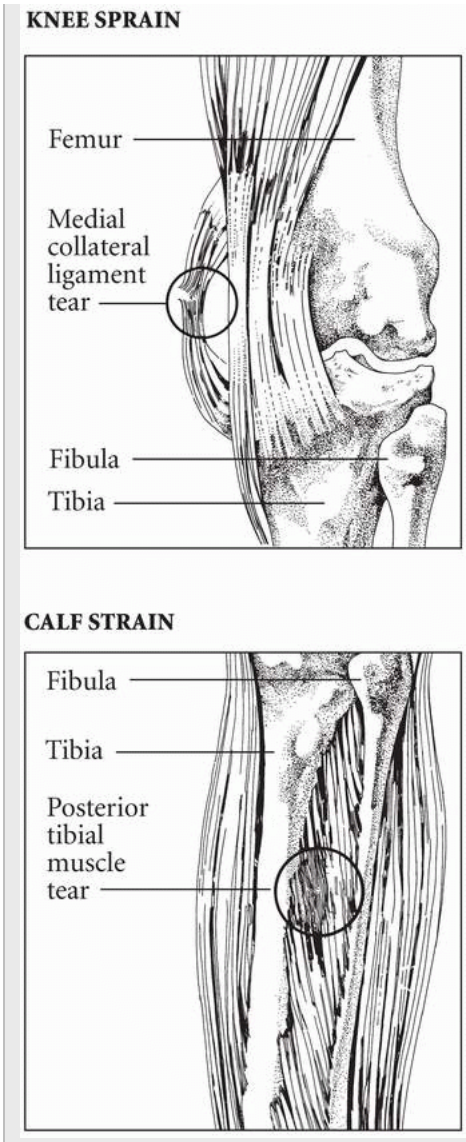
Special considerations

- Tell the patient to elevate the joint for 48 to 72 hours after the injury (pillows can be used while sleeping) and to apply ice intermittently for 24 to 48 hours.
- If an elastic bandage has been applied, teach the patient to reapply it by wrapping

  from below to above the injury, forming a figure eight. For a sprained ankle, apply the bandage from the toes to midcalf. Tell the patient to remove the bandage before going to sleep and to loosen it if it causes the leg to become pale, numb, or painful.
- Instruct the patient to call the physician if the pain worsens or persists; if so, an additional X-ray may reveal a previously undetected fracture.

SPRAINS AND STRAINS: AN INSIDE VIEW

Except for possible swelling and discoloration, you can't see a sprain or a strain. However, these conditions are very painful. With a sprain, the patient feels the stretching or tearing of a ligament—the fibrous tissue that binds joints together. With an acute or chronic strain, the patient will feel a partial muscle tear. A strain also may affect tendons—the fibrous tissue that connects muscle to bone. The following illustrates each type of injury.



Arm and leg fractures

Arm and leg fractures usually result from trauma and commonly cause substantial muscle, nerve, and other soft-tissue damage. The prognosis varies with the extent of disablement or deformity, the amount of tissue and vascular damage, the adequacy of reduction and immobilization, and the patient's age, health, and nutritional status. Children's bones usually heal rapidly and without deformity. Bones of adults in poor health and with impaired circulation may never heal properly. Severe open fractures, especially of the femoral shaft, may cause substantial blood loss and life-threatening hypovolemic shock.

Causes and incidence

Most arm and leg fractures result from major traumatic injury, such as a fall on an outstretched arm, a skiing accident, or child abuse (suggested by multiple or repeated episodes of fractures). However, in a person with a pathologic bone-weakening condition, such as osteoporosis, bone tumors, or metabolic disease, a mere cough or sneeze can also produce a fracture. Prolonged standing, walking,

or running can cause stress fractures of the foot and ankle—usually in soldiers, nurses, postal workers, and joggers.

Fractures are among the most common orthopedic problems; about 6.8 million people seek medical attention for fractures in the United States each year.

ELDER TIP

Brittle bones make an older person especially vulnerable to fractures. A fall on an outstretched arm or hand or a direct blow to the arm or shoulder is likely to fracture the radius or humerus.

IDENTIFYING PERIPHERAL NERVE DAMAGE

The chart below lists signs and symptoms that can help you pinpoint where a patient has nerve damage. Keep in mind that you won't be able to rely on these signs and symptoms in a patient with severed extension tendons or severe muscle damage.

Nerve	Associated injury	Sign or symptom
Radial	Fracture of the humerus (especially the middle and distal thirds)	The patient can't extend his thumb.
Ulnar	Fracture of the medial humeral epicondyle	The patient can't perceive pain in the tip of his little finger.
Median	Elbow dislocation or wrist or forearm injury	The patient can't perceive pain in the tip of his index finger.
Peroneal	Tibia or fibula fracture or dislocation of the knee	The patient can't extend his foot (this also may indicate sciatic nerve injury).
Sciatic and tibial	Rare with fractures or dislocations	The patient can't perceive pain in his sole.

Complications

- Permanent deformity and dysfunction if bones fail to heal (nonunion) or heal improperly (malunion)
- Peripheral nerve damage (see *Identifying peripheral nerve damage*)
- Aseptic necrosis of bone segments from impaired circulation
- Hypovolemic shock as a result of blood vessel damage (This is especially likely to develop in patients with a fractured femur.)
- Muscle contractures
- Renal calculi from decalcification (due to prolonged immobility)
- Fat embolism (see *Fat embolism*, page 1066)
- Compartment syndrome (see *Recognizing compartment syndrome*, page 1066)

Signs and symptoms

Arm and leg fractures may produce any or all of the “5 Ps”: pain and point tenderness, pallor, pulse loss, paresthesia, and paralysis. (The last three occur distal to the fracture site.) Other signs include deformity, swelling, discoloration, crepitus, and loss of limb function. Numbness and tingling, mottled

cyanosis, cool skin at the end of the limb, and loss of pulses distal to the injury indicate possible arterial compromise or nerve damage. Open fractures also produce an obvious skin wound.

Diagnosis

A history of traumatic injury and the results of the physical examination, including gentle palpation and a cautious attempt by the patient to move parts distal to the injury, suggest an arm or leg fracture.

Note: When performing the physical examination, also check for other injuries.

CONFIRMING DIAGNOSIS

Anteroposterior and lateral X-rays of the suspected fracture as well as X-rays of the joints above and below it confirm the diagnosis. (See Classifying fractures, pages 1067 and 1068.*)*

Treatment

Emergency treatment consists of splinting the limb above and below the suspected fracture, applying a cold pack, and elevating the limb to reduce edema and pain.

In severe fractures that cause blood loss, apply direct pressure to control bleeding,

and administer fluid replacement as soon as possible to prevent or treat hypovolemic shock.

FAT EMBOLISM

A complication of long-bone fracture, fat embolism may also follow severe soft-tissue bruising and fatty liver injury. Posttraumatic embolization may occur as bone marrow releases fat into the veins. The fat can lodge in the lungs, obstructing the pulmonary vascular bed, or pass into the arteries, eventually disturbing the respiratory and circulatory systems.

Fat embolism occurs 12 to 48 hours after an injury, typically producing fever, tachycardia, tachypnea, blood-tinged sputum, cyanosis, anxiety, restlessness, altered level of consciousness, seizures, coma, and a rash. Diagnostic test results reveal decreased hemoglobin level, increased serum lipase level, leukocytosis, thrombocytopenia, hypoxemia, and fat globules in urine and sputum. A chest X-ray may show mottled lung fields and right ventricular dilation. An electrocardiogram may reveal tachycardia and large S waves in lead I, large Q waves and an inverted T wave in lead III, and right axis deviation.

Treatment may include steroids to reduce inflammation, heparin to prevent thrombosis, and oxygen to correct hypoxemia. Expect to immobilize fractures early. Assist with endotracheal intubation and ventilation as ordered.

RECOGNIZING COMPARTMENT SYNDROME

Compartment syndrome occurs when pressure within the muscle compartment, resulting from edema or bleeding, increases to the point of interfering with circulation. Crush injuries, burns, bites, and fractures requiring casts or dressings may cause this syndrome. Compartment syndrome most commonly occurs in the lower arm, hand, lower leg, and foot. Symptoms include:

- increased pain

- decreased touch sensation
- increased weakness of the affected part
- increased swelling and pallor
- decreased pulses and capillary refill.

Treatment includes:

- placing the limb at heart level
- removing constricting forces
- monitoring neurovascular status and compartment pressures
- emergency fasciotomy.

After confirming a fracture diagnosis, begin treatment with reduction (which involves restoring displaced bone segments to their normal position).

After reduction, the fractured arm or leg must be immobilized by a splint or a cast or with traction. In closed reduction (accomplished by manual manipulation), a local anesthetic such as lidocaine and an analgesic such as I.V. morphine help relieve pain; a muscle relaxant such as I.V. diazepam or a sedative such as midazolam facilitates the muscle stretching necessary to realign the bone.

X-rays are ordered to confirm that the reduction was successful and that proper bone alignment was achieved.

When closed reduction is impossible, open reduction during surgery reduces and immobilizes the fracture by means of rods, plates, or screws. Afterward, a cast is usually applied.

When a splint or cast fails to maintain the reduction, immobilization requires skin or skeletal traction, using a series of weights and pulleys. In skin traction, elastic bandages and sheepskin coverings are used to attach traction devices to the patient's skin. In skeletal traction, a pin or wire inserted through the bone distal to the fracture and attached to a weight allows more prolonged traction.

PATHOPHYSIOLOGY

CLASSIFYING FRACTURES

One of the best-known systems for classifying fractures uses a combination of general terms to describe the fracture (for example, a simple, nondisplaced, oblique fracture).

Here are definitions of the classifications and terms used to describe fractures, along with illustrations of fragment positions and fracture lines.

General classification of fractures

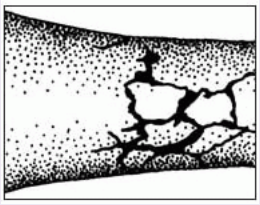
Simple (closed): Bone fragments don't penetrate the skin.

Compound (open): Bone fragments penetrate the skin.

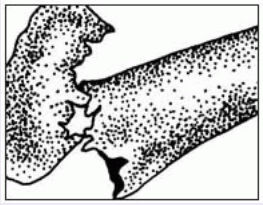
Incomplete (partial): Bone continuity isn't completely interrupted.

Complete: Bone continuity is completely interrupted.

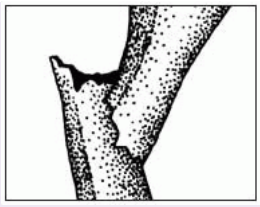
Classification of fragment position



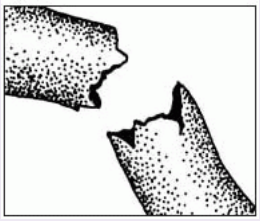
Comminuted: Bone breaks into separate small pieces.



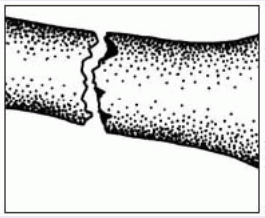
Displaced: Fracture fragments separate and are deformed.



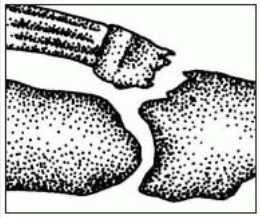
Overriding: Fragments overlap, shortening the total bone length.



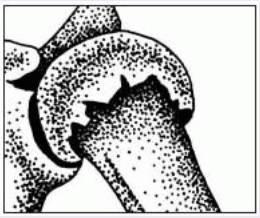
Angulated: Fragments lie at an angle to each other.



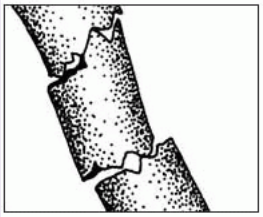
Nondisplaced: The two sections of bone maintain essentially normal alignment.



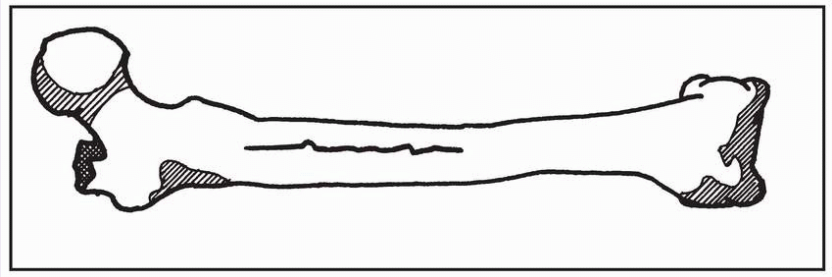
Avulsed: Fragments are pulled from normal position by muscle contractions or ligament resistance.



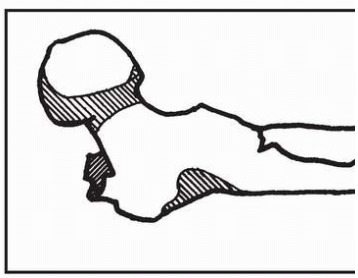
Impacted: One bone fragment is forced into another.



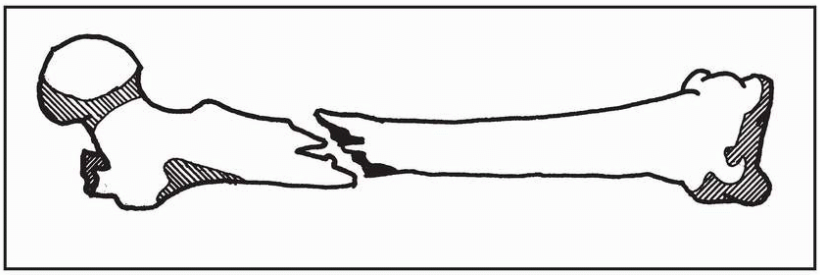
Segmental: Fractures occur in two adjacent areas with an isolated central segment.



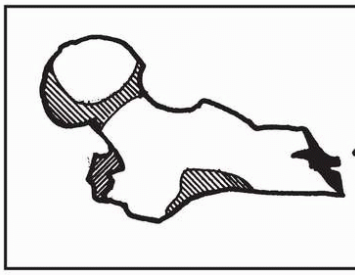
Linear: The fracture line runs parallel to the bone's axis.



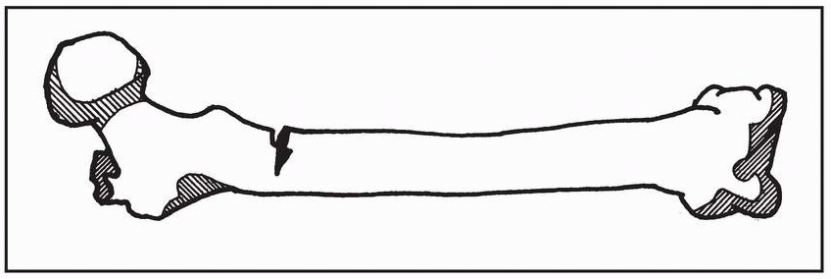
Spiral: The fracture line crosses the bor



Longitudinal: The fracture line extends in a longitudinal (but not parallel) direction along the bone's axis.



Transverse: The fracture line forms a ri



Oblique: The fracture line crosses the bone at roughly a 45-degree angle to the bone's axis.

Treatment of open fractures also requires tetanus prophylaxis, prophylactic antibiotics, surgery to repair soft-tissue damage, and thorough debridement of the wound.

Special considerations

- Watch for signs of shock in the patient with a severe open fracture of a large bone such as the femur.

ALERT

Monitor vital signs and be especially alert for rapid pulse, decreased blood pressure, pallor, and cool, clammy skin—all of which may indicate that the patient is in shock.

- Administer I.V. fluids as indicated.
- Offer reassurance to the patient, who's likely to be frightened and in pain.
- Ease pain with analgesics as needed.
- Help the patient set realistic goals for recovery.
- If the fracture requires long-term immobilization with traction, reposition the patient often to increase comfort and prevent pressure ulcers. Assist with active range-of-motion exercises to prevent muscle atrophy. Encourage deep breathing and coughing to avoid hypostatic pneumonia.
- Urge adequate fluid intake to prevent urinary stasis and constipation. Watch for signs of renal calculi (flank pain, nausea, and vomiting).

- Provide good cast care, and support the cast with pillows. Observe for skin irritation near cast edges and check for foul odors or discharge. Tell the patient to report signs of impaired circulation

(skin coldness, numbness, tingling, or discoloration) immediately. Warn him not to get the cast wet and not to insert foreign objects under the cast.

- Encourage the patient to start moving around as soon as he's able. Help him to walk. (Remember, a patient who has been bedridden for some time may be dizzy at first.) Demonstrate how to use crutches properly.
- After cast removal, refer the patient to a physical therapist to restore limb mobility.
- If the patient is a child who sustained the fracture at or near the growth plate, have the family continue to follow up with the child's pediatrician to ensure that there are no problems as the limb grows.

Dislocations and subluxations

Dislocations displace joint bones so that their articulating surfaces lose contact; subluxations partially displace the articulating surfaces. (See *Common dislocation*.) Dislocations and subluxations occur at the joints of the shoulders, elbows, wrists, digits, hips, knees, ankles, and feet. These injuries may accompany joint fractures or result in deposition of fracture fragments between joint surfaces. Prompt reduction can limit the resulting damage to soft tissue, nerves, and blood vessels.

Causes and incidence

A dislocation or subluxation may be congenital (as in congenital hip dislocation) or it may follow trauma or disease of surrounding joint tissues.

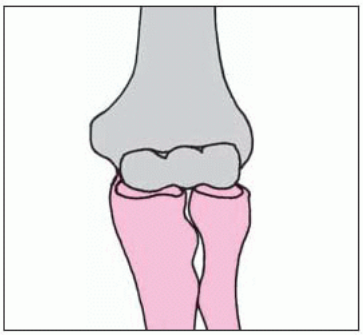
Signs and symptoms

Dislocations and subluxations produce deformity around the joint, change the involved limb's length, impair joint mobility, and cause point tenderness. When the injury results from trauma, it's extremely painful and commonly accompanies joint surface fractures. Even in the absence of concomitant fractures, the displaced bone may damage surrounding muscles, ligaments, nerves, and blood vessels and may cause bone necrosis, especially if reduction is delayed.

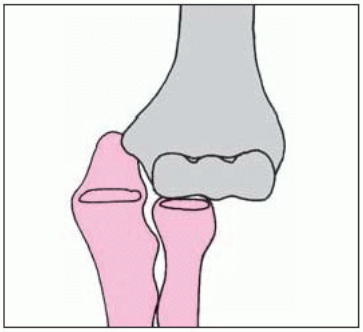
COMMON DISLOCATION

Children commonly dislocate elbow joints as a result of an adult pulling the child by the hand, as occurs when crossing the street; the stress on the joint causes the dislocation.

NORMAL ELBOW JOINT



ELBOW JOINT WITH LATERAL DISLOCATION



Diagnosis

Patient history, X-rays, and a physical examination rule out or confirm a fracture.

Treatment

Immediate reduction (before tissue edema and muscle spasm make reduction difficult)

can prevent additional tissue damage and vascular impairment. Closed reduction consists of manual traction under general anesthesia (or local anesthesia and sedatives). During such reduction, I.V. morphine controls pain; I.V. midazolam controls muscle spasm and facilitates muscle stretching during traction. Some injuries require open reduction under regional block or general anesthesia. Such surgery may include wire fixation of the joint, skeletal traction, and ligament repair.

After reduction, a splint, a cast, or traction immobilizes the joint. In most cases, immobilizing the digits for 2 weeks, hips for 6 to 8 weeks, and other dislocated joints for 3 to 6 weeks allows surrounding ligaments to heal. Follow-up with a physical therapist is usually required to maintain optimal joint function.

Special considerations

- Until reduction immobilizes the dislocated joint, don't attempt manipulation. Apply ice to ease pain and edema. Splint the limb “as it lies,” even if the angle is awkward. If severe vascular compromise is present or is indicated by pallor, pain, loss of pulses, paralysis, or paresthesia, an immediate orthopedic examination (and possibly immediate reduction) is necessary.
- Because a patient who receives opioids or benzodiazepines I.V. may develop respiratory depression or arrest, keep an airway and a bag-valve-mask in the room. Monitor respirations and pulse rate

closely. Also have opioids and benzodiazepine reversal agents readily available.

- To avoid injury from a dressing that's too tight, instruct the patient to report numbness, pain, cyanosis, or coldness of the limb below the cast or splint.
- To avoid skin damage, watch for signs of pressure injury (pressure, pain, or soreness) both inside and outside the dressing.
- After the cast or splint is removed, inform the patient that he may gradually return to normal joint activity.
- A dislocated hip needs immediate reduction. At discharge, stress the need for follow-up visits to detect aseptic femoral head necrosis from vascular damage.

Traumatic amputation

Traumatic amputation is the accidental loss of a body part, usually a finger, toe, arm, or leg. In a complete amputation, the extremity is totally severed; in a partial amputation, some soft-tissue connection remains. The prognosis for such injuries has improved as a result of earlier emergency and critical care management, new surgical techniques, early rehabilitation, prosthesis fitting, and new prosthesis design. New limb reimplantation techniques have been moderately successful, but incomplete nerve regeneration remains a major limiting factor.

Causes and incidence

Traumatic amputations usually result directly from accidents involving factory, farm, power tools, or motor vehicles. Natural disasters, wars, and terrorist attacks can also cause traumatic amputations.

Below-the-knee amputations account for 53% of traumatic leg amputations; with about 33% above the knee. Lower limb amputations account for 91.7% of traumatic amputations. Incidence of below-theelbow amputation is 4.4%, and above the elbow amputations account for 2%.

Complications

- Hypovolemic shock
- Sepsis
- Residual paralysis with reimplantation

Signs and symptoms

The obvious sign of amputation is a body part that has been cut off. Every traumatic amputee requires careful monitoring of vital signs. If amputation involves more than a finger or toe, assessment of airway, breathing, and circulation is also required. Because profuse bleeding is likely, watch for signs of hypovolemic shock, and draw blood for a hemoglobin level, hematocrit, and type and crossmatch. In partial amputation, check for pulses distal to the amputation site. After any traumatic amputation, assess for other traumatic injuries as well. The patient may exhibit crushed body tissue, in which the body part is badly mangled but still partially attached by muscle, bone, tendon, or skin.

Treatment

Because the greatest immediate threat after traumatic amputation is blood loss and hypovolemic shock, emergency treatment consists of local measures to control bleeding, fluid replacement with normal saline solution and colloids, and blood replacement as needed. Reimplantation remains controversial, but it's becoming more common and successful because of advances in microsurgery

techniques. If reconstruction or reimplantation is possible, surgical intervention attempts to preserve usable joints.

When arm or leg amputations are done, the surgeon creates a stump to be fitted with a prosthesis. A rigid dressing permits early prosthesis fitting and rehabilitation.

ELDER TIP

Leg amputation can be a life-threatening procedure, especially in patients older than age 60 with peripheral vascular disease. Such patients suffer significant morbidity with above-the-knee amputations because of associated poor health, disease, or malnutrition; complications such as sepsis; and the physiologic insult of amputation.

Special considerations

- During emergency treatment, monitor vital signs (especially in hypovolemic shock), clean the wound, and give tetanus prophylaxis, analgesics, and antibiotics as ordered.
- After a complete amputation, wrap the amputated part in wet dressings soaked in normal saline solution. Label the part, seal it in a plastic bag, and float the bag in ice water. Flush the wound with sterile saline solution, apply a sterile pressure dressing, and elevate the limb. Notify the reimplantation team.
- After a partial amputation, position the limb in normal alignment and drape it with towels or dressings soaked in sterile normal saline solution.
- Preoperatively, irrigate and debride the wound thoroughly (using a local block). Postoperatively, perform dressing changes using sterile technique to help prevent skin infection and ensure skin graft viability.
- Help the amputee cope with his altered body image. Encourage him to perform prescribed exercises while taking care to prevent stump trauma.

WHOLE BODY

Burns

A major burn is a catastrophic injury, requiring painful treatment and a long period of rehabilitation. It's commonly fatal or permanently disfiguring and incapacitating (both emotionally and physically).

Causes and incidence

Thermal burns, the most common type, are usually the result of residential fires, automobile accidents, children playing with matches, improperly stored gasoline, space heater or electrical malfunctions, or arson. Other causes include improper handling of firecrackers, scalding accidents, and kitchen accidents (such as a child climbing on top of a stove or grabbing a hot iron). Some burns in children are traced to parental abuse.

Chemical burns result from the contact, ingestion, inhalation, or injection of acids, alkalis, or vesicants. Electrical burns usually occur after contact with faulty electrical wiring or high-voltage power lines; many children sustain them by chewing on electric cords. Friction, or abrasion, burns happen when the skin is rubbed harshly against a coarse surface. Sunburn, of course, follows excessive exposure to sunlight.

In the United States, about 2.4 million people suffer burns annually. Fire ranks fifth among accidental injuries, after motor vehicle accidents, poisoning, falls, and drowning.

Complications

- Respiratory complications
- Sepsis
- Hypovolemic shock
- Anemia
- Multiorgan dysfunction syndrome

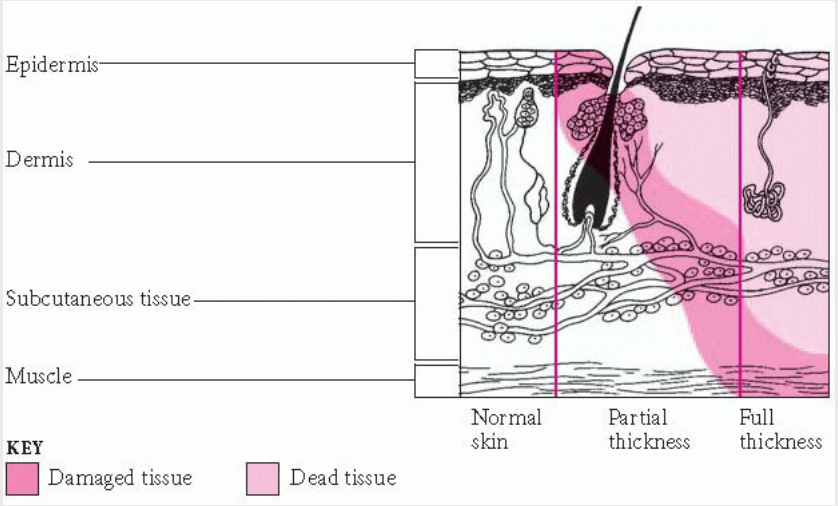
Signs and symptoms

One goal of assessment is to determine the *depth* of skin and tissue damage. A partial-thickness

burn damages the epidermis and part of the dermis, whereas a full-thickness burn affects the full dermis and, possibly, subcutaneous tissue. A more traditional method gauges burn depth by degrees. However, most burns are a combination of different degrees and thicknesses. (See *Gauging burn depth*.)

GAUGING BURN DEPTH

One method of assessing burns is by determining the burn's depth. A partial-thickness burn damages the epidermis and part of the dermis, whereas a full-thickness burn damages the epidermis, dermis, subcutaneous tissue, and muscle, as shown below.



Burn degrees are classified as follows:

- *Superficial (first-degree) burns* — Damage is limited to the epidermis, causing erythema and pain.
- *Partial-thickness (second-degree) burns*—The epidermis and part of the dermis are damaged, producing blisters and mild to moderate edema and pain.
- *Full-thickness (third-degree) burns*—The epidermis and the dermis are damaged. No blisters appear, but white, brown, or black leathery tissue and thrombosed vessels are visible.
- *Fourth degree*—Damage extends through deeply charred subcutaneous tissue to muscle and bone.

Another assessment goal is to estimate the *size* of a burn, which is usually expressed as the percentage of body surface area (BSA) covered by the burn. The Rule of Nines chart usually provides this estimate, but the Lund and Browder chart is more accurate because it allows for BSA changes with age.

A correlation of the burn's depth and size permits an estimate of its severity as follows:

- *major full-thickness (third degree)* — on more than 10% of BSA; second-degree burns on more than 25% of adult BSA (more than 20% in children); burns of hands, face, feet, or genitalia; burns complicated by fractures or respiratory damage; electrical burns; all burns in poor-risk patients
- *moderate full-thickness (third degree)*—third-degree burns on 2% to 10% of BSA; second-degree burns on 15% to 25% of adult BSA (10% to 20% in children)
- *minor full-thickness (third degree)*—third-degree burns on less than 2% of BSA; second-degree burns on less than 15% of adult BSA (10% in children).

Here are other important factors in assessing burns:

MANAGING BURNS WITH SKIN GRAFTS

When a patient has a limited, well-defined burn, he may need a temporary graft to minimize fluid and protein loss from the burn surface, to prevent infection, and to reduce pain. Types of temporary grafts include:

- *allografts (homografts),* which are usually cadaver skin
- *xenografts (heterografts),* which are typically pigskin
- *biosynthetic grafts,* which are a combination of collagen and synthetics.

To treat a full-thickness burn, a patient may need an *autograft.* This method uses the patient's own skin—usually a split-thickness graft—to replace the burned skin. For areas where appearance or joint movement is important, the autograft will be transplanted intact. In flat areas where appearance is less critical, the graft may be meshed (fenestrated) to cover up to three times its original size.

When burns cover the entire body surface, epithelial cells grown in culture for autograft may provide lifesaving treatment. In this method, a small full-thickness biopsy yields epidermal cells that are cultured into sheets and then grafted onto the burns. It takes several weeks to grow confluent sheets and the process is costly. The cells are produced in a fragile sheet that's sensitive to infection.

Bilayer collagen matrices—porous, spongelike lattices are composed of bovine collagen, chondroitin-6-sulfate, and glycosaminoglycans—are another option. These matrices serve as a dermal substitute and a scaffold to support developing fibroblasts and blood vessels, which eventually replace the matrices. A silicone membrane is sealed over the surface, becoming progressively less adherent as it's incorporated into the body After 3 weeks, it's peeled off and replaced with cultured epithelial cells or thin, split-thickness grafts.

- Location—Burns on the face, hands, feet, and genitalia are the most serious because of possible function loss.

- Configuration—Circumferential burns can cause total occlusion of circulation in a limb as a result of edema. Burns on the neck can produce airway obstruction, whereas burns on the chest can lead to restricted respiratory expansion.
- History of complicating medical problems—Note any disorders that impair peripheral circulation, especially diabetes, peripheral vascular disease, and chronic alcohol abuse.
- Patient age—Victims younger than age 4 or older than age 60 have a higher incidence of complications and, consequently, a higher mortality.
- Smoke inhalation—This can result in pulmonary injury. Inhalation injury should be suspected if the victim was in an enclosed space.
- Other injuries sustained at the time of the burn—Explosion and blast injuries can be caused by the person being thrown or falling from a height, resulting in other traumatic injuries.

Treatment

Immediate, aggressive burn treatment increases the patient's chances of survival. Later, supportive measures and strict sterile technique can minimize infection. Because burns require such comprehensive care, good treatment can make the difference between life and death. (See *Managing burns with skin grafts*.)

Moderate or major burns

- Immediately assess the patient's airway, breathing, and circulation (ABCs). Be especially alert for signs of smoke inhalation and pulmonary damage: singed nasal hairs, mucosal burns, voice changes, coughing, wheezing, soot in the mouth or nose, and darkened sputum. Prepare for endotracheal intubation, and administer 100% oxygen as indicated.
- When you have ensured the patient's ABCs, take a brief history of the burn. Draw blood samples for complete blood count, type and crossmatch, and electrolyte, glucose, blood urea nitrogen, creatinine, and arterial blood gas levels, including a carboxyhemoglobin level.
- Control bleeding and remove smoldering clothing (soak it first in normal saline solution if it's stuck to the patient's skin), rings, and other constricting items. Be sure to cover burns with a clean, dry, sterile bed sheet. (Never cover large burns with salinesoaked dressings because they can drastically lower body temperature.)
- Begin I.V. therapy immediately to prevent hypovolemic shock and maintain cardiac output. Use lactated Ringer's solution or a fluid replacement formula as ordered. (See *Fluid replacement after a burn*.) Closely monitor intake and output and frequently check vital signs. You'll need to take the patient's blood pressure despite burned limbs.

FLUID REPLACEMENT AFTER A BURN

Use the Parkland formula as a general guideline for the amount of fluid replacement. Administer 4 ml/kg of crystalloid × % total burn surface area; give half of the solution over the first 8 hours (calculated from the time of the injury) and the balance over the next 16 hours. Vary the specific infusions according to the patient's response, especially urine output.

Minor burns

For minor burns, immerse the burned area in cool normal saline solution (55° F [12.8° C]) or apply cool compresses. Administer pain medication as appropriate. Debride the devitalized tissue, taking

care not to break any blisters. Cover the wound with an antimicrobial agent and a nonstick bulky dressing, and administer tetanus prophylaxis as indicated.

Electrical or chemical burns

- Tissue damage from electrical burns is difficult to assess because internal destruction along the conduction pathway is usually greater than the surface burn would indicate. Electrical burns that ignite the patient's clothes may cause thermal burns as well. If the electric shock caused ventricular fibrillation with cardiac and respiratory arrest, begin cardiopulmonary resuscitation at once. Get a voltage estimate. (For more details, see “Electric shock.”)
- Irrigate a chemical burn with copious amounts of water or normal saline solution. Using a weak base such as sodium bicarbonate to neutralize hydrofluoric acid, hydrochloric acid, or sulfuric acid on skin or mucous membrane is contraindicated because the neutralizing agent can actually produce more heat and tissue damage.

If the chemical entered the patient's eyes, flush them with large amounts of water or normal saline solution for at least 30 minutes; in an alkali burn, irrigate until the pH of the cul-de-sacs returns to 7. Have the patient close his eyes, and cover them with a dry, sterile dressing. Note the type of chemical that caused the burn and the presence of any noxious fumes. The patient will need an emergency ophthalmologic examination.

Special considerations

- Don't treat the burn wound itself in the emergency department if the patient is to be transferred to a specialized burn care unit within 4 hours after the burn. Instead, prepare the patient for transport by wrapping him in a sterile sheet and a blanket for warmth and elevating the burned limb to decrease edema. Then transport him immediately.

While the patient is hospitalized:

- A central venous pressure line and additional I.V. lines (using venous cutdown if necessary) and an indwelling urinary catheter may be inserted. To combat fluid evaporation through the burn and the release of fluid into interstitial spaces (possibly resulting in hypovolemic shock), continue fluid therapy as ordered.
- Check vital signs every 15 minutes (by arterial line if blood pressure is unobtainable with a cuff). Send a urine specimen to the laboratory to check for myoglobinuria and hemoglobinuria.
- Consult the nutritional therapy department to provide tube feeding, total parenteral nutrition, or a high-calorie diet, as appropriate.
- Insert a nasogastric tube to decompress the stomach and avoid aspiration of stomach contents.

Before the patient is released from the hospital:

- Ensure that the patient's immunizations are current, particularly tetanus.
- Arrange physical and occupational therapy consultations for the severely burned patient, as indicated.
- Provide referral to a reconstructive surgeon for the patient disfigured by burns. Psychological counseling may also be beneficial.
- Provide thorough teaching and complete aftercare instructions for the patient. Stress the importance of keeping the dressing dry and clean, elevating the burned limb for the first 24 hours, taking analgesics as ordered, and returning for a wound check in 1 to 2 days.

PEDIATRIC TIP

Consult a pediatrician if the patient is a child; consultation with a child-life therapist may also help to ensure the child's normal growth and development.

Electric shock

When an electric current passes through the body, the damage it does depends on the current's intensity (amperes, milliamperes, or microamperes), the resistance of the tissues through which it passes, the kind of current (AC, DC, or mixed), and the frequency and duration of current flow. Electric shock may cause ventricular fibrillation, respiratory paralysis, burns, and death. The prognosis depends on the site and extent of damage, the patient's health, and the speed and adequacy of treatment.

Causes and incidence

Electric shock usually follows accidental contact with exposed parts of electrical appliances or wiring, but it may also result from lightning or the flash of electric arcs from high-voltage power lines or machines. The increased use in hospitals of electrical medical devices, many of which are connected directly to the patient, has raised serious concerns about electrical safety and has led to the development of electrical safety standards. But even well-designed equipment with reliable safety features can cause electric shock if mishandled. (See *Preventing electric shock,* page 1076.)

Electric current can cause injury in three ways: true electrical injury as the current passes through the body, arc or flash burns from current that doesn't pass through the body, and thermal surface burns caused by associated heat and flames.

In the United States, about 1,000 people die of electric shock each year.

Complications

- Sepsis
- Neurologic, cardiac, or psychiatric dysfunction
- Renal failure
- Electrolyte abnormalities
- Peripheral nerve injuries
- Thrombi
- Cardiac arrhythmias

Signs and symptoms

Severe electric shock usually causes muscle contraction, followed by unconsciousness and loss of reflex control, sometimes with respiratory paralysis (by way of prolonged contraction of respiratory muscles or as a direct effect on the respiratory nerve center). After momentary shock, hyperventilation may follow initial muscle contraction. Passage of even the smallest electric current (if it passes through the heart) may induce ventricular fibrillation or another arrhythmia that progresses to fibrillation or myocardial infarction.

Electric shock from a high-frequency current (which generates more heat in tissues than a low-frequency current) usually causes burns, local tissue coagulation, and necrosis. Low-frequency currents can also

cause serious burns if the contact with the current is concentrated in a small area (for example, when

a toddler bites into an electric cord). Contusions, fractures, and other injuries can result from violent muscle contractions, falls, or being thrown during the shock; later, the patient may develop renal shutdown. Residual hearing impairment, latent rhythm effects on the heart (such as ventricular fibrillation), cataracts, and vision loss may persist after severe electric shock.

PREVENTION

PREVENTING ELECTRIC SHOCK

- Check for cuts, cracks, or frayed insulation on electric cords, call buttons (also check for warm call buttons), and electric devices attached to the patient's bed; keep these away from hot or wet surfaces and sharp corners. Don't set glasses of water, damp towels, or other wet items on electrical equipment. Wipe up accidental spills before they leak into electrical equipment. Avoid using extension cords because they may circumvent the ground; if they're absolutely necessary, don't place them under carpeting or in areas in which they'll be walked on.
- Make sure ground connections on electrical equipment are intact. Line cord plugs should have three prongs, which should be straight and firmly fixed. Check that the prongs fit wall outlets properly and that outlets aren't loose or broken. Don't use adapters on plugs.
- Promptly report faulty equipment to maintenance personnel. If a machine sparks, smokes, seems unusually hot, or gives you or your patient a slight shock, unplug it immediately, if doing so won't endanger the patient's life. Check inspection labels and report equipment overdue for inspection.
- Be especially careful when using electrical equipment near patients with pacemakers or direct cardiac lines because a cardiac catheter or pacemaker can create a direct, low-resistance path to the heart; even a small shock may cause ventricular fibrillation.
- Remember that dry, calloused, unbroken skin offers more resistance to electric current than mucous membranes, an open wound, or thin, moist skin.
- Make sure defibrillator paddles are free of dry, caked gel before applying fresh gel because poor electric contact can cause burns. Also, don't apply too much gel. If the gel runs over the paddle's edge and touches your hand, you'll receive some of the defibrillator shock while the patient loses some of the energy in the discharge.
- Tell all patients how to avoid electrical hazards at home and at work. Warn them not to use electrical appliances when they're wet, such as in the shower. Warn them never to touch electrical appliances while touching faucets or cold water pipes in the kitchen because these pipes often provide the ground for all of the house's circuits.

Diagnosis

In most cases, the cause of electrical injuries is either obvious or suspected. However, an accurate history can identify the voltage and the length of contact.

Treatment

Immediate emergency treatment consists of carefully separating the victim from the current source, quick assessment of vital functions, and emergency measures, such as cardiopulmonary resuscitation (CPR) and defibrillation.

To separate the victim from the current source, immediately turn it off or unplug it. If this isn't possible, pull the victim free with a nonconductive device, such as a loop of dry cloth or rubber, a dry rope, or a leather belt—with metal buckle detached.

Emergency treatment then begins as follows:

- Quickly assess vital functions. If you don't detect a pulse or breathing, start CPR at once. Continue until vital signs return or emergency help arrives with a defibrillator and other advanced life-support equipment. Then monitor the patient's cardiac rhythm continuously and obtain a 12-lead electrocardiogram.
- Because internal tissue destruction may be much greater than indicated by skin damage, give I.V. lactated Ringer's solution as ordered to maintain urine output of 50 to 100 ml/hour. Insert an indwelling urinary catheter and send the first specimen to the laboratory. Measure intake and output hourly and watch for tea- or port wine-colored urine, which occurs when coagulation necrosis and tissue ischemia liberate myoglobin and hemoglobin. These proteins can precipitate in the renal tubules, causing tubular necrosis and renal shutdown. To prevent this, give mannitol and furosemide as indicated.
- Administer sodium bicarbonate as needed to counteract acidosis caused by widespread tissue destruction and anaerobic metabolism.
- Assess the patient's neurologic status frequently because central nervous system damage may result from ischemia or demyelination. Because a spinal cord injury may follow cord ischemia or a compression fracture, watch for sensorimotor deficits.
- Check for neurovascular damage in the extremities by assessing peripheral pulses and capillary refill and by asking the patient if he feels numbness, tingling, or pain. Elevate any injured extremities.
- Apply a temporary sterile dressing, and admit the patient for surgical debridement and observation as needed. Frequent debridement and use of topical and systemic antibiotics can help reduce the risk of infection. As indicated, prepare the patient for grafting or, if his injuries are extreme, for amputation.

Special considerations

Take measures to prevent electric shock in patients.

PEDIATRIC TIP

Advise parents of small children to put safety guards on all electrical outlets and to keep children away from electrical devices.

Cold injuries

Cold injuries result from overexposure to cold air or water and occur in two major forms: localized injuries such as frostbite and systemic injuries such as hypothermia. Untreated or improperly treated frostbite can lead to gangrene and may require amputation; severe hypothermia can be fatal.

Causes and incidence

Localized cold injuries occur when ice crystals form in the tissues and expand extracellular spaces. With compression of the tissue cell, the cell membrane ruptures, interrupting enzymatic and

metabolic activities. Increased capillary permeability accompanies histamine release, resulting in aggregation of red blood cells and microvascular occlusion. Hypothermia effects chemical changes that slow the functions of most major organ systems, such as decreased renal blood flow and decreased glomerular filtration. Frostbite results from prolonged exposure to dry temperatures far below freezing; hypothermia, from near drowning in cold water and prolonged exposure to cold temperatures.

The risk of serious cold injuries, especially hypothermia, is increased by youth, old age, lack of insulating body fat, wet or inadequate clothing, drug abuse, cardiac disease, smoking, fatigue, hunger and depletion of caloric reserves, and excessive alcohol intake (which draws blood into capillaries and away from body organs).

ELDER TIP

The following risk factors put elderly people at increased risk for cold injuries: cardiovascular disease, alcohol abuse, malnutrition, diabetes, skin diseases, scarring from major burns, inadequate fluid intake, working outdoors, wearing inappropriate clothing, and living in poor environmental conditions. The use of anticholinergics, phenothiazines, diuretics, antihistamines, antidepressants, or beta-adrenergic blockers also increases the risk.

RECOGNIZING FROSTBITE

Blackened areas in this photo show tissue necrosis and gangrene—the result of deep frostbite that extends beyond subcutaneous tissue.

Complications

- Renal failure
- Rhabdomyolysis
- Gangrene
- Aspiration pneumonia
- Cardiac arrhythmias
- Hypoglycemia
- Hyperglycemia
- Metabolic acidosis
- Pancreatitis

Signs and symptoms

Frostbite may be deep or superficial. Superficial frostbite affects skin and subcutaneous tissue, especially of the face, ears, extremities, and other exposed areas. Although it may go unnoticed at first, frostbite produces burning, tingling, numbness, swelling, and a mottled, blue-gray skin color when the person returns to a warm place.

Deep frostbite extends beyond subcutaneous tissue and usually affects the hands or feet. The skin becomes white until it's thawed; then it turns purplish blue. Deep frostbite also produces pain, skin blisters, tissue necrosis, and gangrene. (See *Recognizing frostbite*.)

Indications of hypothermia (a core body temperature below 95° F [35° C]) vary with severity:

- *mild hypothermia*—temperature of 89.6° to 95° F (32° to 35° C), severe shivering, slurred speech, and amnesia
- *moderate hypothermia*—temperature of 86° to 89.6° F (30° to 32° C), unresponsiveness or confusion, muscle rigidity, peripheral cyanosis and, with improper rewarming, signs of shock
- *severe hypothermia*—temperature of 77° to 86° F (25° to 30° C), loss of deep tendon reflexes, and ventricular fibrillation. The patient may appear dead (in a state of rigor mortis), with no palpable pulse or audible heart sounds. His pupils may be dilated. A temperature drop below 77° F causes cardiopulmonary arrest and death.

Diagnosis

A history of severe and prolonged exposure to cold may make this diagnosis obvious. Nevertheless, hypothermia can be overlooked if outdoor temperatures are above freezing or if the patient is comatose.

Treatment

In a localized cold injury, treatment consists of rewarming the injured part, supportive measures and, sometimes, a fasciotomy to increase circulation by lowering edematous tissue pressure. However, if gangrene occurs, amputation may be necessary. In hypothermia, therapy consists of immediate resuscitative measures, careful monitoring, and gradual rewarming of the body. If cold injuries in children suggest neglect or abuse, a thorough history should be performed.

Treat localized cold injuries as follows:

- Remove constrictive clothing and jewelry and slowly rewarm the affected part in warm water (100° to 108° F [37.8° to 42.2° C]). Give the patient warm fluids to drink. Never rub the injured area—this aggravates tissue damage.
- When the affected part begins to rewarm, the patient will feel pain, so give analgesics as ordered. Check for a pulse. Be careful not to rupture any blebs. If the injury is on the foot, place cotton or gauze sponges between the toes to prevent maceration. Instruct the patient not to walk.
- If the injury has caused an open skin wound, give antibiotics and tetanus prophylaxis as indicated.

PREVENTION

PREVENTING COLD INJURIES

To prevent cold injuries, teach patients to:

- wear mittens instead of gloves
- wear windproof, water-resistant layers of clothing

- wear two pairs of socks (cotton next to the skin and wool over the cotton socks)
- wear a scarf and a hat that covers the ears (to avoid substantial heat loss through the head).

Before anticipated prolonged exposure to cold, advise the patient not to drink alcohol or smoke cigarettes, and to get adequate food and rest. If he gets caught in severe cold weather, he should find shelter quickly or increase physical activity to maintain body warmth.

- If a pulse fails to return, the patient may develop compartment syndrome and need a fasciotomy to restore circulation. (See *Recognizing compartment syndrome*, page 1066.) If gangrene occurs, prepare the patient for amputation.
- Before discharge, teach the patient about possible long-term effects: increased sensitivity to cold, burning and tingling, and increased sweating. Warn him against smoking, which causes vasoconstriction and slows healing.

Systemic hypothermia is treated as follows:

- If you detect no pulse or respiration, begin cardiopulmonary resuscitation (CPR) immediately and, if necessary, continue it for 2 to 3 hours. (Remember that hypothermia helps protect the brain from anoxia, which normally accompanies prolonged cardiopulmonary arrest. Therefore, even after the patient has been unresponsive for a long time, resuscitation may be possible, especially after cold-water near drownings.) Perform CPR until the patient is adequately rewarmed.
- Move the patient to a warm area, remove wet clothing, and keep him dry. If he's conscious, give warm fluids with a high sugar content such as tea with sugar. If the patient's core temperature is above 89.6° F (32° C), use external warming techniques. Bathe him in water that is 104° F (40° C), cover him with a heating blanket set at 97.9° to 99.9° F (36.6° to 37.7° C), and cautiously apply hot water bottles at 104° F to the groin and axillae, guarding against burns.
- If the patient's core temperature is below 89.6° F (32° C), use internal and external warming methods. Rewarm his body core and surface 1° to 2° F (-0.5° to -1.1° C) per hour concurrently. (If you rewarm the surface first, rewarming shock could cause potentially fatal ventricular fibrillation.) To warm inhalations, provide oxygen heated to 107.6° to 114.8° F (42° to 46° C). Infuse I.V. solutions that have been warmed to 98.6° F (37° C) and perform nasogastric lavage with normal saline solution that has been warmed to the same temperature. Assist with peritoneal lavage, using normal saline solution (full or half-strength) warmed to 104° to 113° F (40° to 45° C); in severe hypothermia, assist with heart and lung bypass at controlled temperatures and thoracotomy with direct cardiac warm saline bath.

Special considerations

- Throughout treatment, monitor arterial blood gas levels, intake and output, central venous pressure, temperature, and cardiac and neurologic status every 30 minutes. Also monitor laboratory test results, such as complete blood count, blood urea nitrogen and electrolyte levels, prothrombin time, and partial thromboplastin time.
- Cold injuries can be prevented (see *Preventing cold injuries*).

- If the patient has developed a cold injury because of inadequate clothes or housing, refer him to a community social service agency, if appropriate.

Heat syndrome

Heat syndrome may result from environmental or internal conditions that increase heat production or impair heat dissipation. The three categories of heat syndrome are heat cramps, heat exhaustion, and heatstroke.

Causes and incidence

Normally, people adjust to excessive temperatures via complex cardiovascular and neurologic changes that are coordinated by the hypothalamus. Heat loss offsets heat production to regulate the body temperature. It does this by evaporation (sweating) or vasodilation, which cools the body's surface by radiation, conduction, and convection.

However, heat production increases with exercise, infection, and the use of certain drugs such as amphetamines, and heat loss decreases with high temperatures or humidity, lack of acclimatization, excess clothing, obesity, dehydration, cardiovascular disease, sweat gland dysfunction, and the use of such drugs as phenothiazines and anticholinergics. When heat loss mechanisms fail to offset heat production, the body retains heat and may develop heat syndrome.

Complications

- Hypovolemic shock
- Cardiogenic shock
- Cardiac arrhythmias
- Renal failure
- Rhabdomyolysis
- Disseminated intravascular coagulation
- Hepatic failure

Signs and symptoms

Signs and symptoms of heat syndrome vary depending on the type (heat cramps, heat exhaustion, or heatstroke) and predisposing factors. (See *Managing heat syndrome*.)

Treatment

For specific guidelines on treating heat syndrome, see *Managing heat syndrome*.

Special considerations

Heat illnesses are easily preventable, so it's important to educate patients about the various factors that cause them. This information is especially vital for athletes, laborers, and soldiers in field training.

- Advise your patients to avoid heat syndrome by taking these precautions in hot weather: wearing loose-fitting, lightweight clothing; resting frequently; avoiding hot places; and drinking adequate amounts of fluid.

ELDER TIP

Vigorous fluid replacement in elderly people or those with underlying cardiovascular disease may cause pulmonary edema.

- Advise patients who are obese, elderly, or taking drugs that impair heat regulation to avoid becoming overheated.
- Tell patients who have had heat cramps or heat exhaustion to exercise gradually and to increase their salt and water intake.
- Tell patients with heatstroke that residual hypersensitivity to high temperatures may persist for several months.

Asphyxia

A condition of insufficient oxygen and accumulating carbon dioxide in the blood and tissues due to interference with respiration, asphyxia results in cardiopulmonary arrest. Without prompt treatment, it's fatal.

Causes and incidence

Asphyxia results from any condition or substance that inhibits respiration such as the following:

- hypoventilation due to opioid abuse, medullary disease or hemorrhage, pneumothorax, respiratory muscle paralysis, or cardiopulmonary arrest

MANAGING HEAT SYNDROME

Management of heat syndrome depends on the injury's severity.

Type and predisposing factors	Signs and symptoms	Management
Heat cramps		
▪ Commonly affect young adults ▪ Strenuous activity without training or acclimatization ▪ Normal to high temperature or high humidity	▪ Muscle twitching and spasms, weakness, severe muscle cramps ▪ Nausea ▪ Normal temperature or slight fever ▪ Diaphoresis	▪ Hospitalization is usually unnecessary. ▪ Replace fluids and electrolytes. ▪ Loosen the patient's clothing and have him lie down in a cool place. Massage his muscles. If muscle cramps are severe, start an I.V. infusion with normal saline solution.
Heat exhaustion		
▪ Commonly affects young people ▪ Physical activity without acclimatization ▪ Decreased heat dissipation ▪ High temperature and humidity	▪ Nausea and vomiting ▪ Decreased blood pressure ▪ Thready, rapid pulse ▪ Cool, pallid skin ▪ Headache, mental confusion, syncope, giddiness ▪ Oliguria, thirst ▪ Elevated temperature ▪ Muscle cramps	▪ Hospitalization is usually unnecessary. ▪ Immediately give salt tablets and a balanced electrolyte drink. ▪ Loosen the patient's clothing and put him in a shock position in a cool place. Massage his muscles. If cramps are severe, start an I.V. infusion as ordered. ▪ Give oxygen if needed.

Heatstroke		
▪ Exertional type—commonly affects young, healthy people involved in strenuous activity ▪ Classical type—commonly affects elderly, inactive people who have cardiovascular disease or who take drugs that influence temperature regulation ▪ High temperature and humidity without any wind	▪ Hypertension followed by hypotension ▪ Atrial or ventricular tachycardia ▪ Hot, dry, red skin, which later turns gray; no diaphoresis ▪ Confusion, progressing to seizures and loss of consciousness ▪ Temperature higher than 104° F (40° C) ▪ Dilated pupils ▪ Slow, deep respiration; then Cheyne-Stokes	▪ Hospitalization is needed. ▪ Maintain airway, breathing, and circulation. ▪ To lower body temperature, cool the patient rapidly with ice packs on arterial pressure points and hypothermia blankets. ▪ To replace fluids and electrolytes, start an I.V. infusion. ▪ Insert a nasogastric tube to prevent aspiration. ▪ Give diazepam to control seizures. ▪ Monitor the patient's temperature, intake and output, and cardiac status. Give dobutamine, as ordered, to correct cardiogenic shock. (Vasoconstrictors are contraindicated.)

- intrapulmonary obstruction, as in airway obstruction, severe asthma, foreign body aspiration, pulmonary edema, pneumonia, and near drowning
- extrapulmonary obstruction, as in tracheal compression from a tumor, strangulation, trauma, or suffocation
- inhalation of toxic agents, as in carbon monoxide poisoning, smoke inhalation, and excessive oxygen inhalation.

Complications

- Neurologic damage
- Death

Signs and symptoms

Depending on the asphyxia's duration and degree, common symptoms include anxiety, dyspnea, agitation and confusion leading to coma, altered respiratory rate (apnea, bradypnea, occasional tachypnea), decreased breath sounds, central and peripheral cyanosis (cherry-red mucous membranes in late-stage carbon monoxide poisoning), seizures, and fast, slow, or absent pulse.

Diagnosis

Diagnosis is based on the patient's history and laboratory results. Arterial blood gas measurement, the most important test, indicates decreased partial pressure of oxygen (less than 60 mm Hg) and increased partial pressure of carbon dioxide (more than 50 mm Hg). Chest X-rays may show a foreign body, pulmonary edema, or atelectasis. Toxicology tests may show drugs, chemicals, or abnormal hemoglobin (carboxihemoglobin). Pulmonary function tests may indicate respiratory muscle weakness.

Treatment

Asphyxia requires immediate respiratory support—with cardiopulmonary resuscitation, endotracheal intubation, and supplemental oxygen, as needed, and elimination of the underlying cause as follows: bronchoscopy for a foreign body extraction, an opioid antagonist such as naloxone for an opioid overdose, gastric lavage for poisoning, and withholding of supplemental oxygen for carbon dioxide narcosis due to excessive oxygen therapy.

Special considerations

Respiratory distress is frightening, so reassure the patient during treatment. Give prescribed drugs. Suction carefully as needed and encourage deep breathing. Closely monitor vital signs and laboratory test results. To prevent drug-induced asphyxia, warn patients about the danger of taking alcohol with other central nervous system depressants.

Near drowning

Near drowning refers to surviving—temporarily, at least—the physiologic effects of hypoxemia and acidosis that result from submersion in fluid. Hypoxemia and acidosis are the primary problems in victims of near drowning.

Near drowning occurs in three forms: “dry,” in which the victim doesn't aspirate fluid, but suffers respiratory obstruction or asphyxia (10% to 15% of patients); “wet,” in which the victim aspirates fluid and suffers from asphyxia or secondary changes due to fluid aspiration (about 85% of patients); and “secondary,” in which the victim suffers a recurrence of respiratory distress (usually aspiration pneumonia or pulmonary edema) within minutes or 1 to 2 days after a near-drowning incident.

Causes and incidence

Near drowning results from an inability to swim or, in swimmers, from panic, a boating accident, a heart attack or blow to the head while in the water, a fall through ice, heavy drinking prior to swimming, or a suicide attempt. Children can also suffer near drowning from swimming accidents, bathing, or falling into a container of water such as a bucket or a body of water such as a pond.

Regardless of the tonicity of the fluid aspirated, hypoxemia is the most serious consequence of near drowning, followed by metabolic acidosis. Other consequences depend on the kind of water aspirated. If

the water is contaminated, such as water from a stagnant pool or contaminated stream, bacteria, fungus, or algae may be aspirated as well, causing infection or sepsis. After fresh water aspiration, changes in lung surfactant character result in exudation of protein-rich plasma into the alveoli. This, plus increased capillary permeability, leads to pulmonary edema and hypoxemia.

After saltwater aspiration, the hypertonicity of seawater exerts an osmotic force, which pulls fluid from pulmonary capillaries into the alveoli. The resulting intrapulmonary shunt causes hypoxemia. Also, the pulmonary capillary membrane may be injured and induce pulmonary edema. In both kinds of near drowning, pulmonary edema and hypoxemia occur secondary to aspiration.

In the United States, drowning claims nearly 6,500 lives annually. No statistics are available for near-drowning incidents.

Complications

- Neurologic impairment
- Seizure disorders

- Pulmonary edema
- Renal damage
- Bacterial aspiration
- Cardiac arrhythmias

Signs and symptoms

Near-drowning victims can display a host of clinical problems: apnea, shallow or gasping respirations, substernal chest pain, asystole, tachycardia, bradycardia, restlessness, irritability, lethargy, fever, confusion, unconsciousness, vomiting, abdominal distention, and a cough that produces a pink, frothy fluid.

Diagnosis

Diagnosis requires a history of near drowning, including the type of water aspirated, along with characteristic features and auscultation of crackles and rhonchi if respirations are present or the patient is being ventilated.

Arterial blood gas (ABG) analysis shows decreased oxygen content, low bicarbonate levels, and low pH. Electrolyte levels may be elevated or decreased, depending on the type of water aspirated. Leukocytosis may occur. Electrocardiogram shows arrhythmias and waveform changes.

Treatment

Emergency treatment begins with cardiopulmonary resuscitation (CPR) and administration of 100% oxygen.

- Stabilize the patient's neck in case he has a cervical injury.
- When the patient arrives at the hospital, assess for a patent airway. Establish one if necessary. Continue CPR, intubate the patient, and provide respiratory assistance such as mechanical ventilation with positive end-expiratory pressure, if needed.
- Assess ABG and pulse oximetry values.
- If the patient's abdomen is distended, insert a nasogastric tube. (Intubate the patient first if he's unconscious.)
- Start I.V. lines and insert an indwelling urinary catheter.
- Drug treatment for near drowning may include sodium bicarbonate for documented acidosis, osmotic diuretics for cerebral edema, antibiotics to prevent infections, and bronchodilators to ease bronchospasms.

Special considerations

- Remember that all near-drowning victims should be admitted for an observation period of 24 to 48 hours because of the possibility of developing delayed drowning symptoms.
- Observe for pulmonary complications and signs of delayed drowning (confusion, substernal pain, adventitious breath sounds). Suction often. Pulmonary artery catheters may be useful in assessing cardiopulmonary status.
- Monitor vital signs, intake and output, and peripheral pulses. Check for skin perfusion and watch for signs of infection.
- To facilitate breathing, raise the bed's head slightly.

PREVENTION

Advise swimmers to avoid drinking alcohol before swimming, to observe water safety rules, and to take a water safety course sponsored by the Red Cross or YMCA.

Decompression sickness

Decompression sickness (the "bends") is a painful condition that results from a toorapid change from a high- to low-pressure environment (decompression). Most victims are scuba divers who ascend too quickly from water deeper than 30′ (9.1 m) and pilots and passengers of unpressurized aircraft who ascend too quickly to high altitudes.

Causes and incidence

Decompression sickness results from an abrupt change in air or water pressure that causes nitrogen to spill out of tissues faster than it can be diffused through respiration. It causes gas bubbles to form in blood and body tissues, which produce excruciating joint and muscle pain, neurologic and respiratory distress, and skin changes.

Complications

- Massive venous air embolism
- Intravascular volume depletion
- Avascular necrosis

Signs and symptoms

Symptoms usually appear during or within 30 minutes of rapid decompression, although they may be delayed up to 24 hours. Typically, decompression sickness results in:

- "the bends," deep and usually constant joint and muscle pain so severe that it may be incapacitating
- transitory neurologic disturbances, such as difficult urination (from bladder paralysis), hemiplegia, deafness, visual disturbances, dizziness, aphasia, paresthesia and hyperesthesia of the legs, unsteady gait and, possibly, coma
- respiratory distress (known as the "chokes"), which includes chest pain, retrosternal burning, and a cough that may become paroxysmal and uncontrollable.

Such symptoms may persist for days and result in dyspnea, cyanosis, fainting and, occasionally, shock. Other symptoms include decreased temperature, pallor, itching, burning, mottled skin, fatigue and, in some patients, tachypnea.

Diagnosis

CONFIRMING DIAGNOSIS

A history of rapid decompression and a physical examination showing characteristic clinical features confirm the diagnosis.

Treatment

Treatment consists of recompression and oxygen administration, followed by gradual decompression. In recompression, which takes place in a hyperbaric chamber (not available in all hospitals), air

pressure is increased to 2.8 absolute atmospheric pressure over 1 to 2 minutes. This rapid rise in pressure reduces the size of the circulating nitrogen bubbles and relieves pain and other clinical effects. During recompression, intermittent oxygen administration, with periodic maximal exhalations, promotes gas bubble diffusion. After symptoms subside and diffusion is complete, a slow decrease of air pressure in the chamber allows for gradual, safe decompression.

Supportive measures include fluid replacement in hypovolemic shock and, sometimes, corticosteroids to reduce the risk of spinal edema. Opioids are contraindicated because they further depress impaired respiration.

Special considerations

- To avoid oxygen toxicity during recompression, tell the patient to alternate breathing oxygen for 5 minutes with breathing air for 5 minutes.
- During oxygen administration, make sure all electrical equipment is grounded. Prohibit smoking, the use of electric appliances such as razors, and the use of blankets made of wool or other materials that produce static electricity in the patient's room.
- If the patient with bladder paralysis needs catheterization, monitor intake and output.

PREVENTION

Advise divers and pilots to follow the U.S. Navy's ascent guidelines.

EFFECTS OF WHOLE BODY IRRADIATION

Symptoms after whole body irradiation are dose-dependent. Below you'll find the effects of radiation dosages ranging from 5 to 5,000 rads.

Radiation dosage (rad)	Clinical and laboratory findings
5 to 49	Patient asymptomatic; conventional blood studies normal; chromosome aberrations detectable
50 to 74	Patient asymptomatic; minor decreases in white blood cell (WBC) and platelet counts in a few patients, especially if baseline values were established
75 to 124	Prodromal symptoms (anorexia, nausea, vomiting, fatigue) in 10% to 20% of patients within 2 days; mild decrease in WBC and platelet counts in some patients
125 to 239	Transient disability and clear hematologic changes in a majority of patients; lymphocyte count decreased by about 50% within 48 hours
240 to 499	Serious, disabling illness in most patients, with about 50% mortality if untreated; lymphocyte count decreased by 75% or more within 48 hours
500 to 4,999	Accelerated version of acute radiation syndrome with GI complications within 2 weeks; bleeding; death in most patients
5,000+	Fulminating course with cardiovascular, GI, and central nervous system complications, resulting in death within 24 to 72 hours

Radiation exposure

Expanded use of ionized radiation (X-rays, protons, neutrons, and alpha, beta, and gamma rays) has vastly increased the incidence of radiation exposure. Cancer patients receiving radiation therapy and

nuclear power plant workers are the most likely victims of this modern anomaly.

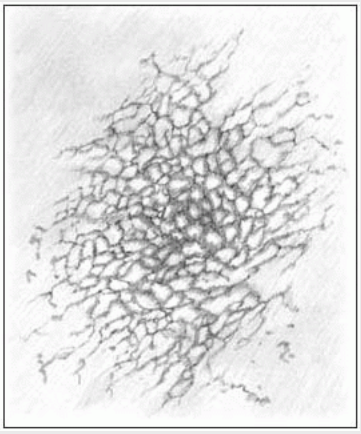
The amount of radiation absorbed by a human body is measured in radiation absorbed doses (rads), not to be confused with roentgens, which are used to measure radiation emissions. A person can absorb up to 200 rads without fatal consequences. A dose of 240 to 340 rads is fatal in about 50% of cases; more than 500 rads is nearly always fatal. (See *Effects of whole body irradiation*.) However, when radiation is focused on a small area, the body can absorb and survive many thousands of rads if they're administered in carefully controlled doses over a long period of time. This basic principle is the key to safe and successful radiation therapy.

Causes and incidence

Exposure to radiation can occur by inhalation, ingestion, or direct contact. The existence and severity of tissue damage depend on the amount of body area exposed (the smaller, the better), length of exposure, dosage absorbed, distance from the source, and presence of protective shielding. Ionized radiation may cause immediate cell necrosis or disturbed deoxyribonucleic acid synthesis, which impairs cell function and division. Rapidly dividing cells—bone marrow, hair follicles, gonads, and lymph tissue—are most susceptible to radiation damage; highly differentiated cells—nerve, bone, and muscle—resist radiation more successfully.

RADIATION DERMATITIS

Repeated prolonged exposure to radiation—even small doses—often induces erythematous dermatitis and atrophy of skin at the site of radiation treatment.



Complications

The complications listed here are delayed.

- Leukemia
- Thyroid cancer
- Fetal growth retardation
- Genetic defects

Signs and symptoms

The effects of ionized radiation can be immediate and acute or delayed and chronic. Acute effects may be hematopoietic (after 200 to 500 rads), GI (after 400 rads or more), cerebral (after 1,000 rads

or more), or cardiovascular (gross after 5,000 rads). They depend strictly on the amount of radiation absorbed.

Acute hematopoietic radiation exposure induces nausea, vomiting, diarrhea, and anorexia, which subside after 24 to 48 hours. Pancytopenia develops during the latent period that follows. Within 2 to 3 weeks, thrombocytopenia, leukopenia, lymphopenia, and anemia produce nosebleeds, hemorrhage, petechiae, pallor, weakness, oropharyngeal abscesses, and increased susceptibility to infection because of impaired immunologic response.

GI radiation exposure causes ulceration, infection, intractable nausea, vomiting, and diarrhea, resulting in severe fluid and electrolyte imbalance. Breakdown of intestinal villi later causes plasma loss, which can lead to circulatory collapse and death.

Cerebral radiation poisoning after brief exposure to large amounts of radiation causes nausea, vomiting, and diarrhea within hours. Lethargy, tremors, seizures, confusion, coma, and even death may follow within hours or days.

Repeated, prolonged exposure to small doses of radiation over a long time can seriously damage skin, causing dryness, erythema, atrophy, and malignant lesions. Such damage can also follow acute exposure. (See *Radiation dermatitis*.)

Other delayed effects include alopecia, brittle nails, hypothyroidism, amenorrhea, cataracts, decreased fertility, anemia, leukopenia, thrombocytopenia, malignant neoplasms, bone necrosis and fractures, and a shortened life span. Long-term exposure to radiation may retard fetal growth or cause genetic defects.

Diagnosis

An accurate history offers the best clues to radiation exposure. Supportive laboratory findings show decreased hematocrit; decreased white blood cell, platelet, and lymphocyte counts; and decreased hemoglobin, serum potassium, and chloride levels due to vomiting and diarrhea. Bone marrow studies show blood dyscrasia; X-rays may reveal bone necrosis. A Geiger counter may help determine the amount of radiation in open wounds.

Treatment

Treatment is essentially aimed at relieving symptoms and includes antiemetics to counter nausea and vomiting, fluid and electrolyte replacement, antibiotics, and possibly sedatives (if seizures occur). Transfusions of plasma, platelets, and red

blood cells may be necessary. Bone marrow transplantation is a controversial treatment but may be the only recourse in extreme cases. When radiation exposure results from inhalation or ingestion of large amounts of radioactive iodine, potassium iodide or a strong iodine solution may be given to block thyroid uptake.

PREVENTION

PREVENTING RADIATION EXPOSURE

Proper shielding and other safety precautions can help you minimize the risk of exposing yourself and your patients to radiation.

Protecting yourself

- When caring for a patient exposed to radiation, cover your entire body with disposable, protective clothing. Wear a surgical mask, cap, goggles, gown, pants, bootcaps, and double gloves. Tape all glove, gown, and boot connections.

- Doublebag all equipment and clothing that comes in contact with a radiationcontaminated patient, and attach a label noting that the bag contains radioactive waste. Make sure the label includes the magenta-colored RADIATION insignia to avoid the danger of improper disposal.
- Wear proper shielding devices when performing X-ray or radiation treatments. If you work in areas where radiation is present, also wear a radiation detection badge and periodically have it read.
- If you are or may be pregnant, ask to be excused from caring for a patient with known or suspected radiation contamination.

Protecting your patient

- When performing diagnostic or treatment procedures that use radiation, shield the patient's reproductive organs from exposure, if feasible.
- Perform fluoroscopic examinations as quickly as possible.

Protecting your patient and yourself

- Make sure that areas housing X-ray and nuclear materials are properly shielded and that filters are used properly.
- If accidental contamination occurs, immediately remove all clothing and wash the body vigorously with soap and water.

Special considerations

- To minimize radiation exposure, dispose of contaminated clothing properly. If the patient's skin is contaminated, wash his body thoroughly with mild soap and water. Debride and irrigate open wounds. If he recently ingested radioactive material, induce vomiting and start lavage.
- Monitor intake and output and maintain fluid and electrolyte balance. Give I.V. fluids and electrolytes as ordered. If the patient can take oral feedings, encourage a high-protein, high-calorie diet. Tell him to use a soft toothbrush to minimize gum bleeding. Offer lidocaine to soothe painful mouth ulcers.
- To prevent skin breakdown, make sure the patient avoids extreme temperatures, tight clothing, and drying soaps. Use rigid sterile technique.
- Prevent complications. Monitor vital signs and watch for signs of hemorrhage.
- Provide emotional support for the patient and his family, especially after severe exposure. Suggest genetic counseling and screening as needed.

Hospital personnel can avoid exposure to radiation by wearing proper shielding devices when supervising X-ray and radiation treatments. If you work in these vulnerable areas, wear radiation detection badges and turn them in periodically for readings. (See *Preventing radiation exposure*.)

MISCELLANEOUS INJURIES

Poisoning

Poisoning—inhalation, ingestion, or injection of, or skin contamination with, a harmful substance—is a common problem. The prognosis depends on the amount of poison absorbed, the poison's toxicity, and the time interval between poisoning and treatment.

Causes and incidence

In the United States, about 2.5 million people are poisoned annually, 1,000 of them fatally. Because of their curiosity and ignorance, children are the primary victims of poisoning. Accidental poisoning—usually from ingestion of salicylates (aspirin), acetaminophen, cleaning agents, insecticides, paints, or cosmetics—is the fourth leading cause of death in children.

In adults, poisoning is most common among chemical company employees, particularly those in companies that use chlorine, carbon dioxide, hydrogen sulfide, nitrogen dioxide, and ammonia, and in companies that ignore safety standards. Other causes of poisoning in adults include improper cooking, canning, and storage of food; ingestion of, or skin contact with, plants (see *Common poisonous plants*); and drug overdose (usually barbiturates or tricyclic antidepressants).

Complications

- Hypotension
- Cardiac arrhythmias
- Seizures
- Coma
- Death

Signs and symptoms

Signs and symptoms vary according to the type of poison.

Diagnosis

A history of ingestion, inhalation, or injection of, or skin contact with, a poisonous substance and typical clinical features suggest the diagnosis. Suspect poisoning in any unconscious patient with no history of diabetes, seizure disorders, or trauma. Odors, such as from kerosene or cleaning fluid, may be detected on the breath or clothing of some poison victims.

CONFIRMING DIAGNOSIS

Toxicologic studies (including drug screens) of poison in the mouth, vomitus, urine, feces, or blood or poison on the victim's hands or clothing confirm the diagnosis.

If possible, have the family or patient bring the container holding the poison to the emergency department for comparable study. In inhalation poisoning, chest X-rays may show pulmonary infiltrates or edema; in petroleum distillate inhalation, X-rays may show aspiration pneumonia.

Effects of some poisonous substances don't become apparent for hours or days.

Treatment

Treatment includes emergency resuscitation and support, prevention of further absorption of poison, continuing supportive or symptomatic care and, when possible, a specific antidote. If barbiturate, glutethimide, or tranquilizer poisoning causes hypothermia, use a hyperthermia blanket to control the patient's temperature. Dialysis may be considered in some situations.

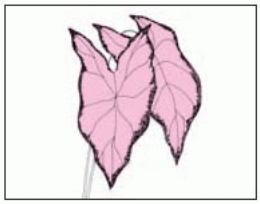
Special considerations

- Assess cardiopulmonary and respiratory function. If necessary, begin cardiopulmonary resuscitation. Carefully monitor vital signs and level of consciousness.

- Depending on the type of poison, prevent further absorption of ingested poison by inducing vomiting using syrup of ipecac or by administering gastric lavage and cathartics. The treatment's effectiveness depends on absorption speed and the time elapsed between ingestion and removal. With syrup of ipecac, give warm water (usually less than 1 qt [1 L]) until vomiting occurs, or give another dose of ipecac as ordered.
- Never induce vomiting if you suspect corrosive acid poisoning, if the patient is unconscious or has seizures, or if the gag reflex is impaired (even in a conscious patient). Instead, neutralize the poison by in-stilling the appropriate antidote by nasogastric tube. Common antidotes include milk, magnesium salts (milk of magnesia), activated charcoal, or other chelating agents (deferoxamine, edetate disodium). When possible, add the antidote to water or juice.

COMMON POISONOUS PLANTS

ELEPHANT EAR
PHILODENDRON



Symptoms: burning throat and GI distress *Treatment:* gastric lavage or emesis; antihistamines and lime juice; symptomatic treatment

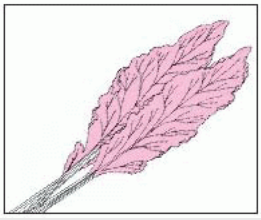
DIEFFENBACHIA

Symptoms: burning throat, edema, GI distress *Treatment:* gastric lavage or emesis; antihistamines and lime juice; symptomatic treatment

POINSETTIA
(MILKY JUICE)

Symptoms: inflammation and blisters *Treatment:* none; condition will disappear after several days

RHUBARB

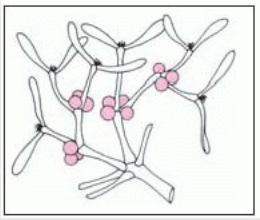


Symptoms: GI and respiratory distress, internal bleeding, coma *Treatment:* gastric lavage or emesis with lime water; calcium gluconate and force fluids

MUSHROOMS

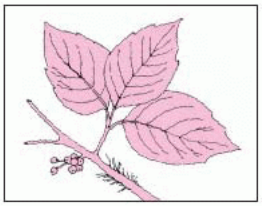
Symptoms: GI, respiratory, central nervous system, and parasympathomimetic effects *Treatment:* gastric emesis with syrup of ipecac; decontamination with activated charcoal with sorbitol for catharsis; atropine

MISTLETOE

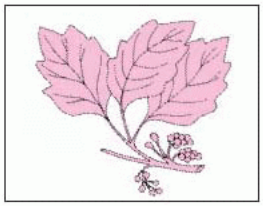


Symptoms: GI distress and slow pulse *Treatment:* gastric lavage or emesis; cardiac drugs, potassium, and sodium

POISON IVY



POISON OAK



POISON SUMAC (SAP)

Symptoms: allergic skin reactions; if ingested, GI distress, liver and kidney damage. *Treatment:* if ingested: demulcents, morphine, fluids, and high-protein, low-fat diet; for skin reactions: antihistamines and topical antipyretics.

Note: The removal of hydrocarbon poisons is controversial. For a conscious patient, gastric lavage is preferred over syrup of ipecac, especially in the emergency department. Some believe that because of poor absorption, kerosene (a hydrocarbon) doesn't require removal from the GI tract; others believe removal depends on the amount ingested.

- To perform gastric lavage, instill 150 to 200 ml of fluid using a large-bore gastric evacuation tube; then aspirate the liquid. Repeat until aspirate is clear. Save vomitus and aspirate for analysis. (To prevent aspiration in an unconscious patient, insert an endotracheal tube before lavage.)
- When you want to induce emesis and the patient has already taken syrup of ipecac, don't give activated charcoal to neutralize the poison until *after* emesis. Activated charcoal absorbs ipecac.
- If several hours have passed since the patient ingested the poison, administer large quantities of I.V. fluids to induce diuresis. The kind of fluid you'll use depends on the patient's acid-base balance and cardiovascular status as well as on the flow rate.
- Severe ingested poisoning may call for peritoneal dialysis or hemodialysis.
- To prevent further absorption of inhaled poison, move the patient to fresh or uncontaminated air. Alert the anesthesia department and provide supplemental oxygen. Some patients may require intubation. To prevent further absorption from skin contamination, remove clothing covering the contaminated skin and flush the area with large amounts of water.
- If the patient is in severe pain, give analgesics as indicated; frequently monitor fluid intake and output, vital signs, and level of consciousness.
- Keep the patient warm and provide support in a quiet environment.
- If the poison was ingested intentionally, maintain suicide precautions and refer the patient for counseling to prevent future suicide attempts.
- For more specific treatment, contact your local poison center.

PREVENTION

To prevent accidental poisoning:

- *Instruct patients to read the label before they take medicine. Tell them to store all medications and household chemicals properly, to keep them out of reach of children, and to discard old medications.*
- *Warn patients not to take medicines prescribed for someone else, not to transfer medicines from their original bottles to other containers without labeling them properly, and never to transfer poisons to food containers.*
- *Tell parents not to take medicine in front of young children and not to call medicine "candy" to get children to take it.*
- *Stress the importance of using toxic sprays only in well-ventilated areas and of following instructions carefully.*
- *Tell patients to use pesticides carefully and to keep the number of their poison control center handy.*

Poisonous snakebites

Poisonous snakebites are medical emergencies. With prompt, correct treatment, they need not be fatal. The only poisonous snakes in the United States are pit vipers (*Crotalidae*) and coral snakes (*Elapidae*). Pit vipers, such as rattlesnakes, water moccasins (cottonmouths), and copperheads, have

a pitted depression between their eyes and nostrils and two fangs, ¾" to 1¼" (2 to 3 cm) long. Because fangs may break off or grow behind old ones, some snakes may have one, three, or four fangs. The fangs of coral snakes are short, but have teeth behind them. Coral snakes have distinctive red, black, and yellow bands (yellow bands always border red ones).

Causes and incidence

Of the about 45,000 snakebites that occur in the United States each year, 7,000 to 8,000 are from poisonous snakes, resulting in 5 to 6 deaths. Such bites are most common during summer afternoons in grassy or rocky habitats.

Pit vipers are nocturnal but active snakes that are responsible for 99% of venomous snake bites in the United States. Coral snakes are also nocturnal, but their placidity makes coral snake bites less common than pit viper bites. Coral snakes tend to bite with a chewing motion, and may leave multiple fang marks, small lacerations, and extensive tissue destruction.

Complications

Pit viper bite

- Extensive vasculitis
- Necrosis
- Skin and subcutaneous tissue sloughing

Coral snake bite

- Respiratory arrest
- Cardiovascular collapse
- Death

Signs and symptoms

Most snakebites happen on the arms and legs, below the elbow or knee. Bites to the head or trunk are most dangerous, but any bite into a blood vessel is dangerous, regardless of location.

Most pit viper bites that result in envenomation cause immediate and progressively severe pain and edema, local elevation in skin temperature, fever, skin discoloration, petechiae, ecchymoses, blebs, blisters, bloody wound discharge, and local necrosis. (See *After a snakebite*.)

Because pit viper venom is neurotoxic, pit viper bites may cause local and facial numbness and tingling, fasciculation and twitching of skeletal muscles, seizures (especially in children), extreme anxiety, difficulty speaking, fainting, weakness, dizziness, excessive sweating, occasional paralysis, mild to severe respiratory distress, headache, blurred vision, marked thirst and, in severe envenomation, coma and death. Pit viper venom may also impair coagulation and cause hematemesis, hematuria, melena, bleeding gums, and internal bleeding. Other symptoms of pit viper bites include tachycardia, lymphadenopathy, nausea, vomiting, diarrhea, hypotension, and shock.

AFTER A SNAKEBITE

Severe edema of the affected limb, as shown below, occurs within hours after a snakebite.

The reaction to coral snakebite is usually delayed—sometimes up to several hours. These snakebites cause little or no local tissue reaction (local pain, swelling, or necrosis). However, because coral snake venom is neurotoxic, a reaction can progress swiftly, producing such effects as local paresthesia, drowsiness, nausea, vomiting, difficulty swallowing, marked salivation, dysphonia, ptosis, blurred vision, miosis, respiratory distress and possible respiratory failure, loss of muscle coordination and, possibly, shock with cardiovascular collapse and death.

Diagnosis

The patient's history and account of the injury, observation of fang marks, snake identification (when possible), and progressive symptoms of envenomation all point to poisonous snakebite. Laboratory test results help identify the extent of envenomation and provide guidelines for supportive treatment.

Abnormal test results in poisonous snakebites may include:

- prolonged bleeding time and partial thromboplastin time
- decreased hemoglobin level and hematocrit
- sharply decreased platelet count (less than 200,000/mm^3)
- urinalysis disclosing hematuria
- increased white blood cell count in victims who develop an infection (A snake's mouth typically contains gram-negative bacteria.)
- pulmonary edema or emboli as shown on chest X-ray
- possibly tachycardia and ectopic heartbeats on the electrocardiogram (usually necessary only in cases of severe envenomation for a patient older than age 40)
- possibly abnormal EEG findings in cases of severe envenomation.

Treatment

Prompt, appropriate first aid can reduce venom absorption and prevent severe symptoms.

- If possible, identify the snake, but don't waste time trying to find it.
- Place the victim in the supine position to slow venom metabolism and absorption.
- Don't give the victim any food, beverage, or medication orally.
- Authorities disagree about what constitutes appropriate prehospital care. Some recommend against placing a constrictive tourniquet (band) on the affected limb unless the victim is far from a medical facility.

- Whether you apply a tourniquet or not, immediately immobilize the victim's affected limb below heart level, and instruct the victim to remain as quiet as possible.
- If a tourniquet is applied, the victim or the person applying the tourniquet should check the victim's distal pulses regularly and loosen the tourniquet slightly as needed to maintain circulation. Remember that the goal of applying a tourniquet is to obstruct lymphatic drainage, not blood flow.
- When indicated, apply the tourniquet so that it's slightly constrictive, obstructing only lymphatic and superficial venous blood flow. Apply the band about 4″ (10 cm) above the fang marks or just above the first joint proximal to the bite. The tourniquet should be loose enough to allow a finger between the band and the skin. After the tourniquet is in place, don't remove it until a physician has examined the victim.

ALERT

Don't apply a tourniquet if more than 30 minutes have elapsed since the bite. Keep in mind also that total tourniquet time shouldn't exceed 2 hours and that the use of a tourniquet shouldn't delay antivenin administration. Loss of a limb is possible if a tourniquet is too tight or if tourniquet time is too long.

- If the patient is more than a few hours away from a hospital, wash the skin over the fang marks. Within 5 to 15 minutes of a pit viper bite, make an incision through the fang marks about ½″ (1.3 cm) long and 1/8″ (3.2 mm) deep. Be especially careful if the bite is on the hand, where blood vessels and tendons are close to the skin surface.

Using a bulb syringe—or, if no other means is available, mouth suction—apply suction for up to 1 hour in the absence of antivenin administration.

ALERT

Remember, an incision and suction are effective only in pit viper bites and only within 1 hour of the bite. Suction is also indicated if transport time to an emergency facility would exceed 30 minutes. Mouth suction is contraindicated if the rescuer has oral ulcers, if the victim is close to a medical facility, or if antivenin can be given promptly.

ALERT

Never give the victim alcoholic drinks or stimulants because they speed venom absorption. Never apply ice to a snakebite because it will increase tissue damage.

- Record the signs and symptoms of progressive envenomation and when they develop. Most snakebite victims are hospitalized for only 24 to 48 hours. Treatment usually consists of antivenin administration, but minor snakebites may not require antivenin. Other treatments include tetanus toxoid or tetanus immune globulin; various broad-spectrum antibiotics; and, depending on respiratory status, severity of pain, and the type of snakebite, acetaminophen, codeine, morphine, or meperidine. (Opioids are contraindicated for the treatment of coral snakebites.)

Necrotic snakebites usually need surgical debridement after 3 or 4 days. Intense, rapidly progressive edema requires fasciotomy within 2 or 3 hours of the bite; extreme envenomation may require amputation of the limb and subsequent reconstructive surgery, rehabilitation, and physical therapy.

Special considerations

When the patient arrives at the hospital, immobilize the limb if this hasn't already been done. If a tight tourniquet has been applied within the past hour, apply a loose tourniquet proximally and remove the first tourniquet. Release the second tourniquet gradually during antivenin administration as ordered. A sudden release of venom into the bloodstream can cause cardiorespiratory collapse, so keep emergency equipment handy.

- On a flow sheet, document vital signs, level of consciousness, skin color, swelling, respiratory status, a description of the bite and surrounding area, and symptoms. Monitor vital signs every 15 minutes and check for a pulse in the affected limb.
- Start an I.V. line with a large-bore needle for antivenin administration. Severe bites that result in coagulotoxic signs and symptoms may require two I.V. lines: one for antivenin and one for blood products.
- Before antivenin administration, obtain a patient history of allergies and other medical problems. Perform hypersensitivity tests as appropriate and desensitization as needed. During antivenin administration, keep epinephrine, oxygen, and vasopressors available to combat anaphylaxis from horse serum.
- Give packed red blood cells, I.V. fluids and, possibly, fresh frozen plasma or platelets, as indicated, to counteract coagulotoxicity and maintain blood pressure.
- If the patient develops respiratory distress and requires endotracheal intubation or a tracheotomy, provide good tracheostomy care.
- Give analgesics as needed. Don't give opioids to coral snakebite victims. Clean the snakebite using sterile technique. Open, debride, and drain any blebs and blisters because they may contain venom. Change dressings daily.
- If the patient requires hospitalization for more than 48 hours, position him carefully to avoid contractures. Perform passive exercises until the fourth day after the bite; after that, perform active exercises and give whirlpool treatments as ordered.

Insect bites and stings

Among the most common traumatic complaints are insect bites and stings, the more serious of which include those of ticks, brown recluse spiders, black widow spiders, scorpions, bees, wasps, and yellow jackets. (See *Comparing insect bites and stings*, pages 1094 to 1097.)

Open trauma wounds

Open trauma wounds (abrasions, avulsions, crush wounds, lacerations, missile injuries, and punctures) are injuries that commonly result from home, work, or motor vehicle accidents and from acts of violence.

Causes and incidence

Open wounds most commonly result from an accidental injury at home or work, or from a car accident. Other open wounds, such as stab and gunshot wounds, may be intentionally inflicted by the victim or by someone else. Open wounds are occasionally self-inflicted by patients with psychiatric disorders or suicidal ideations.

Complications

- Infection
- Organ tissue damage
- Scarring

Signs and symptoms

In all open wounds, assess the extent of injury, vital signs, level of consciousness (LOC), obvious skeletal damage, local neurologic deficits, and general patient condition. Obtain an accurate history of the injury from the patient or witnesses, including such details as the mechanism and time of injury and any treatment already provided. If the injury involved a weapon, notify the police.

Also assess for peripheral nerve damage—a common complication in lacerations and other open trauma wounds—as well as for fractures and dislocations. Signs of peripheral nerve damage vary with location:

- *radial nerve*—weak forearm dorsiflexion, inability to extend thumb in a hitchhiker's sign
- *median nerve*—numbness in tip of index finger; inability to place forearm in prone position; weak forearm, thumb, and index finger flexion
- *ulnar nerve*—numbness in tip of little finger, clawing of hand
- *peroneal nerve*—footdrop, inability to extend the foot or big toe
- *sciatic and tibial nerves*—paralysis of ankles and toes, footdrop, leg weakness, numbness in sole.

Most open wounds require emergency treatment. In those with suspected nerve involvement, however, electromyography, nerve conduction, and electrical stimulation tests can provide more detailed information about possible peripheral nerve damage.

Diagnosis

A thorough physical examination of the patient will reveal traumatic wounds. They may be seen during the primary and secondary assessment of the patient.

Treatment

If hemorrhage occurs, stop bleeding by applying direct pressure on the wound and, if necessary, on arterial pressure points. If the wound is on a limb, elevate it if possible. Don't apply a tourniquet except in a life-threatening hemorrhage. If you must do so, be aware that resulting lack of perfusion to tissue could require limb amputation. (For a description of types of wounds and specific management, see *Managing open trauma wounds*, pages 1098 to 1100.)

COMPARING INSECT BITES AND STINGS

In addition to maintaining airway, breathing, and circulation and assessing neurologic function, treatment varies according to the type of bite or sting.

General information	Clinical features	Treatment	Special considerations
Tick			
▪ Common in woods and fields	▪ Itching may be the sole symptom or, after several days, the host may develop tick	▪ Removal of tick	▪ To remove a tick, cover it with a tissue or gauze pad soaked in mineral, salad, or

throughout the United States ▪ Attaches to host in any of its life stages (larva, nymph, or adult); fastens to host with its teeth, then secretes a cementlike material to reinforce attachment ▪ Flat, brown, speckled body about ¼" (6.4 mm) long; has eight legs ▪ Also transmits Rocky Mountain spotted fever and Lyme disease	paralysis (acute flaccid paralysis, starting as paresthesia and leg pain and resulting in respiratory failure from bulbar paralysis).	▪ Local antipruritics for itching papule ▪ Mechanical ventilation for respiratory failure	machine oil or alcohol. This blocks the tick's breathing pores and causes it to withdraw from the skin. If the tick doesn't disengage after the pad has been in place for a half hour, carefully remove it with tweezers, taking care to remove all parts. ▪ To reduce the risk of being bitten, teach the patient to keep away from wooded areas, to wear protective clothes, and to carefully examine his body for ticks after being outdoors. ▪ Teach patients how to safely remove ticks.
Brown recluse (violin) spider ▪ Common to south-central United States; usually found in dark areas (outdoor privy, barn, or woodshed) ▪ Dark brown violin on its back; three pairs of eyes; female more dangerous than male ▪ Most bites occur between April and October	▪ Venom is coagulotoxic. Reaction begins within 2 to 8 hours after bite. ▪ Localized vasoconstriction causes ischemic necrosis at bite site. A small, reddened puncture wound forms a bleb and becomes ischemic. In 3 to 4 days, the center becomes dark and hard. Within 2 to 3 weeks, an ulcer forms. ▪ Minimal initial pain increases over time. ▪ Other symptoms include fever, chills, malaise, weakness, nausea, vomiting, edema, seizures, joint pain, petechiae, cyanosis, and phlebitis. ▪ Rarely, thrombocytopenia and hemolytic anemia develop, leading to death within the first 24 to 48 hours (usually in a child or a patient with a previous history of cardiac disease). Prompt and appropriate treatment results in recovery.	▪ No known specific treatment ▪ Combination therapy with corticosteroids, antibiotics, antihistamines, tranquilizers, I.V. fluids, and tetanus prophylaxis ▪ Dapsone 100 mg b.i.d. to suppress the leukocyte response ▪ Surgical debridement and skin grafting (large ulcerative lesions) ▪ Skin grafting (large chronic ulcer)	▪ Clean the lesion with a 1:20 Burow's aluminum acetate solution, and apply antibiotic ointment as ordered. ▪ Take a complete patient history, including allergies and other pre-existing medical problems. ▪ Monitor vital signs, general appearance, and any changes at bite site. ▪ Reassure the patient with a disfiguring ulcer that skin grafting can improve his appearance. ▪ To prevent brown recluse bites, tell the patient to spray areas of infestation with creosote at least every 2 months, to wear gloves and heavy clothing when working around woodpiles or sheds, to inspect outdoor work clothing for spiders before use, and to discourage children from playing near infested areas.
Black widow spider ▪ Common	▪ Venom is neurotoxic. Age, size, and	▪ Neutralization	▪ Take a complete patient history,

throughout the United States, particularly in warmer climates; usually found in dark areas (outdoor privy, barn, or woodshed) ▪ Female: coal black with red or orange hourglass on ventral side; larger than male (male doesn't bite) ▪ Mortality less than 1% (increased risk among elderly people, infants, and those with allergies)	sensitivity of the patient determine the severity and progression of symptoms. ▪ Pinprick sensation, followed by dull, numbing pain (may go unnoticed). ▪ Edema and tiny, red bite marks appear. ▪ Rigidity of stomach muscles and severe abdominal pain occur (10 to 40 minutes after bite). ▪ Muscle spasms occur in the extremities. ▪ Ascending paralysis develops, causing difficulty swallowing and labored, grunting respirations. ▪ Other symptoms include extreme restlessness, vertigo, sweating, chills, pallor, seizures (especially in children), hyperactive reflexes, hypertension, tachycardia, thready pulse, circulatory collapse, nausea, vomiting, headache, ptosis, eyelid edema, urticaria, pruritus, and fever.	of venom using antivenin I.V., preceded by desensitization when skin or eye tests show sensitivity to horse serum ▪ Calcium gluconate I.V. to control muscle spasms ▪ Muscle relaxants such as diazepam for severe muscle spasms ▪ Adrenaline or antihistamines ▪ Oxygen by nasal cannula or mask ▪ Tetanus immunization ▪ Antibiotics to prevent infection	including allergies and other pre-existing medical problems. ▪ Have epinephrine and emergency resuscitation equipment on hand in case of anaphylactic reaction to antivenin. ▪ Keep the patient quiet and warm and the affected part immobile. ▪ Clean the bite site with an antiseptic; apply ice to relieve pain and swelling and to slow circulation. ▪ Check vital signs frequently during the first 12 hours after the bite. Report any changes to the physician. Symptoms usually subside in 3 to 4 hours. ▪ When giving analgesics, monitor respiratory status. ▪ To prevent black widow spider bites, tell the patient to spray areas of infestation with creosote at least every 2 months, to wear gloves and heavy clothing when working around woodpiles or sheds, to inspect outdoor work clothing for spiders before use, and to discourage children from playing near infested areas.
Scorpion ▪ Common throughout the United States (30 different species); two deadly species in southwestern states ▪ Curled tail with stinger on end; eight legs; 3″ (7.6 cm) long ▪ Most stings occur during warmer months ▪ Mortality less than 1% (increased risk among elderly people and children)	*Local reaction* ▪ Local swelling and tenderness, sharp burning sensation, skin discoloration, paresthesia, and lymphangitis with regional gland swelling occur. *Systemic reaction (neurotoxic)* ▪ Immediate sharp pain; hyperesthesia; drowsiness; itching of the nose, throat, and mouth; impaired speech (due to sluggish tongue); generalized muscle spasms (including jaw muscle spasms, laryngospasms, incontinence, and seizures) nausea, vomiting, and drooling occur. ▪ Symptoms last from 24 to 78 hours; the bite site recovers last. ▪ Anaphylaxis is rare. ▪ Death may follow cardiovascular or respiratory failure. ▪ The prognosis is poor if symptoms progress rapidly in the first few hours.	▪ Antivenin (made from goat serum) if available, to neutralize toxins ▪ Calcium gluconate I.V. for muscle spasm ▪ Phenobarbital I.M. for seizures ▪ Emetine subcutaneously to relieve pain (opioids, such as morphine and codeine, contraindicated because they enhance the venom's effects)	▪ Take a complete patient history, including allergies and other pre-existing medical conditions. ▪ Immobilize the patient, and apply a tourniquet proximal to the sting. ▪ Pack the area extending beyond the tourniquet in ice. After 5 minutes of ice pack, remove the tourniquet. ▪ Monitor vital signs. Watch closely for signs of respiratory distress. (Keep emergency resuscitation equipment available.)
Bee, wasp, and yellow jacket ▪ Honeybee	*Local reaction*	▪ Antihistamines	▪ If the stinger is in place, scrape it off.

(rounded abdomen) or bumblebee (over 1″ [2.5 cm] long; furry, rounded abdomen)—stinger remains in the victim; bee flies away and dies ▪ Wasp or yellow jacket (slender body with elongated abdomen)—retains stinger and can sting repeatedly	▪ Painful wound (protruding stinger from bees), edema, urticaria, and pruritus can occur. *Systemic reaction (anaphylaxis)* ▪ Symptoms of hypersensitivity usually appear within 20 minutes and may include weakness, chest tightness, dizziness, nausea, vomiting, abdominal cramps, and throat constriction. The shorter the interval between the sting and systemic symptoms, the worse the prognosis. Without prompt treatment, symptoms may progress to cyanosis, coma, and death.	and corticosteroids (in urticaria) ▪ Tetanus prophylaxis ▪ In anaphylaxis, oxygen by nasal cannula or mask and epinephrine 1:1,000 subcutaneously or I.M. ▪ In bronchospasm, albuterol and corticosteroids ▪ In hypotension, epinephrine and isoproterenol	Don't pull it; this action releases more toxin. ▪ Clean the site and apply ice. ▪ Watch the patient carefully for signs of anaphylaxis. Keep emergency resuscitation equipment available. ▪ Tell a patient who's allergic to bee stings to wear a medical identification bracelet or carry a card and to carry an anaphylaxis kit. Teach him how to use the kit, and refer him to an allergist for hyposensitization. ▪ To prevent bee stings, tell the patient to avoid wearing fragrant cosmetics during insect season, to avoid wearing bright colors and going barefoot, to avoid flowers and fruit that attract bees, and to use insect repellent.

MANAGING OPEN TRAUMA WOUNDS

After securing airway, breathing, circulatory, and neurologic status, specific treatment of the wound will depend on its severity.

Type	Clinical action
Abrasion	
▪ Open surface wounds (scrapes) of epidermis and possibly the dermis, resulting from friction; nerve endings exposed ▪ Diagnosis based on scratches, reddish welts, bruises, pain, and history of friction injury	▪ Obtain a history to distinguish injury from second-degree burn. ▪ Clean the wound gently with topical germicide, and irrigate it. Too vigorous scrubbing of abrasions will increase tissue damage. ▪ Remove all imbedded foreign objects. Apply a local anesthetic if cleaning is very painful. ▪ Apply a light, water-soluble antibiotic cream to prevent infection. ▪ If the wound is severe, apply a loose protective dressing that allows air to circulate. ▪ Administer tetanus prophylaxis if necessary.
Avulsion	
▪ Complete tissue loss that prevents approximation of wound edges, resulting from cutting, gouging, or complete tearing of skin; frequently affects nose tip, earlobe, fingertip, and penis ▪ Diagnosis based on full-thickness skin loss, hemorrhage, pain, history of trauma; X-ray required to rule out bone damage	▪ Check the patient's history for bleeding tendencies and use of anticoagulants. ▪ Record the time of injury to help determine if tissue is salvageable. Preserve tissue (if available) in cool normal saline solution for a possible split-thickness graft or flap. ▪ Control hemorrhage with pressure, an absorbable gelatin sponge, or topical thrombin. ▪ Clean the wound gently, irrigate it with normal saline solution, and debride it if necessary. Cover with a bulky dressing.

	▪ Tell the patient to leave the dressing in place until the return visit, to keep the area dry, and to watch for signs of infection (pain, fever, redness, and swelling). ▪ Administer analgesics and tetanus prophylaxis, if necessary.
Crush wound ▪ Heavy falling object splits skin, causes necrosis along split margins, and damages tissue underneath; may look like a laceration ▪ Diagnosis based on history of trauma, edema, hemorrhage, massive hematomas, damage to surrounding tissues (fractures, nerve injuries, or loss of tendon function), shock, and pain; X-rays required to determine extent of injury to surrounding structures; complete blood count (CBC) and differential and electrolyte count also required	▪ Check the patient's history for bleeding tendencies and use of anticoagulants. ▪ Clean open areas gently with soap and water. ▪ Control hemorrhage with pressure and a cold pack. ▪ Apply a dry, sterile bulky dressing; wrap the entire extremity in a compression dressing. ▪ Immobilize the injured extremity, and encourage the patient to rest. Monitor vital signs, and check peripheral pulses and circulation often. ▪ Administer tetanus prophylaxis if necessary. ▪ A severe injury may require I.V. infusion of lactated Ringer's or normal saline solution with a large-bore catheter as well as surgical exploration, debridement, and repair.
Laceration ▪ Open wound, possibly extending into deep epithelium, resulting from penetration with knife or other sharp object or from a severe blow with a blunt object ▪ Diagnosis based on hemorrhage, torn or destroyed tissues, pain, and history of trauma	*In a laceration less than 8 hours old and in all lacerations of the face and areas of possible functional disability (such as the elbow):* ▪ Apply pressure and elevate the injured extremity to control hemorrhage. ▪ Clean the wound gently with normal saline solution or water; irrigate with normal saline solution. ▪ As necessary, debride necrotic margins and close the wound, using strips of tape or sutures. ▪ A severe laceration with underlying structural damage may require surgery. *In grossly contaminated lacerations or lacerations more than 8 hours old (except lacerations of the face and areas of possible functional disability):* ▪ Administer a broad-spectrum antibiotic for at least a 5-day course. ▪ Don't close the wound immediately. ▪ Instruct the patient to elevate the injured extremity for 24 hours after the injury to reduce swelling. ▪ Tell him to keep the dressing clean and dry and to watch for signs of infection. ▪ If, after 5 to 7 days, the wound appears uninfected with healthy granulated tissue, you may close it with sutures or a butterfly dressing or allow it to heal by itself. ▪ Apply a sterile dressing and splint. *In all lacerations:* ▪ Check the patient's history for bleeding tendencies and anticoagulant use. ▪ Determine the approximate time of injury, and estimate the amount of blood lost. ▪ Assess for neuromuscular, tendon, and circulatory damage. ▪ Administer tetanus prophylaxis as needed. ▪ Stress the need for follow-up and suture removal.

	▪ If sutures become infected, culture the wound and scrub with surgical soap preparation. Remove some or all sutures, and give a broad-spectrum antibiotic as appropriate. Instruct the patient to soak the wound in warm, soapy water for 15 minutes, three times daily, and to return for a follow-up visit every 2 to 3 days until the wound heals. ▪ If the injury is the result of foul play, report it to the police department.
Missile injury	
▪ High-velocity tissue penetration, such as a gunshot wound ▪ Diagnosis based on entry and possibly exit wounds, signs of hemorrhage, shock, pain, and history of trauma; X-rays, CBC and differential, and electrolyte levels required to assess extent of injury and estimate blood loss	▪ Check the patient's history for bleeding tendencies and use of anticoagulants. ▪ Control hemorrhage with pressure if possible. If the injury is near vital organs, use large-bore catheters to start two I.V. lines, using lactated Ringer's or normal saline solution for volume replacement. Prepare for possible exploratory surgery. ▪ Maintain a patent airway, and monitor for signs of hypovolemia, shock, and cardiac arrhythmias. Check vital signs and neurovascular response often. ▪ Cover a sucking chest wound during exhalation with an occlusive dressing. ▪ Clean the wound gently with normal saline solution or water; debride as necessary. ▪ If damage is minor, apply a dry, sterile dressing. ▪ Administer tetanus prophylaxis if necessary. ▪ Obtain X-rays to detect retained fragments. ▪ If possible, determine the caliber of the weapon. ▪ Report the injury to the police department.
Puncture wound	
▪ Small-entry wounds that probably damage underlying structures, resulting from sharp, pointed objects ▪ Diagnosis based on hemorrhage (rare), deep hematomas (in chest or abdominal wounds), ragged wound edges (in bites), small-entry wound (in very sharp object), pain, and history of trauma; X-rays can detect retention of injuring object	▪ Check the patient's history for bleeding tendencies and use of anticoagulants. ▪ Obtain a description of the injury, including force of entry. ▪ Assess the extent of the injury. ▪ Don't remove impaling objects until the injury has been completely evaluated. (If the eye is injured, call an ophthalmologist immediately.) ▪ Thoroughly clean the injured area with soap and water. Irrigate all minor wounds with normal saline solution after removing a foreign object. ▪ Unless they're on the face, very large, or gaping, leave human and animal bite wounds open. Apply a dry, sterile dressing to other minor puncture wounds. ▪ Tell the patient to apply warm soaks daily. ▪ Administer tetanus prophylaxis and, if necessary, a rabies vaccine. ▪ Deep wounds that damage underlying tissues may require exploratory surgery; retention of the injuring object requires surgical removal.

Special considerations

- Frequently assess vital signs in patients with major wounds. Be alert for a 20-beat increase in pulse and 20 mm Hg drop in blood pressure (compare the patient's pulse and blood pressure taken when he's sitting with those taken when he's lying down), increased respiratory rate, decreased LOC, thirst, and cool, clammy skin—all indicate blood loss and hypovolemic shock.
- Administer oxygen as needed.
- Send blood samples to the laboratory for type and crossmatch, complete blood count (including hematocrit and hemoglobin level), and prothrombin and partial thromboplastin times.

- Prepare the patient for surgery if needed.
- As much as possible, tell the patient about the procedures that he'll undergo (even if he's unconscious) and provide reassurance.
- Start I.V. lines, using two large-bore catheters, and infuse lactated Ringer's solution, normal saline solution, or whole blood as ordered.
- Insert a central venous pressure line and place the patient in a modified V position (with his head flat and his legs elevated). If the modified V position doesn't help, Trendelenburg's position may be an alternative.

Rape trauma syndrome

The term *rape* refers to sexual intercourse without consent. It's a violent assault in which sex is used as a weapon. Rape inflicts varying degrees of physical and psychological trauma. Rape trauma syndrome occurs during the period following the rape or attempted rape; it refers to the victim's short-term and long-term reactions and to the methods the victim uses to cope with this trauma.

In most cases, the rapist is a man and the victim is a woman. However, rapes do occur between persons of the same sex, especially in prisons, schools, hospitals, and other institutions. In some cases, the victim is a man and a woman is the rapist.

The prognosis is good if the rape victim receives physical and emotional support and counseling to help her deal with her feelings. Victims who articulate their feelings are able to cope with fears, interact with others, and return to normal routines faster than those who don't.

Causes and incidence

Rape isn't primarily about sex. It's a violent crime linked to feelings of rage or hatred in the assailant. Some of the cultural, sociological, and psychological factors that contribute to rape are increased exposure to sex, permissiveness, cynicism about relationships, feelings of anger, and powerlessness amid social pressures. Many rapists have feelings of violence or hatred toward women or sexual problems, such as impotence or premature ejaculation. They may feel socially isolated and be unable to form warm, loving relationships. Some rapists may be psychopaths who need violence for physical pleasure, no matter how it affects their victims; others rape to satisfy a need for power. Some were abused as children.

In the United States, a rape is reported every 6 to 7 minutes. The incidence of reported rape is highest in large cities and continues to rise. However, many rapes—possibly even most—are never reported.

Known victims of rape range in age from 2 months to 97 years. The age-group most affected is 10- to 19-year-olds; the average victim's age is 13½. About one in seven reported rapes involves a prepubertal child; most of these cases involve manual, oral, or genital contact with the child's genitals by a member of the child's family. More than 50% of rapes occur in the home; about one-third of these involve a male intruder who forces his way into a home. In about half the cases, the victim

has some casual acquaintance with the attacker. Most rapists are between ages 25 and 44 and have planned the attack. Alcohol is involved in one-third of cases.

Complications

- Depression
- Guilt
- Anxiety
- Suicide

Signs and symptoms

When a rape victim arrives in the emergency department, assess her physical injuries. If she isn't seriously injured, allow her to remain clothed and take her to a private room where she can talk with you or a counselor before the necessary physical examination. (See *If the rape victim is a child*, page 1102.) Remember, immediate reactions to rape differ and can include crying, laughing, hostility, confusion, withdrawal, or outward calm; anger and rage may not surface until later. During the attack, the victim may have felt demeaned, helpless, and afraid for her life; afterward, she may feel ashamed, guilty, shocked, and vulnerable and have a sense of disbelief and lowered self-esteem. Offer support and reassurance.

Help her explore her feelings; listen, convey trust and respect, and remain nonjudgmental. Don't leave her alone unless she asks you to do so.

IF THE RAPE VICTIM IS A CHILD

Carefully interview the child to assess how well she'll be able to deal with the situation after going home. Interview the child alone, away from the parents. Tell the parents that this is being done for the child's comfort, not to keep secrets from them. Ask them what words the child is comfortable with when referring to parts of the anatomy.

History and examination

A young child will place only as much importance on an experience as others do, unless there's physical pain. A good question to ask is, “Did someone touch you when you didn't want to be touched?” As with other rape victims, record information in the child's own words. A complete pelvic examination is necessary only if penetration has occurred; such an examination requires parental consent and an analgesic or a local anesthetic.

Need for counseling

The child and the parents will need counseling to minimize possible emotional disturbances. Encourage the child to talk about the experience, and try to alleviate any confusion. After a rape, a young child may regress; an older child may become fearful about being left alone. The child's behavior may change at school or at home.

Help the parents understand that it's normal for them to feel angry and guilty, but warn them against displacing or projecting these feelings onto the child. Instruct them to assure the child that they aren't angry with her; that the child is good and didn't cause the incident; that they're sorry it happened, but glad the child is all right; and that the family will work the problems out together.

Being careful to upset the victim as little as possible, obtain an accurate history of the rape, pertinent to physical assessment. (Remember, your notes may be used as evidence if the rapist is tried.) Record the victim's statements in the first person, using quotation marks. Also, document objective information provided by others. Never speculate as to what may have happened or record subjective impressions or thoughts. Include in your notes the time the victim arrived at the facility, the date and time of the alleged rape, and the time that the victim was examined. Ask the victim if she's allergic to penicillin or other drugs, if she has had recent illnesses (especially venereal disease), and if she was pregnant before the attack. Find out the date of her last menstrual period and details of her obstetric and gynecologic history.

Thoroughly explain the examination she'll have, and tell her it's necessary to rule out internal injuries and obtain a specimen for venereal disease testing. Obtain her informed consent for treatment and for the police report. Allow her some control if possible; for instance, ask her if she's ready to be examined or if she would rather wait a bit.

Before the examination, ask the victim whether she douched, bathed, or washed before coming to the hospital. Note this on her chart. Have her change into a hospital gown, and place her clothing in paper bags. Label each bag and its contents.

ALERT

Never use plastic bags because secretions and semen stains will mold, destroying valuable evidence.

Tell the victim she may urinate, but warn her not to wipe or otherwise clean the perineal area. Stay with her, or ask a counselor to stay with her, throughout the examination.

Diagnosis

Even if the victim wasn't beaten, the physical examination (including a pelvic examination by a gynecologist) will probably show signs of physical trauma, especially if

the attack was prolonged. Depending on specific body areas attacked, a patient may have a sore throat, mouth irritation, difficulty swallowing, ecchymoses, or rectal pain and bleeding.

If additional physical violence accompanied the rape, the victim may have hematomas, lacerations, bleeding, severe internal injuries, and hemorrhage; if the rape occurred outdoors, she may suffer from exposure. X-rays may reveal fractures. If severe injuries require hospitalization, introduce the victim to her primary nurse if possible.

Throughout the examination, carefully label all possible evidence. Before the victim's pelvic area is examined, take vital signs; if she's wearing a tampon, remove it, wrap it, and label it as evidence. The pelvic examination is typically very distressing for the victim. Reassure her and allow her as much control as possible. During the examination, specimens should be collected, including those for semen and gonorrhea. Carefully label all specimens with the patient's name, the physician's name, and the location from which the specimen was obtained. List all specimens in your notes. If the case comes to trial, specimens will be used for evidence, so accuracy is essential. (See *Legal considerations*.) Most emergency departments have “rape kits” that include containers for specimens.

Carefully collect and label fingernail scrapings and foreign material obtained by combing the victim's pubic hair; these also provide valuable evidence. Note to whom you give these specimens.

For a male victim, be especially alert for injury to the mouth, perineum, and anus. As ordered, obtain a pharyngeal specimen for a gonorrhea culture and rectal aspirate for acid phosphatase or sperm analysis.

Assist in photographing the patient's injuries (this may be delayed for 1 day or repeated when bruises and ecchymoses are more apparent).

Most states require medical facilities to report rape. The patient may choose not to press charges or assist the police. If the patient doesn't go to a facility, she may choose not to report the rape.

LEGAL CONSIDERATIONS

If your facility observes a protocol for emergency care of rape victims, it may include a rape evidence kit. If it does, follow the kit's instructions carefully. Include only medically relevant information in your notes.

If you're called as a witness during a trial, try to provide the judge and jury with pertinent facts while maintaining your own credibility.

Tips for the courtroom

- Go to court tastefully dressed and well-groomed.
- Keep your posture erect, and look confident.
- Look the prosecuting and defense attorneys in the eye when answering their questions, but avoid long eye contact with the victim—this may cause you to appear biased.
- Don't offer speculations about the rape or volunteer information. Just answer questions that you're asked. If you don't know an answer, don't be afraid to say so.

If the police interview the patient in the facility, be supportive and encourage her to recall details of the rape. Your kindness and empathy are invaluable.

The patient may also want you to call her family. Help her to verbalize anticipation of her family's response.

Treatment

Treatment consists of supportive measures and protection against venereal disease, human immunodeficiency virus (HIV) testing and, if the patient wishes, testing for pregnancy.

Special considerations

- Give antibiotics, as ordered, to prevent venereal disease.
- Because cultures can't detect gonorrhea or syphilis for 5 to 6 days after the rape, stress the importance of returning for follow-up venereal disease testing.
- To prevent pregnancy as a result of the rape, the patient may be given two Norgestrel and ethinyl-estradiol (Ovral) tablets orally immediately, plus two tablets 12 hours later. If so, explain the possible adverse effects of Ovral. The victim may wait 3 to 4 weeks and undergo dilatation and curettage or vacuum aspiration to abort a pregnancy.
- If the patient has vulvar lacerations, the physician will clean the area and repair the lacerations after all the evidence is obtained. Topical use of ice packs may reduce vulvar swelling.
- Offer all victims of rape testing for HIV infection as well as medical counseling and follow-up. If there's a chance that the rapist was infected with HIV, postexposure prophylaxis may be done to reduce the odds of infection by the immediate use of antiretroviral organisms.
- Refer the patient for psychological counseling, if needed, to cope with the aftereffects of the attack. Recovery from rape, which may be prolonged, consists of the acute phase (immediate reaction) and the reorganization phase. During the acute phase, physical effects include pain, loss of appetite, and wound healing; emotional reactions typically include shaking, crying, and mood

swings. Feelings of grief, anger, fear, or revenge may color the victim's social interactions. Counseling helps the victim identify her coping mechanisms. She may relate more easily to a counselor of the same sex.

During the reorganization phase, which usually begins 1 to 3 weeks after the rape and may last months or years, the victim is concerned with restructuring her life. Initially, she often has nightmares in which she's powerless; later dreams show her gradually gaining more control. When she's alone, she may also suffer from "daymares"—frightening thoughts about the rape. She may have reduced sexual desire or may develop fear of intercourse or mistrust of men.

- If the patient is engaged in legal proceedings during this time, she'll be forced to relive the trauma, leaving her feeling lonely and isolated, perhaps even temporarily halting her emotional recovery. To help her cope, encourage her to write her thoughts, feelings, and reactions in a daily diary, and refer her to organizations such as Women Organized Against Rape or a local rape crisis center for empathy and advice.

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