



Orthopedic Trauma: Assessment and Care

2 Contact Hours

Course Expires: April 30, 2018

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First Published: November 4, 2011
Revised: April 18, 2015

Acknowledgments

RN.com acknowledges the valuable contributions of...

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Purpose and Objectives

The purpose of this course is to provide information about the principles of care related to various types of orthopedic trauma.

After successful completion of this course, you will be able to:

1. Define orthopedic trauma.
2. Identify complications that can arise related to orthopedic trauma.
3. Describe the process of assessment used to identify orthopedic injuries.
4. Identify the most important goal in caring for a patient with orthopedic trauma.
5. Identify methods utilized to diagnose orthopedic injuries.
6. Define principles that guide the provision of fracture care.
7. Identify individuals at risk for orthopedic injuries.
8. Identify considerations specific to children and orthopedic injuries.
9. Identify barriers that delay or prevent normal healing.
10. Describe criteria used to guide diagnostic testing for orthopedic injuries.
11. Define RICE.
12. Describe considerations related to replantation associated with traumatic amputation.
13. Identify life threatening conditions related to orthopedic injuries.

**Please note:
This course does NOT discuss head trauma.**

Introduction

Trauma patients often require immediate intervention or they will be at risk of succumbing to potentially life-threatening injuries. As a healthcare professional, it is important to understand the principles of care with regards to trauma, and as presented in this course, orthopedic trauma.

Orthopedic Trauma

Orthopedic trauma consists of injuries to the bony skeleton. This includes traumatic amputations, fractures, dislocations, injury to connective tissue (such as sprains and strains), and injury to soft tissue (such as hematomas and contusions).

Patients who sustain orthopedic trauma can also suffer from compartment syndrome, fat embolism, hemorrhage from fractures, osteomyelitis and septic arthritis (ENA, 2014; Mistovich, Limmer, Werman & Batsie, 2011). The most important goal in caring for a patient with orthopedic trauma is to **restore** and **preserve function**.

Assessment

As a healthcare professional, providing care to a victim of orthopedic trauma, as with any patient, begins with the ABCs (airway, breathing and circulation) and a primary assessment.

The most effective type of patient assessment is comprised of several phases, and includes:

- A primary assessment, including focus on the system(s) affected
- A secondary assessment

The most important factor to remember is that as a healthcare professional, you must prioritize patient care (within your scope of practice) with the intent of preventing a life-threatening condition from developing or progressing.

In addition to providing a patient's care, you may also be involved in the decision-making process as to whether an individual requires an accelerated intervention such as an immediate transfer to the operating room.

The Primary Assessment

The primary assessment of an individual who has sustained a traumatic injury is similar to that of any patient. What differentiates the type of care that is delivered is when caring for trauma victims, the goal is to quickly identify and initiate treatment of any potentially life-threatening problems before continuing with the remainder of the assessment (ENA, 2007; CPM Resource Center 2010a & b). Securing a patient's airway, for example, while protecting their cervical spine is essential and should always occur prior to examining a wound. Some care might occur concurrently, such as, maintaining the cervical spine while applying pressure to a wound with pulsatile bleeding (arterial bleeding or other related circulation problems). This condition can also be life-threatening and will require immediate intervention.

A primary assessment should include:

- Complete set of vital signs (blood pressure, heart rate, respiratory rate and temperature)
- Immediate pain level. Use the acronym "**PQRST**" for quick pain assessment:
 - P** = Provoking factors (What brought on the pain?)
 - Q** = Quality (Describe the pain - i.e. stabbing, throbbing, burning)
 - R** = Radiation (Does the pain radiate anywhere?)
 - S** = Severity/symptoms (How bad is the pain - rate it; Are there other symptoms with the pain?)
 - T** = Timing (Is it constant? What makes it better/worse?)
- Level of consciousness

The Primary Assessment

When performing a primary patient assessment, the information you collect should contain subjective and objective information about the injury (such as open or closed fracture), the mechanism of injury, medical history, and clinical signs and symptoms.

Subjective assessment factors are those that are reported by the patient.

Objective assessment data includes that which is observable and measurable (Jarvis, 2011). Assessment questions for consideration include the “**Six P’s**” (Mistovich et al., 2011).

The six P’s of assessment data include:

- **Pain:** Is there pain at the injured area? Is there pain with palpation or movement?
- **Pallor:** Is the color pale at the site of injury or distal to the injury? This can indicate circulatory compromise.
- **Paresthesia:** Is there numbness and/or tingling at the affected area or with the affected limb? This can indicate neurological compromise.
- **Pulses:** If a limb is injured, is the pulse to all extremities equal to palpation?
- **Paralysis:** Can the patient move the affected area or limb?
- **Pressure:** Is there a feeling of pressure at the affected area or limb?

The Secondary Assessment

The secondary assessment should include:

- Complete set of vital signs (blood pressure, heart rate, respiratory rate and temperature)
- Glasgow coma scale
- Trauma score
- Additional assessment gathering tools such as pulse oximetry, carbon dioxide detection device, nasogastric tube, urinary catheter (when indicated), imaging and lab studies
- Pain assessment and comfort measures
- Pre-hospital information, past medical history
- A head-to-toe assessment that includes posterior surfaces
- Family involvement
- Administration of medications, wound care, splints and other treatments should be initiated as well (CPM Resource Center, 2010a & b)

Glasgow Coma Scale

The Glasgow Coma Scale is scored between 3 and 15 points. Patients with scores between 3 and 8 points are usually in a coma (unless sedated / paralyzed). The total score is the sum of the points in three categories: eye opening response, verbal response, and motor response (Jennings, 2012).

For adults, the scores are:

Eye Opening Response	Spontaneous-open with blinking at baseline	4 points
	Opens to verbal command, speech, or shout	3 points
	Opens to pain, not applied to face	2 points
	None	1 point
Verbal Response	Oriented	5 points
	Confused conversation, but able to answer questions	4 points
	Inappropriate responses, words discernible	3 points
	Incomprehensible speech	2 points
	None	1 point
Motor Response	Obeys commands for movement	6 points
	Purposeful movement to painful stimulus	5 points
	Withdraws from pain	4 points
	Abnormal (spastic) flexion, decorticate posture	3 points
	Extensor (rigid) response, decerebrate posture	2 points
	None	1 point

Did You Know?

The Glasgow Coma Scale was first developed in 1974 to assess impaired consciousness. It has been accepted across the world, used in more than 80 countries, and translated into over 60 languages (Teasdale, 2014).

Trauma Score

The Revised Trauma Score is a scoring system with high reliability and demonstrated accuracy in predicting death.

It is scored from the first set of data obtained on the patient, consisting of the Glasgow Coma Scale, systolic blood pressure and respiratory rate (Jennings, 2012).

Glasgow Coma Scale	Systolic Blood Pressure	Respiratory Rate	Coded Value
13-15	>89	10-29	4
9-12	76-89	>29	3
6-8	50-75	6-9	2
4-5	1-49	1-5	1
3	0	0	0

Deciding if a Patient Needs a Trauma Center

Not all victims of trauma require the services of a trauma center. Although emergency departments and trauma centers both respond to the emergency needs of their patients, trauma centers provide a higher level of care.

Paramedics and emergency medical technicians utilize formal triage criteria to determine whether or not an injured person should go to a trauma center.

Trauma categories are usually based on criteria that were established in 1999 by the American College of Surgeons Committee on Trauma (ASCOT): Resources for Optimal Care of the Injured Patient.

Categories include:

- Physiologic parameters
- Anatomic parameters
- Mechanism of injury
- Historical information (ENA, 2014)

Deciding if a Patient Needs a Trauma Center

Differentiating between patients who require a trauma center versus an emergency department include some of the following; for example:

Emergency Department

- Concussion
- Back sprain
- Fractured rib
- Fractured femur
- Laceration

Trauma Center

- Brain injury
- Paralysis
- Pneumothorax
- Multiple fractures
- Stab wound

Test Yourself

Components of the Revised Trauma Score include the Glasgow Coma Scale, systolic blood pressure, and:

- A. Heart rate
- B. Respiratory rate
- C. Temperature

The correct answer is B.

Read the scenario on the next page to decide which level of care Marge should receive.

Case Study Scenario

You have just received a call from Medic One: they are en route with a 73-year-old female, Marge. Marge was found lying on her kitchen floor this morning when her daughter stopped by to check on her. Marge is alert and oriented, but can't remember what happened to her. The medics state Marge has an obvious deformity of the right leg with no other visible signs of trauma. The leg is shortened and externally rotated. The medics notice a small area rug bunched up on the floor near to where Marge is lying.

What's Important to Know

In order to determine what could have happened to Marge, there are a number of key pieces of information that can help you decide what level of care Marge might require when she arrives at your organization.

You listen as the medics continue with a brief head to toe assessment:

- Vital signs: BP 140/84. HR: 110. RR 18.
- PQRST: Marge has constant dull pain that increases with any movement and radiates down her right leg; a 2/10 at rest, an 8/10 sharp spasm like pain with movement. Marge isn't sure how long she has had pain but she has been uncomfortable since she awoke on the floor.
- Oriented x 3 but amnesic to the event. Follows commands to move all extremities x 4, equal hand grasps and pulls. Strong movement of the left leg, complaints of pain to the right leg with limited movement. Denies head or neck pain, no visible signs of trauma except shortening and outward rotation of the right leg.
- Cardiac monitor shows sinus tachycardia with an occasional premature ventricular contraction.
- Lungs are clear.
- Blood glucose is 75mg/dL.
- Skin slightly cool and dry.
- Capillary refill to both feet is normal (2 seconds or less), bilateral normal dorsalis and post tibial pulses. Right foot slightly cooler than left.

Test Yourself

A normal capillary refill for an adult is _____ seconds or less.

The correct answer is TWO.

What's Important to Know

The medics place Marge on a scoop to immobilize her movement during transport. As they begin to move her, she cries out in pain. They stabilize her and one of the medics starts a #18 gauge intravenous catheter (IV) in her left antecubital fossa (AC) and according to pre-hospital protocol, administers morphine sulfate 2 milligrams (mg) intravenous push (IVP) after determining she is not allergic to any medications and takes only vitamins on a routine basis.

By now a small group of neighbors has gathered outside and according to one of them, Marge was last seen the evening before out watering her lawn. Marge is loaded into the ambulance with an estimated time of arrival (ETA) to your organization of about 15 minutes. Marge's daughter will follow the ambulance over to the hospital.

What You Have Learned So Far

Based on what you have learned so far, it sounds like this is a case of orthopedic trauma.

You review and evaluate what the medics have told you about Marge:

- She has a blood glucose level of 75mg/dL; no signs or history of diabetes.
- She has equal hand grasps and pulls.
- She follows commands and is oriented to person, place, and date. She is not sure what happened; although she thinks she might have slipped on some cooking oil she might have spilled the night before. She remembers getting up this morning and going to the kitchen and suddenly realizing she was lying on the floor and couldn't get up. Syncope can't be fully ruled out at this time; however, it doesn't appear to be the cause for the fall.
- She denies any neck or back pain and there is no sign of trauma (no lacerations or hematomas on visual and physical inspection).
- Her electrocardiogram (ECG) appears normal with a sinus tachycardia at 110; however, it's likely this is a response to pain.
- Her lungs are clear; respirations slightly shallow, slightly diminished at the bases but not unusual for her age. If Marge has sustained a fracture of a large bone, the potential for a fat embolism is always a concern.

What You Have Learned So Far

Pulse Quality

- She has a strong dorsalis (D.P.) and post tibial (P.T.) pedal pulse to the right (and left) leg, capillary refill less than 2 seconds. She has good sensation to all extremities with complaints of pain to that right leg that increases with any movement. To help immobilize the right leg, the medics have placed her on a scoop for transport to the hospital.

Description	Grade
No pulse	0
Weak, easy to block with pressure	1
Difficult to find but easy to palpate	2
Normal, easy to palpate	3
Bounding and strong	4

Once the medics arrive, you direct them to take Marge to the orthopedic pod of your department. Although other potential injuries have not been completely ruled out, the orthopedic pod seems to be the most appropriate area for her care. You are aware that the most important goal in caring for a patient with orthopedic trauma is to *restore and preserve function*.

Test Yourself

The most important goal in caring for a patient with orthopedic trauma is to restore and preserve function.

- A. True
- B. False

The correct answer is A.

The Assessment - Subjective Factors

A focused assessment that evaluates subjective and objective data will help you to determine the patient's status (Jarvis, 2011).

Subjective factors to include in your assessment consist of:

- The history of the injury: mechanism, onset of symptoms, length of symptoms, penetrating or blunt force that caused the injury
- Precipitating factors such as pre-existing conditions or other medical problems
- Associated symptoms: weakness versus pain, range of motion, weight bearing ability, any change in neurovascular functioning
- Any areas of swelling including location, size, onset and associated symptoms such as numbness, weakness, pain
- The use of and results of any remedies used to relieve the symptoms such as medication or alternative therapies

It is also important to determine the individual's past medical history and whether or not they have any pre-existing illness or disease (Jarvis, 2011).

Questions of importance that help to collect subjective data include:

- Allergies
- Medications
- Immunizations
- Cardiovascular disease
- Diabetes
- Any type of blood disorder (including anemia)
- Infections
- Recent injury or health problem
- Lifestyle and social factors such as living alone, stairs

The Assessment - Objective Factors

You will also need to collect objective information.

This should include:

- Level of consciousness and general appearance/hygiene
- Vital signs
- Pain level
- Inspection and comparison between both sides of the body
- Status of soft tissue and skin such as color, bruising, deformities, scars, muscle tone, swelling
- Palpation to check for swelling, capillary refill, presence and quality of pulses, muscle strength,

temperature, pain, crepitus

- Flexibility, movement and limitations of the joints

Diagnostic Tests

There are a number of tests that can be performed that will help a healthcare provider determine a patient's condition.

These include:

- Imaging studies
- Lab tests

Diagnostic Tests: Imaging Studies

A variety of imaging studies might be used to determine a patients' injury. Advances in technology have added to and refined the ability to determine an injury. Standard x-rays remain very useful to identify acute fractures and dislocations. They can be used to diagnose open joint injuries and air in the joint space. X-rays will show swelling but they do not show actual soft tissue problems (CPM Resource Center, 2010a & b).

Magnetic resonance imaging (MRI):

An MRI can identify stress fractures. It's also very useful to identify soft tissue injuries, such as:

- Muscle tears
- Hematomas
- Ligament injury
- Spinal structures
- Meniscal injury
- Tendon ruptures
- Degenerative problems
- Tumors

Computed tomography (CT) scans:

CT scans are frequently used to identify fractures and dislocations that might not be readily visualized with a standard x-ray, such as:

- Dislocations of femoral and humeral heads, sternoclavicular or radioulnar joints
- Stress fractures
- Fractures or dislocations of the pelvis, sacrum or acetabulum
- Fractures of the talus, calcaneus, tibial plateau (articular surfaces)
- Metastatic or bony changes

Test Yourself

MRI studies are best used to identify:

- A. Soft tissue injuries
- B. Open joint fractures
- C. Articular surface fractures
- D. Dislocations of the femoral head

The correct answer is A.

Diagnostic Tests: Imaging Studies

Angiography

Angiography is sometimes used to not only diagnose vascular injuries but to treat them as well by embolizing major bleeding vessels via an arterial catheter. Angiography can relieve ischemia and prevent hemorrhage. Other tests that might be used include Doppler studies to check arterial flow, bone scans to identify occult fractures, and arthroscopy to examine joints (CPM Resource Center, 2010a & b).

Ottawa Rules

Ottawa Rules are a series of rules pertaining to diagnostic x-rays called the Ottawa ankle, knee and foot rules. The rules are used as criteria guidelines to order X-rays (ENA, 2014).

The Ottawa **ankle** rules consist of the presence of acute ankle pain and one of the following:

- Inability to bear weight
- Bony tenderness at the tip or posterior edge of the lateral malleolus
- Bony tenderness at the tip or posterior edge of the medial malleolus

The Ottawa **foot** rules for x-ray include:

- Inability to bear weight
- Bony tenderness over the cuboid or navicular
- Bony tenderness at the base of the fifth metatarsal

The Ottawa **knee** rules for x-ray include:

- Inability to bear weight (at least four steps)
- Inability to flex the knee to 90 degrees
- Isolated tenderness of the patella
- Tenderness at the head of the fibula
- 55 years old or greater

Diagnostic Tests: Lab Tests

Lab tests can help to identify a number of injuries and disease processes that a patient may be experiencing in addition to an injury (CPM Resource Center, 2010a & b).

These tests include:

- Arterial blood gases (ABGs)
- Complete blood count (CBC) with a differential
- Erythrocyte sedimentation rate (ESR)
- Blood cultures
- Urinalysis

Prioritizing Care

Just as with any patient, prioritizing care for an orthopedic trauma victim consists of maintaining the ABCs (airway, breathing and circulation) and providing interventions specific to their individual needs. It is also a priority to educate the patient and their significant others about the course of their treatment and to involve them as much as possible in the patient's care.

In cases of orthopedic trauma, the primary goals are immediate fracture fixation and stabilization. Early fixation will decrease the amount of avascular necrosis at the fracture site and help to diminish devitalization of the surrounding tissues. Early immobilization will help with the healing of soft tissue and stabilization will help to restore the fracture to as near as possible to the bone's normal anatomic position. Stabilization of the fracture will also help increase circulation (Curtis & Ramsden, 2011).

Age Related Orthopedic Care

Certain patients may require special care related to age. Children's bones are usually more elastic and therefore more resistant to fractures than an older adult that is already experiencing loss of bone mass and bone minerals (Mistovich et al., 2011; CPM Resource Center, 2010a & b).

Important note:

A torus or buckle type of fracture is unique to children. In a torus fracture, the bone is compressed. This type of fracture causes pain but no deformity. Children can also sustain a greenstick fracture- the shaft of the bone (diaphysis) fractures on one side only.

Fractures in Children

Common sites of fractures in children include the distal radius, clavicle, elbow, fibula, and tibia (Koelink & Boutis, 2014). Considerations specific to children include the possibility of injury from abuse.

Healthcare professionals should be suspicious if:

- A fracture occurs in an infant (less than one year old)
- Fractures are present in different stage of healing
- There's a spiral fracture- common with "twisting" a bone in child abuse

- The child sustains an unexplained or unwitnessed injury
- The child has a history of other fractures
- A fracture doesn't fit the mechanism of injury

According to the ENA, approximately one quarter of fractures in children under the age of three result from non-accidental trauma (CPM Resource Center, 2010c).

Subluxation of the Radial Head, AKA, Nursemaids's Elbow:

Nursemaid's elbow is commonly seen in children age two to three and results from a pulling injury to the arm. Parents may report that the child started to fall so they grabbed the child's arm.

Fractures in the Elderly

Fractures in the elderly can occur with minimal trauma. This is related to the process of aging, loss of bone mass, and loss of bone minerals (ENA, 2014). Common sites of fractures in the elderly include the distal radius, femoral neck, and vertebrae (Walker, 2013).

Osteoporosis can lead to fractures that will be seen in the proximal femur, ribs, and vertebral bodies. Osteoarthritis is the degeneration of movable joints and generally affects weight-bearing joints of the hands, knees, feet and vertebrae. Pathologic fractures can also be caused by chronic disease (CPM Resource Center, 2010d).

Types of Fractures

When a break occurs that does not penetrate the skin, it is known as a "closed" fracture. If bone fragments penetrate through the skin, or a wound opens down to the broken bone, the fracture is called an "open" fracture. Open fractures have a higher chance for infection (American Academy of Orthopaedic Surgeons, 2012).

Common types of fractures include:

Stable fracture

The broken ends of the bone line up and are barely out of place.

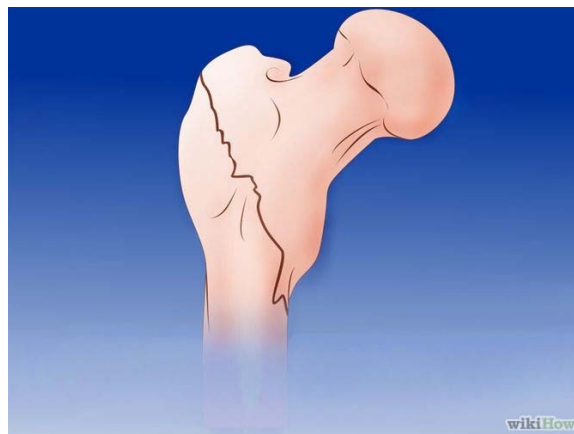


Image retrieved from <http://www.wikihow.com/Identify-a-Fracture>

Open, compound fracture

The skin may be pierced by the bone itself or by the actual trauma that breaks the skin at the time of the fracture. The bone may or may not be visible in the wound.



Image retrieved from http://upload.wikimedia.org/wikipedia/commons/3/35/612_Types_of_Fractures.jpg

Types of Fractures

Transverse fracture

This type of fracture has a horizontal fracture line.



Image retrieved from <http://www.wikihow.com/Identify-a-Fracture>

Oblique fracture

This type of fracture has an angled pattern.



Image retrieved from <http://www.wikihow.com/Identify-a-Fracture>

Types of Fractures

Comminuted fracture

In this type of fracture, the bone shatters into three or more pieces.

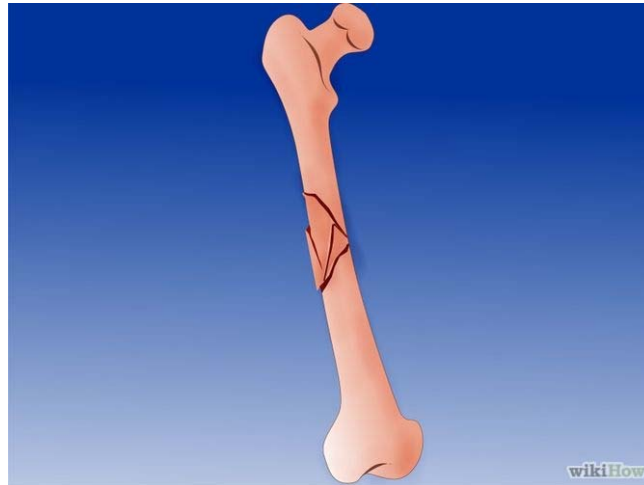


Image retrieved from <http://www.wikihow.com/Identify-a-Fracture>

Greenstick fracture

This type of fracture is common in children. This is an incomplete transverse fracture, due to the flexibility of the child's bones.

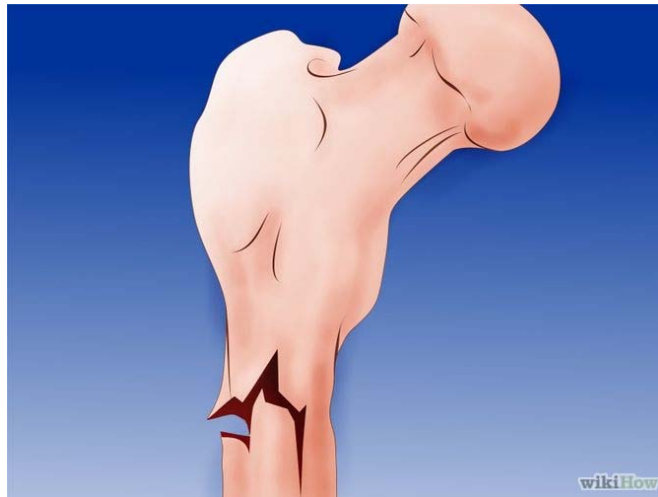


Image retrieved from <http://www.wikihow.com/Identify-a-Fracture>

Immediate Interventions for Fracture Care

Immediate care of a fracture usually consists of ice, elevation, application of a splint or immobilization devices, and application of a cast (ENA, 2014). Treatment might also include narcotics, non-narcotics, and NSAIDs (nonsteroidal anti-inflammatory medications).

Nursing diagnosis and fractures:

A variety of nursing diagnosis can be utilized for patients that have sustained a fracture. One example is to make a table with two columns, "Diagnosis" and "Outcome":

Diagnosis	Outcome
Acute Pain	The individual will verbalize decreased or absence of pain as evidenced by verbally stating relief of pain; or diminished or absent pain indicators such as restlessness, tachypnea, tachycardia, increased blood pressure, diaphoresis.

Diagnosis	Outcome
Ineffective tissue perfusion: peripheral	Strong palpable peripheral pulses, skin warm, dry, normal in color

RICE

If a patient will be discharged home it is important that the healthcare professional educates the patient and significant others about how to care for the injury.

General instructions include use of the **RICE** acronym (ENA, 2014):

- **Rest** the affected joint, no weight bearing, and avoid use. Perform range of motion four times a day as soon as recommended.
- **Ice.** The general rule is to apply ice for 20 minutes at a time, four times a day for the first 24 hours to promote vasoconstriction and reduce swelling.
- **Compression** with an elastic bandage is recommended to help reduce swelling and provide support. The elastic bandage should be rewrapped twice a day and removed at night.
- **Elevation** above the level of the heart the first 24 hours after an injury is recommended to reduce swelling.

The healthcare provider will determine the course of treatment and decide which interventions are appropriate and which are not.

Test Yourself

What does the "C" stand for in RICE?

The correct answer is COMPRESSION.

Risks & Complications of Orthopedic Injuries: Infection

One of the goals when managing the care of a patient with a fracture(s) is minimizing the risk of infection and tissue degradation that can occur secondary to the fracture. Individuals who have sustained multisystem injury are at great risk of infection not only because of contamination of the wound, but also because of diminished inflammatory responses from hypoperfusion and hematomas (CPM Resource Center, 2010a & b).

In addition, surgical wounds and devices may provide portals of entry for a variety of organisms (CPM Resource Center, 2010a & b). In some cases prophylactic use of antibiotics may be considered; however, no one antibiotic can eradicate all organisms.

Different pathogens tend to occur at different times during the trauma cycle. Early on in the first five days, infection from staph aureus, streptococci, Klebsiella, mycoplasma, proteus, chlamydia, E.coli, and other anaerobes may set in.

Early infections include community-acquired pneumonia, aspiration pneumonia, line-related infections, and wound infections.

Possible mid-cycle infections (stay of more than six days in the intensive care unit) that can occur may be caused from Vancomycin Resistant (VRE) or Vancomycin Sensitive Enterococci (VSE) as well as fungi, enterobacter, acinetobacter, Methicillin Resistant Staph Aureus (MRSA), pseudomonas, clostridium difficile and more. Infections related to these microbes include fungal infections, urinary tract infection, skin and wound infection, pneumonia, colitis, and more.

Late infections after intensive care can be a combination of infections. Severe traumatic injury can also produce an inflammatory response, which can lead to Systemic Inflammatory Response Syndrome (SIRS) (CPM Resource Center, 2010d).

Important note:

Patients who sustain multisystem trauma with orthopedic injuries are at a higher risk for infection

(CPM Resource Center, 2010a & b).

Risks & Complications of Orthopedic Injuries: Type of Fixation

Another factor that can influence managing fracture care is the type of fixation (internal versus external). The presence of a foreign body (appliance) is considered by some as a medium to increase bacterial growth, delayed union of the bones, interference with soft tissue healing and large open wounds (CPM Resource Center, 2010d).

Suggested guidelines on the care of patients with external fixation devices:

- Allow serous drainage to flow
- Avoid using a thick layer of antimicrobial ointment at the pin insertion site and do not use occlusive dressings
- Crust formation at the skin-pin junction site should be removed gently
- Notify the healthcare provider if any skin tension develops at the skin-pin insertion site
- Avoid local tissue trauma at the skin-pin insert site
- Use antiseptic solutions based on individualized needs
- Lubricate pin traction junctions and avoid stress and strain on the fixator

(Ohio State University Medical Center, 2008)

Risks & Complications of Orthopedic Injuries: Osteomyelitis

Infection involving bone and its marrow is called osteomyelitis and can be caused by:

- Trauma
- A surgical procedure
- Spread of another contagious infection
- Hematogenous infection spread from another site

Signs of posttraumatic osteomyelitis include any combination or complaint of:

- Heat
- Tenderness or pain
- Redness
- Draining sinuses over the site of the bone infection

Fever, elevated white blood cell count and rising sedimentation rates are not usually present. Surgical debridement, antibiotic therapy for a minimum of four weeks and removal of any hardware is the recommended method of treatment (Curtis & Ramsden, 2011).

Fracture infection, also known as post-traumatic osteomyelitis is an infection that results from diminished microcirculation, indwelling device, traumatic injury, or failure to debride or evacuate hematomas. Post-traumatic bone infections can occur weeks, months, or even years after the initial injury (CPM Resource Center, 2010a & d).

Nurses and other healthcare professionals can help to prevent infection by adhering to infection control guidelines and meticulous care, evaluation of the skin and fixation device, and good alignment. Complications related to immobility must be minimized and activities that promote skin perfusion and pulmonary function should be implemented (CPM Resource Center, 2010a & d).

Other Complications Associated with Orthopedic Injuries

In addition to infection, other life-threatening conditions related to orthopedic injuries include:

- **Blood loss from fractures:** Fractures can be the cause of mild to severe bleeding and can be life threatening. Non-visible bleeding may continue for 24 to 72 hours after an injury and might be concealed by soft tissue swelling (ENA, 2014; CPM Resource Center, 2010a & b). Suspect bleeding if your patient is hypovolemic, or prone to bleeding-related clotting problems.
- **Fat embolism:** Fat embolism is a major cause of morbidity and mortality in patients who have sustained musculoskeletal trauma. Patients who have pelvic and long bone fractures are at most risk (ENA, 2014; CPM Resource Center, 2010a & b).

Signs of fat embolism syndrome include:

- Fever
 - Altered level of consciousness
 - Petechiae over chest, axilla, conjunctiva (occurs in approximately 50% of cases)
 - Syncopal episodes
 - Hypotension
 - Tachypnea
 - Hemoptysis
 - Hematuria
- (ENA, 2007)

Other Complications Associated with Orthopedic Injuries

- **Compartment syndrome:** Compartment syndrome occurs when pressures inside compartments that encase blood vessels, nerves, and muscles begin to increase. This can result from external (casts, splints) or internal (bleeding for example) force (ENA, 2014).

As the pressure begins to increase the nerves and vascular structures become compressed and compromised. Areas susceptible to compartment syndrome include the foot, lower leg, hand, and lower arm. If prolonged compression occurs a fasciotomy may be required (ENA, 2014; CPM Resource Center, 2010a & b).

Assessment for Compartment Syndrome

- Includes assessment of neurovascular integrity of the area and/or limb involved. Recognition of deterioration can lead to immediate treatment of compartment syndrome.
- Includes the “**Six P’s**” for pain assessment (Mistovich et al., 2011). These include:
 1. **Pain:** Is there pain at the injured area? Is there pain with palpation or movement?
 2. **Pallor:** Is the color pale at the site of injury or distal to the injury? This can indicate circulatory compromise
 3. **Paresthesia:** Is there numbness and/or tingling at the affected area or with the affected limb? This can indicate neurological compromise
 4. **Pulses:** If a limb is injured, is the pulse to all extremities equal to palpation?
 5. **Paralysis:** Can the patient move the affected area or limb?
 6. **Pressure:** Is there a feeling of pressure at the affected area or limb?

Other Complications Associated with Orthopedic Injuries

- **Septic arthritis:** Septic arthritis is usually caused by bacteria penetrating the joint and can result in permanent disability. Bacteria can enter the joint via a direct injury such as a puncture wound, from nearby infected bone or from infected blood (ENA, 2014).
- **Contusions and Hematomas:** When a blood vessel ruptures in a closed wound and bleeds into the surrounding tissue a contusion occurs. A hematoma might form if enough blood collects in the surrounding area. Hematomas and contusions usually cause mild to moderate discomfort, however, certain populations at risk for more significant injury include individuals with clotting disorders or those taking anticoagulants (ENA, 2014).

Symptoms of contusions and hematomas include tenderness, swelling, and discoloration of the skin. Elevating the affected extremity, use of splints or other devices ordered by the healthcare provider, and applying ice or cold packs intermittently over the first two to three days can minimize bleeding. Pain medication may be required.

Dislocations

A dislocation is defined as a loss of anatomic position when the articular surfaces of bones that form a joint are no longer in contact with each other and lose their anatomic position (ENA, 2014).

Patients who sustain orthopedic injuries should be evaluated for fractures and potential dislocations. Dislocations are considered to be an emergency because of the potential injury to the surrounding nerves and blood vessels. Injury might occur due to stretching, compression, or ischemia (ENA, 2014).

If a fracture or dislocation of a limb is suspected the extremity should be splinted as soon as possible and neurovascular checks should be performed (ENA, 2014). Dislocations are described using terms of the distal to the proximal segments such as lateral, medial, posterior, or anterior.

Common dislocations include fingers and thumbs, shoulder, elbow, hip, patella, knee, and ankle (ENA, 2014). Patients who have sustained dislocations usually complain of severe pain and may experience neurovascular compromise that is evidenced by numbness, paralysis, paresthesia, and inability to move the affected joint. Initial treatments for dislocations include ice, compressive dressing, immobilization, and attempts to reduce the joint that is affected.

Physical Exam Findings of Dislocation

Patients with dislocations generally express significant discomfort and will likely have an obvious deformity of the affected joint. The patient might be unable to walk or have difficulty with movement. Upon examination the extremity may have an abnormal alignment or rotation with swelling and discoloration.

The area will be tender on palpation and there may be signs of circulatory compromise such as:

- Difficulty palpating local pulses due to swelling
- Delayed capillary refill (greater than two seconds)
- Cooler temperature of the extremity distal to the injury

Reduction is a technique used to re-align a joint and/or bones. Prior to reduction an X-ray of the

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affected joint should be obtained. Not all dislocations will be reduced and therefore many require the procedure to be performed under anesthesia in the operating room. After a joint has been reduced, a post-reduction X-ray is also recommended (ENA, 2014).

Please note:

Many organizations follow their procedural sedation policy and procedure when preparing to reduce a dislocation.

Principles of Splinting

Splints are usually used to immobilize dislocations, fractures, tendon injuries, or cellulitis of extremities to reduce swelling and pain.

Traumatic Amputation

It is important to remember to focus on life-threatening injuries rather than limb-threatening injuries (Mistovich et al., 2011). The body part that has been amputated may or may not be replantable and the outcome will depend on a number of factors. Timing is important (how long since injury and the onset of cooling). Another major consideration for replantation is whether or not the body part will be functional if it is reattached (ENA, 2014).

The mechanism of injury also dictates the success for replantation. A straight edge knife-like laceration has the greatest success. Crush and avulsion injuries with extensive soft tissue damage decrease the success of replantation (ENA, 2014). Concerns regarding amputation include amount and type of contamination and blood loss.

Care of the Patient with an Amputation

Care of the patient with an amputation includes controlling hemorrhage without causing any additional tissue damage (ENA, 2014; Mistovich, 2011). Direct pressure and a pressure dressing should be applied to the amputated area. Tourniquet and clamps should be avoided if possible.

In addition:

- Splint and slightly elevate the affected extremity
- If the distal part is partially attached avoid manipulation since injury may increase
- The patient should have nothing by mouth in preparation for possible surgery
- The skin around the stump should be cleaned with large amounts of normal saline to remove any debris or contaminants
- Prepare the patient for transfer to a replantation center (ENA, 2014)

Care of the amputated part includes wrapping in moistened normal saline or Ringer's lactate sterile gauze after cautiously removing any contaminants (never use water or other liquids). The part should be placed in a sealed bag and placed on ice without allowing the part to come in contact with the ice or freeze since tissue damage will occur (ENA, 2014).

Soft Tissue and Connective Tissue Injuries, Sprains and Strains

Soft tissue injuries can occur with or without a bone injury and include:

- Skin
- Nerves
- Tendons
- Muscles
- Ligaments
- Blood vessels

X-rays are often indicated to rule out skeletal injuries when a soft tissue injury has been sustained (ENA, 2014). Injuries can include sprains and strains.

Sudden force or excessive stretch to the structures around a joint can cause tears in muscle and tendons. A strain is the separation or tear of a musculotendinous area away from the bone. A sprain is the tear, stretching or separation of a supporting ligament. Strains and sprains are classified on the amount of damage that has occurred (ENA, 2014).

Soft Tissue and Connective Tissue Injuries, Sprains and Strains

There are three classifications of sprains and strains:

Mild:

This involves light overstretching of the fibers. There will be mild pain, minimal swelling, and minimal disruption of function.

Moderate:

This involves significant (up to 50%) tearing of the ligament, tendon, and/or muscle. The pain and swelling will be significant.

Severe

This involves a complete rupture of the tissue. This will result in immediate swelling and pain.

Treatment includes use of the RICE acronym (rest, ice, compression, elevation), and may or may not require splinting (CPM Resource Center, 2010a & b).

Drug Therapy

Complex drug therapy may be required for orthopedic patients, which can interfere with a patient's ability to resist infection.

Some commonly used drugs that may affect bone healing include medications with adverse skeletal effects.

Medication drug class	Adverse effect/mechanism on bone
Glucocorticoids	Decreased bone formation
Unfractionated heparin (used to prevent blood clot formation)	Decreased bone formation Increased resorption
Aromatase inhibitors (used in treating cancer, such as breast cancer)	Reduced estrogen production
Gonadotropin-releasing hormone agonists (used in treating cancer, such as breast cancer)	Hypogonadism
Medroxyprogesterone acetate (depot) (contraception injection)	Reduced estrogen levels
Thiazolidinediones (used in treating cancer)	Possible decreased bone formation
Excessive thyroid hormone replacement (used for hypothyroid)	Increased bone resorption
Proton pump inhibitors and antacids (used in treating GI disorders)	Possible decreased calcium absorption
Serotonin selective reuptake inhibitors (used in treating depression)	Inhibition of serotonin transporter
Antiepileptics (used in treating seizures)	Uncertain
Calcineurin inhibitors (used to suppress immune system)	Uncertain

(From Davidge Pitts & Kearns, 2011)

Conclusion

In this course, you learned:

The provision of care associated with orthopedic trauma shares an important goal, which is to restore and preserve function.

A focused assessment that embodies subjective and objective data will assist the healthcare professional to determine a patient's needs and deliver the most appropriate level of care.

Learning to collect data about factors associated with an orthopedic injury is an integral part of providing care for individuals who have sustained an orthopedic trauma.

Appendix One

Key Factors in Orthopedic Trauma

The most important goal in caring for a patient with orthopedic trauma is to **restore** and **preserve function**.

Assessment is vital. Immediate focus is on the ABC's (airway, breathing and circulation) and a primary assessment. The primary assessment includes focus on the affected areas, and may involve stabilization and treatment along with assessment. The secondary assessment includes use of diagnostic tests and imaging, and trauma and neurological scoring (ENA, 2014; CPM Resource Center 2010a & b). Determination of appropriate transfer should also be done.

Use the acronym "**PQRST**" for quick pain assessment:

P = Provoking factors (what brought on the pain?)

Q = Quality (describe the pain- i.e. stabbing, throbbing, burning)

R = Radiation (does the pain radiate anywhere?)

S = Severity/symptoms (how bad is the pain- rate it; are there other symptoms with the pain?)

T = Timing (is it constant? What makes it better/worse?)

Appendix Two

Key Factors in Orthopedic Trauma

Subjective assessment factors are those that are reported by the patient. Objective assessment data includes that which is observable and measurable (Jarvis, 2011). Assessment questions for consideration include the "**Six P's**" (Mistovich et al., 2011).

These include:

- **Pain:** Is there pain at the injured area? Is there pain with palpation or movement?
- **Pallor:** Is the color pale at the site of injury or distal to the injury? This can indicate circulatory compromise.
- **Paresthesia:** Is there numbness and/or tingling at the affected area or with the affected limb? This can indicate neurological compromise.
- **Pulses:** If a limb is injured, are the pulses to all extremities equal to palpation?
- **Paralysis:** Can the patient move the affected area or limb?
- **Pressure:** Is there a feeling of pressure at the affected area or limb?

In cases of orthopedic trauma, immediate fracture fixation and stabilization are primary goals. It is important to remember that fractures in children and the elderly have different considerations (Mistovich et al., 2011; CPM Resource Center, 2010a & b).

Appendix Three

Key Factors in Orthopedic Trauma

General instructions for care of orthopedic injuries include use of the **RICE** acronym (ENA, 2014):

- **Rest** the affected joint, no weight bearing, and avoid use. Perform range of motion four times a day as soon as recommended.
- **Ice**. The general rule is to apply ice for 20 minutes at a time, four times a day for the first 24 hours to promote vasoconstriction and reduce swelling.
- **Compression** with an elastic bandage to help reduce swelling and provide support. The elastic bandage should be rewrapped twice a day and removed at night.
- **Elevation** above the level of the heart the first 24 hours after an injury to reduce swelling.

Complications of orthopedic trauma include blood loss, potential for embolism, compartment syndrome, and infection.

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Glossary of Terms

Acetabulum: The cup-shaped cavity at the base of the hipbone into which the ball-shaped head of the femur fits

Amnesia: The loss or impairment of memory

Amputation: The intentional surgical removal of a limb or body part

Anaerobe: An organism that lives and grows in the absence of molecular oxygen

Antecubital fossa: A depression at the bend of the elbow

Anterior: Before or in front of; in anatomical nomenclature, refers to the ventral or abdominal side of the body

Arterial blood gases (ABGs): Analysis of arterial blood for O₂, CO₂, bicarbonate content, and pH, which reflects the functional effectiveness of lung function

Articulate: To unite by forming a joint or joints

Auscultation: Listening for sounds within the body

Avascular necrosis: The consequence of temporary or permanent cessation of blood flow to the bones. The absence of blood causes the bone tissue to die, resulting in fracture or collapse of the entire bone

Blood culture: A blood test to find and identify any microorganism present and growing in the blood

Calcaneus: The heel bone

Capillary refill: A test of blood circulation by blanching

Cardiovascular: Relating to both the heart and blood vessels

Compartment syndrome: A condition in which a muscle swells but is constricted by the connective tissue around it, which cuts off blood supply to the muscle

Complete blood count (CBC): A series of tests of the peripheral blood, including the hematocrit, the amount of hemoglobin, and counts of each type of formed element (red blood cells, white blood cells, etc.)

Concussion: An injury to a soft structure, especially the brain, produced by a violent blow and followed by a temporary or prolonged loss of function

Contusion: An injury of a part without a break in the skin; a bruise

Crepitus: A sound or feel that resembles the crackling noise heard when rubbing hair between the fingers or throwing salt on an open fire

Debride: Removing nonliving tissue

Decerebrate posture: The position in which the arms are extended and internally rotated and the legs are extended with the feet in forced plantar flexion

Decorticate posture: The position in which the upper extremities are rigidly flexed at the elbows and at the wrists. The legs also may be flexed

Degenerative: Pertaining to or involving degeneration or change to a lower or dysfunctional form

Devitalization: To diminish or destroy the strength or vitality of

Dislocation: Displacement of a part

Distal: Farthest from the center, from a medial line, or from the trunk; opposed to proximal

Dorsalis pedis: Dorsal artery of the foot

Embolism: An obstruction in a blood vessel due to a blood clot or other foreign matter that gets stuck while traveling through the bloodstream

Erythrocyte sedimentation rate (ESR): A measure of the settling of red blood cells in a tube of blood during one hour. The rate is an indication of inflammation and increases in many diseases

External rotation: Turning outwardly or away from the midline of the body

Femoral: Pertaining to the femur or to the thigh

Fixation: The process of holding, suturing, or fastening in a fixed position

Flexion: The act of bending a joint or limb in the body by the action of flexors

Fracture: The breaking of a part, especially a bone

Hematoma: A localized collection of extravasated blood, usually clotted, in an organ, space, or tissue

Hemorrhage: The escape of blood from the vessels; bleeding

Humeral: Pertaining to the humerus or the shoulder

Immobilization: The process of holding a joint or bone in place with a splint, cast, or brace

Inspection: Visual examination

Internal rotation: The turning of a limb about its axis of rotation toward the midline of the body

Ischemia: An insufficient supply of blood to an organ

Laceration: Separation of skin or other tissue by a tremendous force, producing irregular edges; a

tear

Lateral: Pertaining to the side

Ligament: A band of tough, fibrous dense regular connective tissue comprising attenuated collagenous fibers. Ligaments connect bones to other bones to form a joint

Medial: Pertaining to, situated in, or oriented toward the midline of the body

Meniscus: A disk of cartilage that serves as a cushion between the ends of bones that meet at a joint

Metastatic: The term used to describe a secondary cancer, or one that has spread from one area of the body to another

Microcirculation: The flow of blood through the fine vessels (arterioles, capillaries, and venules)

Musculoskeletal: Pertaining to or comprising the skeleton and muscles

Neurovascular: Relating to both nerves and blood vessels

Osteomyelitis: A bone infection, almost always caused by bacteria

Osteoporosis: Means "porous bones." It occurs when bones lose an excessive amount of their protein and mineral content, particularly calcium

Palpate: To examine by feeling and pressing with the palms of the hands and the fingers

Paralysis: A complete loss of strength in an affected limb or muscle group

Paresthesia: An abnormal or unpleasant sensation that results from injury to one or more nerves, often described by patients as numbness or as a prickly, stinging, or burning feeling

Pathogen: A disease-producing agent or microorganism

Pathologic fractures: Fracture due to weakening of the bone structure by pathologic processes, such as neoplasia, osteomalacia, or osteomyelitis

Pelvis: The lower (caudal) portion of the trunk, bounded anteriorly and laterally by the two hipbones and posteriorly by the sacrum and coccyx

Peripheral: Located at, or pertaining to, the periphery; occurring away from the center

Pneumothorax: A collection of air or gas in the chest or pleural space that causes part or all of a lung to collapse

Post tibial: Artery located behind the tibia of the leg

Posterior: Pertaining to or located at or toward the back

Premature ventricular contraction: An extra beat involving the ventricles of the heart

Proximal: Nearest the point of attachment, center of the body, or point of reference; the opposite of distal

Radioulnar: Pertaining to the radius and ulna

Sacrum: The triangular bone just below the lumbar vertebrae

Sinus tachycardia: A rapid heartbeat generated by discharge of the sinus node

Spastic: Hypertonic, so that the muscles are stiff and movements awkward

Sprain: An injury to a ligament that is caused by being stretched beyond their normal capacity and possibly torn

Stabilization: The process of making firm and steady

Sternoclavicular: Pertaining to the sternum and clavicle

Strain: An injury to a muscle or tendon in which the muscle fibers tear as a result of overstretching

Stress fracture: A fracture caused by unusual or repeated stress on a bone

Syncope: Transient (and usually sudden) loss of consciousness, accompanied by an inability to maintain an upright posture

Talus: The anklebone

Tendon: A tough band of fibrous connective tissue that usually connects muscle to bone and is capable of withstanding tension

Union: The renewal of continuity in a broken bone or between the edges of a wound

Urinalysis: A diagnostic physical, chemical, and microscopic examination of a urine sample

Vertebrae: Bones in the cervical, thoracic, and lumbar regions of the body that make up the vertebral column