TREATING BROKEN BONES

Resistance Medicine

Sanctum of the Craft
Akiima Nicholls Shields

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Dedicated to

the medic who set my fingers...

Contents

Introduction

- Musculoskeletal injuries are extremely common. Every year, about six million people in the United States seek treatment for a broken bone.
- Musculoskeletal injuries can be easily identified due to three symptoms: pain, swelling, and deformity. These injuries are very rarely fatal.
- Street medics provide emergency, temporary assistance directly after the physical trauma, by identifying the injury and contacting emergency medical services. However, that care may extend to splinting and evacuation with a person to where emergency services can reach them.
- Always prioritize treating life-threatening injuries first before treating broken bones (refer to the section on XABCDEs).

The Musculoskeletal System

The Musculoskeletal System consists of part of one bodily system and the entirety of another.

Part of it is the Muscular System, which consists of skeletal, smooth, and cardiac muscle. The muscular system is a system of muscles that run throughout an organism to move the organism and stimulate the function of internal organs.

Skeletal muscle attaches to the skeleton but is not considered part of the skeletal system. Thus, the systems are often combined and called the Musculoskeletal System. It is responsible for moving the body via contracting or relaxing the muscles. It is almost entirely controlled by the somatic nervous system and requires conscious control.

The Skeletal System consists of bones, tendons, ligaments, cartilage, and joints. It is responsible for the structure and support of the body and the organs, movement, blood cell production, calcium storage, endocrine regulation, and the protection of the organs from damage.

In humans, damage to the Musculoskeletal System may indicate that there are more significant injuries to the organs protected by the bones. There are 206 bones in the human body. It is a myth that AFAB people and AMAB people have a different number of ribs.

The skeleton is divided into the axial skeleton and the appendicular skeleton. The axial skeleton is composed of the bones of the central axis of the body, including the vertebral column, skull, ribs, and sternum. Breaks within the axial skeleton are beyond the scope of this guide and will be covered in Head and Spinal Injuries. The appendicular skeleton consists of the bones of the upper and lower extremities, including the scapulae (shoulder blades) and clavicle (collarbones), and the pelvic girdle.

The shoulder girdle is the base of the upper arm, consisting of the scapula and clavicle, which work together to keep the shoulder joint (glenohumeral joint) functional and also serve as sites of muscle attachment. The muscles that attach at this joint allow the upper arm to flex, extend, move the arm away from the body (abduction) and back to the body (adduction), and to rotate.

The upper extremities consist of the bones of the upper arms, forearms, and hands, as well as the joints of the shoulders, elbows, wrists, and hands. The upper extremities also serve as an important site of muscle attachments that permit extension

(straightening or stretching), supination (rotating the forearm upward, turning the palm of the hand toward the sky), and flexion (the action of a joint that causes the angle between the two bones it connects to decrease, bending that body part), and pronation (a movement where the forearm and hand rotate inward) some of which come from the shoulder girdle and other of which start further down the upper extremity.

Many muscles (bigger and smaller) run through the upper extremities, as well as tendons, nerves, and blood vessels. Most of how human hands function comes from muscles and tendons that come from the forearms down into the hands, not from muscles in the hands themselves.

The pelvic girdle connects the torso with the lower extremities. The pelvic girdle is incredibly strong and has multiple sites where large muscles attach to it. The muscles allow for the flexion of the legs towards the torso or torso towards the legs, extension, abduction and adduction, and the rotation of each hip.

The lower extremities consist of the bones of the thighs, legs, and feet, as well as the joints of the hips, knees, and ankles. The muscles of the lower extremities control flexion and extension, foot supination (not desirable if it goes too far), pronation, abduction, and adduction.

What is a Fracture?

A fracture is a break in the bone. Sanctum of the Craft medics have heard, over and over, “it’s not broken, it’s just a fracture” or “is it a fracture or a break?” A fracture is a break; a break is a fracture. They occur when a force applied, direct or indirect, is greater than the strength of the bone.

During healing, bone-forming cells that come from the bone marrow, called osteoblasts, go to the fracture and form a callus. The osteoblasts form a matrix called an osteoid, of collagen fibers, proteoglycans, and growth factors, where eventually calcium will form as the framework to remodel the bone.

The callus is initially weak, and it is very easy for the bone to be re-broken again during the early stages of healing. As the bone heals, there is a brief period where the bone is temporarily stronger than it was originally. It is a myth that a previously broken bone is always stronger than it was previously; it just regains the same strength as the rest of the bone (provided the person has adequate nutrition and no complicating health conditions that would cause it to form weaker than before).

People at More Risk

Some medical conditions cause bones to become easier to break. People who are malnourished and undernourished are more likely to have fractures from injuries. Bone density decreases with age. Osteoporosis is a common bone disease that causes bones become weak and brittle. People with this condition may break bones from a minor fall or, in serious cases, from sneezing or minor bumps.

Musculoskel-etal Injury

Skeletal injury is caused when the bones of the skeleton are impacted by forces that exceed their limitations.

Common causes of broken bones include falls, motor vehicle crashes, and athletic activities.

Direct Force:

If an object strikes someone, it will transfer its energy at the point of impact. If the force of that impact is greater than the strength of the tissues it contacts, it will cause injury. When direct force applied exceeds the strength of the bone, this causes a fracture. If the impact is on or near a joint, direct force may dislocate the joint, and may or may not also cause a fracture. Sometimes soft tissues in the area are bruised, lacerated, or punctured by the direct force of an object.

In the case of a penetrating injury (e.g. by a bullet), the speed of the penetrating object has more influence on the force than the size does. A high-velocity penetrating injury will likely cause a fracture if it connects with bone, in addition to soft-tissue damage.

An impalement injury may fracture a bone if force is applied to the bone. Impaling objects must always be left in place and removed by medical professionals.

Indirect force:

If force is applied to one region of the body, but the injury occurs in another region of the body, this is referred to as an indirect injury. The force is

transmitted through the skeleton until it reaches an area that is weaker than the other parts of the skeleton that the force traveled through, at which point a fracture occurs.

Forces can be transmitted along the entire length, even of a long bone, or through several bones in series. When forces travel through several bones in series, it can cause an injury anywhere and in multiple places. This is very often seen in one of the most common injuries - falling onto outstretched arms. Often, a bone in the hand (scaphoid bone) is fractured by direct force, but then the force radiates up the distal ulna and radius (sometimes fracturing both), then up into the shoulder, where it either fractures or dislocates it, and sometimes also fractures the collarbone.

Twisting injuries, as are often observed in sports, can cause spiral fractures of the bone. This occurs when one part of the limb makes direct contact and then remains fixed, while the torsional force travels down the bone. The resulting torsional force can tear tendons and ligaments, as well as break the bone in spirals along its length.

Stress fractures (also called fatigue fractures) are caused by repetitive stress, which causes micro-cracks, generally in areas with a deficient or insufficient supply of blood. The micro-cracks in the cortical bone result in an imbalance of bone resorption and formation, slowly weakening the bone further over time.

Associated Fractures:

Some fractures may co-occur if one fracture is present. These are called associated fractures. If one of them is present, the other is likely to be:

Primary Fracture	Associated Fracture or Injury
Scapular Fracture	Rib fracture, pulmonary contusions, pneumothorax
Scaphoid fracture	Wrist, elbow, or shoulder fracture
Pelvic fracture	Lumbosacral spine, long bone fractures, intra-abdominal or genitourinary injury
Hip dislocation	Fracture of the acetabulum or femoral head
Femoral fracture	Dislocation of the ipsilateral hip
Patellar fracture	Fracture or dislocation of the ipsilateral hip
Knee dislocation	Tibial fracture; distal pulse may be absent
Calcaneal fracture	Fracture of the ankle, leg, hip, pelvis, lumbar spine, and the other calcaneus

Fracture Types

Fractures are classified based on the direction that the break travels through the bone, the number of breaks on the bone, or the number of layers (cortices) involved.

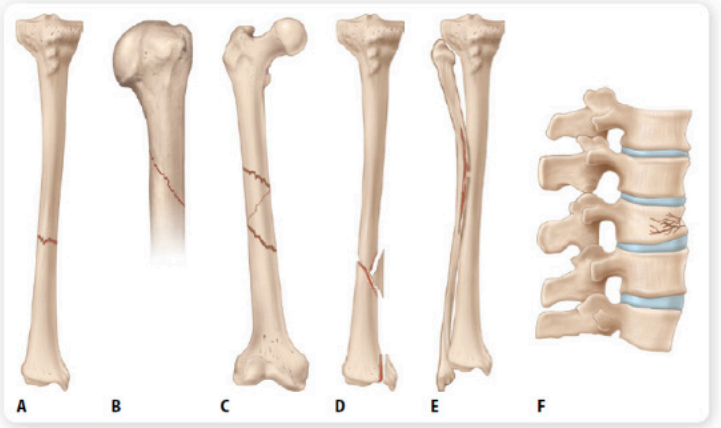

Figure 37-2 Types of fractures. **A.** Transverse fracture of the tibia. **B.** Oblique fracture of the humerus. **C.** Spiral fracture of the femur. **D.** Comminuted fracture of the tibia. **E.** Greenstick fracture of the fibula. **F.** Compression fracture of a vertebral body.

Fracture Classification Based on Displacement:

Fractures can be classified based on the type of displacement. A displaced fracture is a broken bone where the broken pieces have moved out of alignment, often causing a gap at the fracture site. Symptoms can include severe pain, swelling, bruising, and visible deformity. Deformities of the limb might be angulated, rotated, or shortened.

In an angulated displacement, each end of the fracture is not aligned in a straight line, creating an angle between the pieces. Angulation can be on the frontal plane (also called the coronal plane), which divides the entire body into the front (anterior) and back (posterior) planes. Angulation may be on the sagittal plane (also known as the median plane), which

divides the body into left and right sides. An angulated displacement can occur on both planes simultaneously.

Fracture Classification Based on Open vs. Closed:

Fractures can be either open or closed. In a closed fracture, the bone does not penetrate through the skin. In an open fracture (also called an exposed or compound fracture), there is a break in the skin from the transferred force or from the broken bone poking through the skin. If there is a wound through the skin, even if the bone does not visibly poke through the skin, this is still considered an open fracture because there is an exposure to the broken bone from the external environment. Even very small skin punctures from the inside qualify an injury as an open fracture. Open fractures lead to exposure to foreign contaminants, including dirt and microorganisms, which increase the risk of infection. Soft tissue damage can also hinder the normal healing process of the bone itself.

Open fractures also have greater potential for blood loss than a closed fracture. Open fractures often result from high-energy transfers of force, which often cause more soft-tissue injury.

In a closed fracture, the blood vessels surrounding the fracture are damaged, leading to a hematoma (a localized collection of blood outside the blood vessels, typically caused by trauma or injury), but that hematoma is kept compressed by the inflammation of the injury, which slows the bleeding and limits the size of the hematoma. In an open fracture, that pressure and compression is absent, and so the blood isn't slowed or halted and can flow away from the wound, leading to higher blood loss.

An example of this is a femur fracture (break in the thighbone, the longest and strongest bone in the body). A femur fracture is often dangerous because major blood vessels run along the femur. These blood vessels can be broken by the force that caused the fracture, or the fractured bone can cut the blood vessels. In a closed femur fracture, blood vessels that are severed can hemorrhage 2 pints (1 liter) of

blood before pressure builds up and tamponades the bleeding. Tamponade of the bleeding refers to a condition where excessive fluid accumulates in a closed space, exerting pressure on surrounding tissues or organs. In this case, the pressure is enough to halt further bleeding. Which is good, because 2 pints (1 liter) of blood loss is enough to trigger hemorrhagic shock in an AFAB person. And in an open fracture, the pressure doesn't halt the bleeding. If the blood vessels are severed, a person can bleed to death from the bleeding associated with a femur fracture (and other open fractures, as well).

Signs and Symptoms of a Fracture

- Pain
- A "snap" or "break" as a feeling or something the person hears
- Deformity
- Limb in an unnatural position
- Motion or bend where there is no joint
- Shortening (which occurs in fractures where the broken ends of a bone overlap one another, which is common in femur fractures because the broken femur cannot oppose the spasm of powerful muscles in the thighs)
- Swelling
- Ecchymosis (a discoloration of the skin resulting from bleeding underneath, typically caused by bruising, which is flat)
- Hematoma (a collection of blood under the skin, which is not flat)
- Guarding or protecting of the area
- Loss of use
- Tender in response to palpation
- Crepitus (a grating or grinding sound or sensation caused by the broken bones touching each other)

In an open fracture:

- Laceration
- Bleeding
- Possibly exposed bone (though sometimes the bone protrudes and then retracts)

The medic must contact emergency services if the person:

- Is unresponsive
- Experiences confusion, decreased alertness, or unusual behavior
- If the suspected broken bone is in the head, neck, back, hip, pelvis, or femur
- You cannot immobilize the injury at the scene by yourself
- Has severe bleeding
- The area below the injury is pale, cold, clammy, blueish, or purpleish
- There is a bone projecting through the skin

If a child or non-verbal person refuses to put weight on an arm or leg, won't move the arm or leg, or the medic can clearly see a deformity, the medic should assume they have a broken bone.

Dislocations

When the bones that form a joint are forced beyond their normal limits, they may break or become dislocated or both, and the supporting ligaments and joint capsule may tear. In a dislocation, a bone is totally displaced from the joint, and at least part of the joint capsule and some of the ligaments are disrupted.

A partial dislocation of a joint is a subluxation, where the bones that form the joint are no longer completely in alignment, but not fully displaced. Part of the joint capsule and the ligaments may be damaged, but the patient may be able to move the joint to some degree. A luxation is a full, complete dislocation.

Signs and Symptoms of Dislocations

- Pain
- Pressure
- Loss of motion of the joint
- A frozen or rigid joint
- Deformity
- An extremity hanging unconnected
- Tingling
- Numbness
- Weakness
- Absent distal pulses (if the dislocation is putting pressure on an artery)

Since a dislocation can put pressure on an artery, it is important to check a person's pulse prior to and after splinting, to make sure the splint isn't putting additional pressure on the artery.

Sprains

Sprains are injuries where the ligaments are damaged. They may be stretched, partially torn, or fully severed. They are usually caused by a joint being twisted past its normal range of motion, which causes a temporary subluxation. Sprains, dislocations, and fractures can all co-occur. This is common in injuries to the ankle and shoulder.

Signs & Symptoms of Sprains

Type One (Stretched Ligament):

- Mild pain
- Tenderness when palpated
- Slight swelling
- Discomfort with pressure
- Functional with minimal pain

Type Two (Partial Tear of the Ligament):

- Moderate pain
- Swelling
- Bruising
- Instability
- Less functional with more pain

Type Three (Full Tear of the Ligament):

- Severe pain
- Swelling
- Bruising
- Instability
- Floppiness
- Inability to control mobility
- Not-functional

Type Three sprains require surgical intervention to reattach the ligament.

If there is deformity of a sprained area, medics should assume there is also a fracture. If there is no deformity, no joint or extremity incongruity, and the mobility is limited by pain, not lack of function, then the injury may only be a sprain.

It can be very difficult, in the field, for a medic to differentiate a sprain from a fracture. If the injury was associated with a lot of force, it is best to assume a fracture. Either way, if the injury is severe enough for the medic to be intervening before emergency medical services can diagnose, the treatment is the same - immobilize the area with splinting.

Strains

A strain is a pulled muscle or tendon that results from either too much stretching, too much contraction, or too much torsion. It is possible for a strain and a fracture to occur at the same time.

Signs and Symptoms of a Strain:

Grade 1 (Mild)

- **Injury:** A mild overstretch and microscopic tearing of muscle fibers.
- **Symptoms:** Minimal damage, pain, slight swelling, possibly light bruising. Possibly light cramping that goes away.
- **Function:** Loss of strength and range of motion are mild.
- **Recovery:** Can heal in a few weeks.

Grade 2 (Moderate)

- **Injury:** A partial tear of the muscle fibers.
- **Symptoms:** More extensive damage, some loss of strength, a more significant decrease in range of motion, and worse bruising. Possibly a visible or felt lump or knot in the injured muscle. Possibly more severe cramping.
- **Function:** Weakness and pain increase.
- **Recovery:** Can take a few months and may require physical therapy.

Grade 3 (Severe)

- **Injury:** A complete rupture or tear of the entire muscle or tendon.
- **Symptoms:** Severe pain, significant bruising, swelling, and loss of function. You may be able to see or feel a "gap" in the muscle.
- **Function:** Complete loss of strength.
- **Recovery:** Often requires surgery to repair the muscle.

In strains, the pain is often the lack of deformity of the bone or joint, but a visible or felt lump, knot, or gap that is present in more severe strains may make it difficult to determine whether there is a fracture or a strain. The lump, knot, or gap should be in the muscle, not the bone, but that can be difficult to determine with just palpation. In cases of severe injury, it is best to assume a fracture, and again, in both cases, a splint or sling is going to be used to hold the area immobile until it can be assessed by professionals.

Scene Assessment

We teach an entire class on scene assessment and threat modeling for street medics, so this is a shallow overview.

Anytime a medic encounters a person whom they intend to assess who has become injured, they should assess the scene before moving to assist. This can be done very quickly, but it is a vital self-protection step that also ensures they will be able to help the person they want to assist.

Although fractures may appear significant and frightening, most are relatively non-threatening. They are rarely going to be the immediate cause of someone's death, although there are exceptions for multiple broken bones that are related to large transfers of force, often resulting in internal bleeding, and for cases where an open fracture bleeds heavily and the person is at a risk of bleeding to death.

The first aspect of scene assessment is safety. They need to check if it is safe for them to approach, if it is safe for the person who is injured to remain where they are, and if the danger is to others present in the area as well. They need to check for environmental conditions that would make it unsafe for them to enter (the danger of more falling objects, fire, flood waters, rapidly speeding traffic, etc.)

If the scene is unsafe, they need to check if there is anything they can do to make it safe (if there is a fire, can they put it out? If there is traffic speeding by, could they put out flashers to redirect traffic? etc.) A medic should not enter the scene if it will endanger their life to do so.

If the scene is not safe and there is a way to call for additional help to make it safe, the medic should do so as quickly as possible and provide assistance as soon as they can.

Another aspect of safety is exposure to bloodborne illness. Skin injuries may result in the medic being exposed to blood and other bodily fluids. Depending on the severity of bleeding, a medic may need to use gloves, a mask, and an eye shield. The medic should avoid contact with bodily fluids to any open wounds on their own body and to mucous membranes.

(We teach an entire class on safety and risk-aware PPE for medics).

If there is no other option and the wound is life-threatening, the medic may have to assist an injured person without adequate protective equipment. If the medic is exposed to blood from the person they are assisting and the person has an unknown medical history (is not their child, spouse, partner, etc.), they should, as soon as possible, clean the affected area with soap and water, and flush eyes, nose, or mouth with water or sterile saline. Then, they should report that exposure to medical personnel and receive a medical evaluation, possibly including blood tests for both them and the source person, to determine risk and potential necessary follow-ups. For example, they may be given post-exposure prophylaxis (PEP), a medication that can significantly reduce the risk of HIV infection.

Assessment

The first step to assessing the injured person is to make sure that no immediate threat to them is present.

The medic should assess the person's Mechanism of Injury (MOI), which refers to how the injury occurred, the forces involved, and the potential severity of the injury. In some cases, this is quite simple to assess (a fall where someone put their hand out to catch themself, a broken bone from someone being pushed to the ground, etc.) The injury may not be severe enough to cause more complex symptoms, and the assessment can proceed to how to manage the injury.

In cases of more severe injury or injury from an unknown cause, the assessment is more complex. This can occur if someone has hurt themself more severely or if the soft tissue injury is complicated by more complex injuries, like those caused by a beating, and thus also involves contusion, concussion, crush injuries, compromised airways, etc.

The medic should rapidly assess if the individual is in an altered state of consciousness, if they have compromised breathing, if there is uncontrolled heavy bleeding, if they are exhibiting signs of shock, or if they are unconscious.

This should be done by checking the person's airway, breathing, circulation, disability, and exposure (XABCDEs).

The medic should not focus on the broken bone at first, but check for these critical problems in order:

1. **eXternal Bleeding:** Is there severe, life-threatening bleeding? If yes, they should stop everything and put direct pressure on the wound or apply a tourniquet immediately.
2. **Airway:** Is the person's airway open and clear? Are they choking or gurgling?

3. **Breathing:** Are they breathing? Look, listen, and feel. The medic doesn't need to count the exact rate—just check if it's absent, extremely slow, or very fast.
4. **Circulation:** Do they have a pulse? The medic doesn't need to count it—just check if it's absent, very weak, or extremely fast.
5. **Disability:** What is their level of consciousness?

    A - Alert

    V - Responds to a Voice

    P - Responds only to Pain

    U - Unresponsive
6. **Exposure:** Carefully remove or cut away clothing to fully check the body for other hidden injuries.

If someone is in immediate danger of bleeding to death, the rest of the assessment can wait while that is addressed (see the sections on hypovolemic, hemorrhagic shock, tourniquets, and wound packing).

If the pulse is absent, the medic needs to take immediate resuscitative measures.

Head-to-Toe Assessment

A head-to-toe assessment should be performed after the xABCDEs to determine the nature of the person's injury. It should be performed in its entirety before treatment is begun, but should not be performed if the person requires immediate treatment for life-threatening injury, such as in cases of compromised breathing or severe hemorrhage.

The responder performs a head-to-toe assessment to determine the location of all injuries, the extent of those injuries, and what treatment the person needs.

The Memory Tool DCAP-BTLS

This acronym guides a medic on what to look for and feel as they check the body from head to toe.

- **Deformities:** Does anything look misshapen, crooked, or out of place?
- **Contusions:** Are there any bruises?
- **Abrasions:** Are there any scrapes or grazes?
- **Punctures:** Are there any stab or puncture wounds?
- **Burns:** Are there any burns?
- **Tenderness:** Does the person feel pain when you gently press on an area?
- **Lacerations:** Are there any cuts or tears in the skin?
- **Swelling:** Is any area puffed up or swollen?

Understanding the MOI (mechanism of injury, i.e., what caused the harm) will help provide additional information on what injuries are likely. For example, a rubber bullet is likely to cause contusions, tenderness, and swelling, as well as possibly lacerations and even a puncture wound. So if the MOI is “rubber bullet”, the head-to-toe assessment will be informed by that information, and so will treatment.

Patient Assessment

If They Are Capable of Answering Questions

Sometimes the medic knows the injured person–they are a family member, a housemate, a friend, a coworker, a volunteer they work with, or even another medic. Other times, they are a stranger.

Regardless, the primary concerns for assessing a conscious, communicating patient are basically the same.

First, obtain consent. Yes, even if the person is a member of the medic's family, they should still ask for consent to assist them.

Secondly, prevent further injury. The shock from being injured, even if the medic perceives the injury as minor, may cause the injured person and onlookers to pass out. It is recommended that the injured person be placed in a resting position. If there is doubt as to how well the person is coping with their injury (they are dizzy, lightheaded, white, blanking in and out), that position may need to be fully supine (lying flat on the back, staring at the ceiling or sky). Bystanders may also need to be directed to sit or lie down if they show signs of pre-syncope (feeling as if they are about to faint).

The medic should then obtain a brief description of the current injury and how it occurred. They should ask the person if they are dizzy, lightheaded, nauseated, and/or having trouble breathing.

Gather Information (SAMPLE History):

To get a quick and useful medical history, remember SAMPLE:

- **Signs & Symptoms:** What are they feeling? (e.g., pain, nausea, dizziness)
- **Allergies:** Are they allergic to any medications?

- **Medications:** Are they taking any prescription drugs, especially blood thinners (critical if bleeding) or heart medications (critical if in shock)?
- **Past Medical History:** Do they have any medical conditions that affect bones (like osteoporosis) or bleeding?
- **Last Intake:** When did they last eat or drink?
- **Events:** What happened? How did the injury occur?

Relevant medical history in the case of a fracture involves whether or not the person has a medical condition that impacts the health of their bones (osteoporosis, brittle bone disease, bone-related cancer).

If the person is bleeding, the medic should ask about any medications that thin the blood or anticoagulants and if the person has a history of excessive bleeding or clotting insufficiency. If they are showing signs of shock, they should ask if they are on medications that affect how the body handles shock, including beta-blockers, calcium channel blockers, antidysrhythmics, and nitroglycerin.

To evaluate broken bones, the medic should remember the **6 P's** of musculoskeletal assessment:

- **P**ain
- **P**aralysis
- **P**aresthesias (numbness or tingling)
- **P**ulselessness
- **P**alor (pale, grey, purplish)
- **P**ressure

When assessing the pain of a broken bone, the **OPQRST** mnemonic may help:

- **O**nset of Pain

- **P**rovoking or Palliating Factors (what makes it worse; what makes it better)
- **Q**uality of Pain (sharp, throbbing, pressure, etc.)
- **R**egion of Pain
- **S**everity of Pain (scale of 1 to 10)
- **T**ime (duration of how long they've been experiencing pain)

Palpation of a fractured extremity should include the injury site and the region above and below it.

The medic should look for the signs and symptoms of a broken bone as they go over the entire area, paying special attention to instability, deformity, abnormal bone or joint continuity, displaced bones, crepitus, and reaction to pain from the injured person. The medic should note if there is a change in pulse between the injured extremity and the uninjured extremity, as that can indicate arterial injury. Other signs of arterial injury include an expanding hematoma, a vibration on the site of injury that matches the patient's heartbeat, and difficult-to-staunch bleeding in an open fracture.

Any instability in the pelvic girdle should be communicated to emergency medical services as quickly as possible. If instability is found, the physical examination should be halted, as manipulation of a pelvic instability can disrupt blood clotting and worsen internal and external bleeding.

The medic should always monitor and treat for shock, especially if the injury was caused by a bad fall, a beating that may have caused internal injury, or if there is heavy bleeding.

Children have a lower tolerance for injury than adults, especially blood loss. They may appear fairly stable and normal, though upset, with good blood pressure and pulse, until they suddenly collapse.

Children with fractures may not want anyone to see, touch, or splint the injury. Medics should always obtain consent from a parent, guardian, or caregiver

if they are present before touching any broken bone. The parent, guardian, or caregiver may also have to be managed for their own upset reaction to their child's injury. If possible, a parent can be asked to hold an injured child while they are splinted. Always have an injured child sit down for treatment.

Pregnant people will naturally have a faster pulse, lower blood pressure, and often nausea, so evaluation can be complicated. We recommend that their symptoms still be taken seriously if they present with the signs of shock, even if the signs of shock could be caused by them being pregnant, and that medics not automatically dismiss the altered signs of their medical state as being caused by them being pregnant.

Sometimes clothing may need to be shifted or removed to make a head-to-toe assessment possible. In this case, the medic should ideally be the same gender as the person they are assessing, but that is not always possible. Cultural and religious beliefs regarding the removal of clothing and inspection by a person of another gender must be respected (we encourage cultural competency training). Clothing must never be removed without consent, unless the person is unconscious and treatment is necessary to save their life.

Conducting the Assessment

If the person is unconscious and unresponsive, the medic should always suspect brain and spinal injury and be very careful when handling the head and neck.

The responder should go from the head to the toes while conducting a head-to-toe assessment, checking the head, neck, shoulders, chest, arms, hands, abdomen, pelvis, legs, and feet in that order.

The responder should look, listen, and feel for anything that is unusual. If they are uncertain if something is out of place or "feels different," they can compare the potential site of injury to its mirror on the other side of the person's body or compare it to their own body.

While passing their hands over the body, they can check their own hands to see if blood has come

off onto their hands. They can also check for medical alert jewelry or the presence of medical devices, such as insulin pumps or an inhaler, on a person who is unconscious.

The medic should attempt to never cause new or additional harm while conducting a head-to-toe assessment. They should move a person as little as possible, as gently as possible, and with care and compassion.

Basic Treatment

After an assessment has found a broken bone, the basic treatment of closed fractures is to immobilize the broken extremity with splinting. Cold packs can also be applied to slow down internal bleeding and reduce pain.

The treatment of open fractures also involves managing bleeding, reducing the chances of infection with the dressing and bandage, and immobilizing the broken bone with a splint. Cold packs can still be applied to slow bleeding and reduce pain.

Severe Injury

If the medic finds that the person is unresponsive, unconscious, struggling to breathe, has a very altered pulse, is showing signs of shock, or is severely bleeding, emergency services must be contacted. The person should be assessed and treated for shock. If there is severe bleeding, first control the hemorrhage before treating anything else

Medics must prioritize assessing and treating life-threatening injuries before non-life threatening injuries. Life over Limb. If there has been significant trauma to a person, with multiple body systems affected, then the musculoskeletal injuries may not be the priority.

If someone has multiple broken bones, they should not be moved at all unless absolutely necessary. If there is no choice, the medic has to decide if the person must be evacuated to safety or if the medic should splint each broken bone before moving the

person on a backboard or blanket. The decision they make may depend on whether it is safe for them to remain where they are for long enough to individually treat each broken bone.

Severe bleeding from an open fracture has to take precedence over the splinting of the broken bone. The bleeding wound may need to be treated with a dressing and direct pressure until it has stopped, before the bone can be splinted. This may be extremely painful for a person if the wound is directly over the fracture or has bone poking out from it.

Once the bleeding has stopped, it can be bandaged. The bandage has to be secure enough to control bleeding without restricting circulation to the injury. Swelling from fractures and internal bleeding can cause a bandage to become too tight. The medic needs to monitor bandage tightness by assessing circulation, sensation, and movement of the bandaged area.

A tourniquet may be necessary in combination with a splint in cases where bleeding cannot be stopped with pressure alone.

Potential Blood Loss from Fracture Sites:

Fracture Site	Blood Loss in milileters (mL)
Radius or Ulna	150 to 250 mL
Elbow	250 to 500 mL
Ankle	250 to 500 mL
Tibia or Fibula	250 to 500 mL
Humerus	250 to 500 mL
Femur	1000 to 1500 mL
Pelvis	1500 to 3000 mL

Shock:

Hemorrhagic shock is most likely to occur with severe lacerations that damage vascular tissues from

penetrating injuries, blunt injuries to organs, long bone or pelvic fractures, multi-system injury, and amputations. Hemorrhagic shock can occur from both external and internal bleeding.

If the femur is fractured, there is a very good chance of someone going into shock.

A factor in how hemorrhagic shock affects the body is how fast it happens. A person can donate one pint (475 mL) over 20 minutes and not necessarily feel adverse effects from doing so, but if that same amount of fluid loss happened over a minute to two minutes, they may experience hemorrhagic shock.

If an average American AMAB adult person has lost just under one liter of blood, they are likely in hemorrhagic shock. This is the equivalent of two large beers poured out on the ground. For an average American AFAB adult person, the number is lower, at approximately 750 ml. This is the equivalent of one bottle of wine poured out on the ground.

Because infants and children have less blood than adults, they experience hypovolemia very rapidly. A one-year-old child has approximately 2 pints of blood in their entire body (950 mL), so they may suffer from hypovolemia after a loss of only 3 to 6 ounces of blood (100 to 200 mL). Keep in mind that the average glass of water in the United States is 8 to 10 fluid ounces, to help put that in perspective.

It should be noted that the symptoms of shock are not a perfect guide to assessing blood loss severity or determining treatment. Symptoms vary, and no system of assessment is perfect.

The signs and symptoms of shock can be measured using a four-stage system that is detailed in our guide on Abrasions and Lacerations or using the Compensated and Decompensated model.

The Compensated and Decompensated model is best for rapid assessment in more chaotic environments. Compensated shock is the phase of shock in which the body is still able to compensate for fluid loss and maintain adequate blood pressure. Decompensated shock happens when the person's body is unable to compensate for fluid loss and cannot maintain the brain and the vital organs.

Compensated Shock:

- Anxiety and/or sense of impending doom
- Agitation and restlessness
- Weak and/or thready pulse
- Rapid pulse
- Cool, clammy skin
- White or grey pallor, possibly with blueish or purplish lips
- Shortness of breath
- Nausea or vomiting
- Thirst
- Normal blood pressure

Decompensated Shock:

- Confusion
- Altered consciousness
- Possibly non-verbal and unresponsive
- Labored breathing
- Thready or absent pulse in extremities
- Ashen, mottled, or blueish or purplish skin
- Low blood pressure

Management of Hemorrhagic Shock

The first steps of treating hemorrhagic shock are the same as in preceding to treat any injury - it has to start with scene assessment and ensuring the safety of the medic and bystanders. Standard precautions for blood-borne illness should still be met if at all possible.

If the person is conscious, continue with patient assessment in a calm, compassionate fashion. If they are unconscious, check airway constriction and

breathing. Heavy bleeding must be stopped (by use of a pressure bandage, tourniquet, etc.) before attempting CPR.

If the person is conscious, help them get into a supine position. Do not allow the person to eat or drink anything, even if very thirsty.

The person should be kept warm with a shock blanket while waiting for emergency services. Most external hemorrhage can be halted with direct, even pressure for 10 minutes. Once hemorrhaging is controlled and a sterile dressing or appropriate other bandage has been applied, they can be transported to the emergency department by the emergency services.

If a person's bleeding cannot be stopped with firm, direct pressure, it may be necessary to employ more extreme measures, including wound packing or using a tourniquet. In the case of treating a broken bone, we recommend applying a tourniquet, not wound packing.

Splinting

Splinting provides support to broken bones and prevents them from moving, which can worsen the fracture. Correctly splinting decreases the pain a person is in and reduces the risk of further damage to the bones, as well as the surrounding muscles, nerves, blood vessels, and skin. It also helps to control both internal and external bleeding.

To apply a splint:

1. Properly see the injury in detail. This may require the removal of clothing.
2. Stop bleeding, if necessary.

3. Apply a sterile dressing, if necessary, and bandage it in place. If bone ends are exposed, loosely place a moist dressing over them to keep the bones damp.
4. Assess and record the PMS (Pulse, Motor, and Sensory - is there a healthy pulse, are they able to move their extremities like fingers and toes, and can they feel touches past the point of the injury on the extremity
5. Apply a splint that immobilizes the bone ends and adjacent joints. Knees should be splinted straight if they are not already angulated. Elbows should be splinted at a 90-degree angle. Do not cover fingers or toes with the splint
6. Slint firmly, but not so tightly as to occlude circulation
7. Take the PMS again
8. Monitor for changes in skin color, temperature, and condition
9. If possible, apply cold packs
10. If possible, elevate the splinted extremity to minimize swelling
11. Wait for EMS or transport to safety and further assessment

Do Not:

- Enter or probe into the wound to remove debris
- Push the exposed bone back under the skin
- Move the patient before splinting unless there is an immediate danger to them if they are not moved

Should a Medic Straighten a Bone?

Generally, no. They should stay with a person, keeping them stable, until EMS arrives. But if EMS are significantly delayed, cannot reach the person, or the person has to be moved for their safety, then the answer is "sometimes."

Doing so incorrectly can further worsen an injury. Additionally, the pain of doing so in the field is extreme, which generally outweighs the benefit of doing so if medical professionals are on the way.

If a long bone fracture is severely angulated or if there is a loss of distal circulation, it may be more urgent to reposition a fracture.

The medic may need to apply gentle traction and tension lengthwise along the bone, realigning the bone into a more natural position and improving circulation. They have to apply a firm grip and move slowly and smoothly, avoiding any sudden, jerky movements of the extremity.

If the person experiences severe pain or is resistant to continuing, the limb may need to be splinted in the position it's already in, and the medic may need to carefully monitor the distal pulse.

Types of Splints

Any device used to immobilize a fracture or dislocation is considered a splint. Medics should not allow the lack of a commercially made splint to cause them not to help an injured person.

Rigid Splints:

A rigid splint is any inflexible splint that can be attached to an extremity to maintain stability of the fracture. This can be a board, a piece of heavy cardboard, rolled up newspapers, a SAM splint (structural aluminum malleable), or full metal splints that are secured with straps. It should ideally be padded to ensure even pressure. It needs to be long enough to be secured above and below the fracture site, not directly on it.)

Soft Splints:

Soft splints may be used if no other material is available. They can be fashioned from pillows and rolled up towels or blankets.

Anatomical Splint:

An anatomical splint is fashioned in an emergency when other splinting material is not available. It is done for breaks in the legs. The legs are straightened next to one another with a blanket or towel rolled up in between them. The two legs are then tied together at several places down their lengths, although not directly over the site of the break itself.

Buddy Splints:

Buddy splints are used to splint injuries of the fingers or toes. They are a form of anatomical splint where the injured finger or toe is splinted to an uninjured one. To buddy splint, a gauze pad is placed between the digits, and then taped together. Again, the tape should not be placed directly on the break.

Advanced Splints (Typically Used by EMS)

These are mentioned so medics know what they are, but they are generally not recommended for basic or street medic kits due to cost, complexity, or risk.

Pneumatic Splints (also known as air splints or inflatable splints):

A pneumatic splint may be used by EMS to stabilize fractures of the lower leg or forearm. They apply pressure and can minimize swelling and bleeding.

They should not be used for angulated fractures or fractures of a joint because they will forcibly straighten them. They also should not be used for open fractures where the bone ends are poking out of the skin.

We do not recommend street medics utilize them, as there are so many times they are not appropriate to use, because they need special devices to inflate them (they cannot be inflated with compressed air tanks), and because if they are overinflated, they can cut off blood flow, and overinflation is easy to accidentally do.

Vacuum Splints:

A vacuum splint is a sealed plastic container filled with air and thousands of small plastic beads. It is wrapped around an extremity, a suction pump is attached, and it pulls the air from inside. This compresses the beads so that the entire split becomes like a plaster cast that conforms to the contours of a person's extremity.

We do not recommend that street medics utilize them, as they need special suction pumps, they are expensive, and they are difficult to use without causing further injury.

Vacuum Mattresses:

Vacuum mattresses are used by EMS. They are essentially vacuum splints, but very large. They are applied underneath a person in place of a backboard, splinting their entire body at once. They are often used for the elderly who have fallen, who may have multiple breaks and very fragile bones, and also for people who have spinal column injuries.

We do not recommend that medics carry vacuum mattresses because they are quite bulky, difficult to operate in cramped or chaotic environments, take up a lot of storage room in a kit or medic tent, require a specialized suction pump, and are very, very expensive.

Traction Splints:

Traction splints are used to provide a constant pull on a fractured bone, preventing the broken bone ends from overlapping. They are commonly used for fractured femurs, as the strong muscles of the thigh involuntarily spasm and contract, causing the broken

bone ends to overlap. Traction splints also help reduce blood loss from femur fractures by putting the muscles back into alignment, so they keep the blood vessels under pressure.

They should not be used if the person has also fractured their lower leg below the knee.

Traction splints are somewhat expensive and take up space in a medic's kit, so they should only be prioritized as an item to have in a kit if a medic feels they are likely to be providing support for people who will be delayed in getting professional medical assistance.

Slings

A sling may be needed if the break is to the shoulder, arm, elbow, or wrist. The sling holds the injured extremity steady against the chest wall, prevents it from being further injured by knocking into things, and takes the weight off the injured area.

To apply a sling:

1. First, splint the break
2. If the person can support their arm with their other hand, ask them to do so.
3. Gently slide the triangular bandage underneath the arm so that the point of the triangle is under the elbow of the injured arm. Bring the pointed end of the triangle that is closest to their body around the back of their neck.
4. Fold the other, hanging pointed end of the triangle bandage up over the forearm to meet the other end of the triangle around the back of the neck.
5. Tie or pin the two ends together at the shoulder of the injured side.

6. Adjust the sling so that it is supporting the arm .
7. Tuck the point of the triangle in at the elbow or pin it so that it is supporting the elbow.
8. Keep the fingers out of both the splint at the sling so that PMS can be checked periodically.
9. If the person is very large, two triangular bandages can be tied together.

Do not use a sling tied around the neck if a person has a neck injury.

Complications

Peripheral Nerve Injury:

If the blood vessels are damaged following a fracture, loss of blood flow can occur in the area of the body supplied by that vessel (devascularization). Broken bones can also cut nerves (more common in injuries to joints.) Splinting the injury in a correct anatomical position can help relieve pressure on nerves and prevent nerve injury.

Compartment Syndrome:

In an extremity, groups of muscles are surrounded by a membrane called the fascia in a compartment. Each compartment can only accommodate a certain amount of swelling before it prevents blood flow from supplying the muscles in a compartment. This can lead to muscle ischemia and eventual death. This can occur if bandages, splints, or casts are applied too tightly (or tourniquets left on for longer than four hours). It is a myth that open fractures cannot have compartment syndrome. This is one reason to monitor the pulse in an affected extremity and adjust as necessary to maintain a pulse.

Crush Syndrome:

When a body part (like a limb) is crushed for a long time (typically 4-6 hours), the muscle cells begin to die. When the crushing weight is lifted, toxins from the dead muscles flood the bloodstream.

These toxins can cause sudden cardiac arrest from high potassium levels and kidney failure. A classic sign is tea-colored or cola-colored urine.

This is complex. If someone has been trapped for many hours, medical direction is needed before freeing them. First aid involves managing the xABCs and preparing for a rapid transport to a hospital.

Blood Clots (Thromboembolic Disease):

After a major injury (especially to the pelvis or legs), a person is at high risk for developing blood clots. A clot can break free and travel to the lungs, causing a pulmonary embolism. A pulmonary embolism can cause sudden shortness of breath and chest pain, which can be fatal. In the field, treatment is supportive, including recognizing the signs and symptoms and providing rapid transport to a hospital.


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