# Fractures and Complications

***2025***

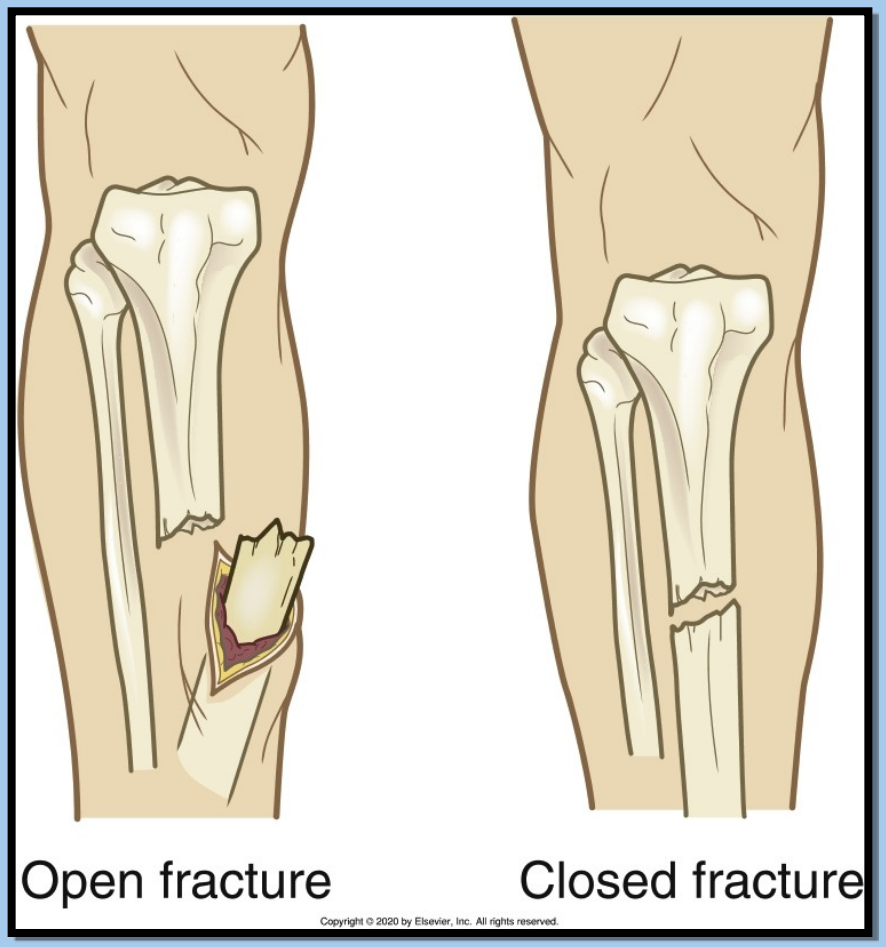
# Fracture Definition

- Disruption or break in continuity of structure of bone
- Majority of fractures from traumatic injuries
- Some fractures secondary to disease process (pathologic)
  - Cancer or osteoporosis

# Classification (1 of 4)

- Communication with environment
  - Open—skin broken, bone exposed
    - Usually from severe external forces
  - Closed—skin intact
- Extent of break
  - Complete—completely through bone
  - Incomplete—partly across bone shaft

# Fracture Classification According to External Environment



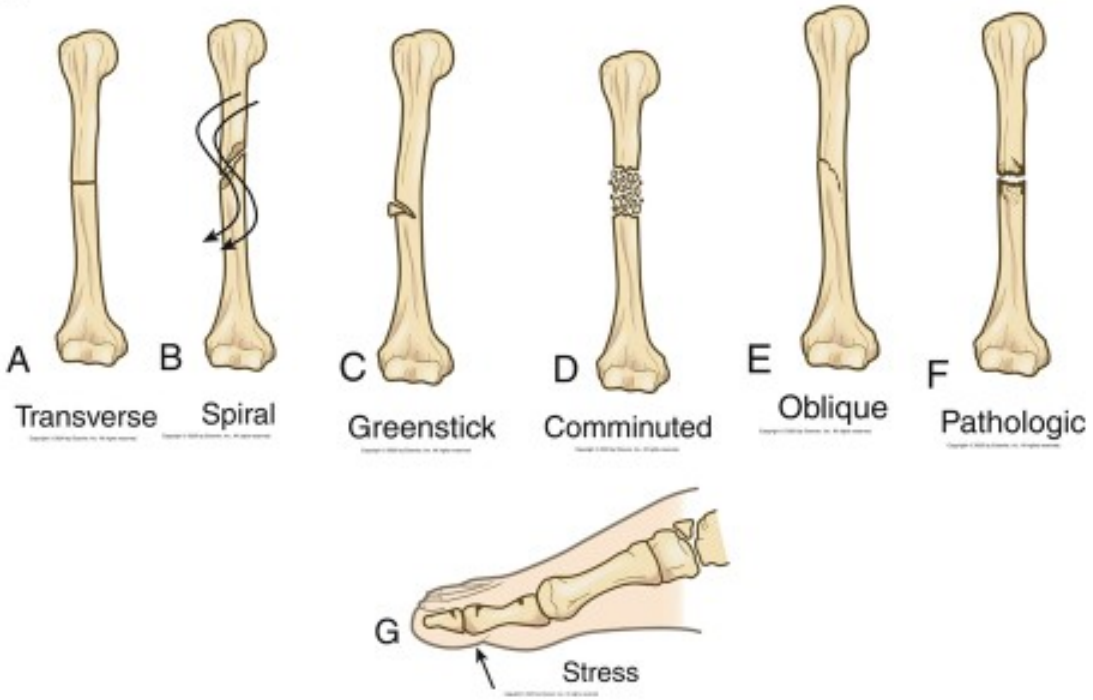
# Classification (2 of 4)

- Based on direction of fracture line:
  - Linear
  - Oblique
  - Transverse
  - Longitudinal
  - Spiral

# Classification (3 of 4) -Types of Fractures

## Classification (3 of 4)

- Types of Fractures



# Classification (4 of 4)

- Displaced or nondisplaced:
  - *Displaced*: two ends separated from one another
    - Often comminuted or oblique
  - *Nondisplaced*: periosteum is intact and bone is aligned
    - Usually transverse, spiral, or greenstick

# Clinical Manifestations

- **S/S of fractures vary according to:**
  - The location
  - The bone involved
  - The type of fx
  - The amount of related soft tissue damage

# Clinical Manifestations

- Signs & Symptoms Include:
  - Pain/tenderness
  - Edema
  - Muscle Spasms
  - Loss of Normal Function
  - Obvious Deformity
  - Excessive Motion at Site
  - Crepitus
  - Guarding
  - Warmth Over the Injured Area
  - Ecchymosis of Skin
  - Loss of Sensation

# Bone Healing Stages

1. Hematoma Formation
   - Hematoma surrounds the ends of the fragments
   - Begins within 24 hours
2. Cellular Proliferation Stage
   - Fibrin meshwork formation – phagocytosis of necrotic tissue
   - Hematomas changes to granulation tissue
   - New bone formed
   - Invasion of osteoblasts

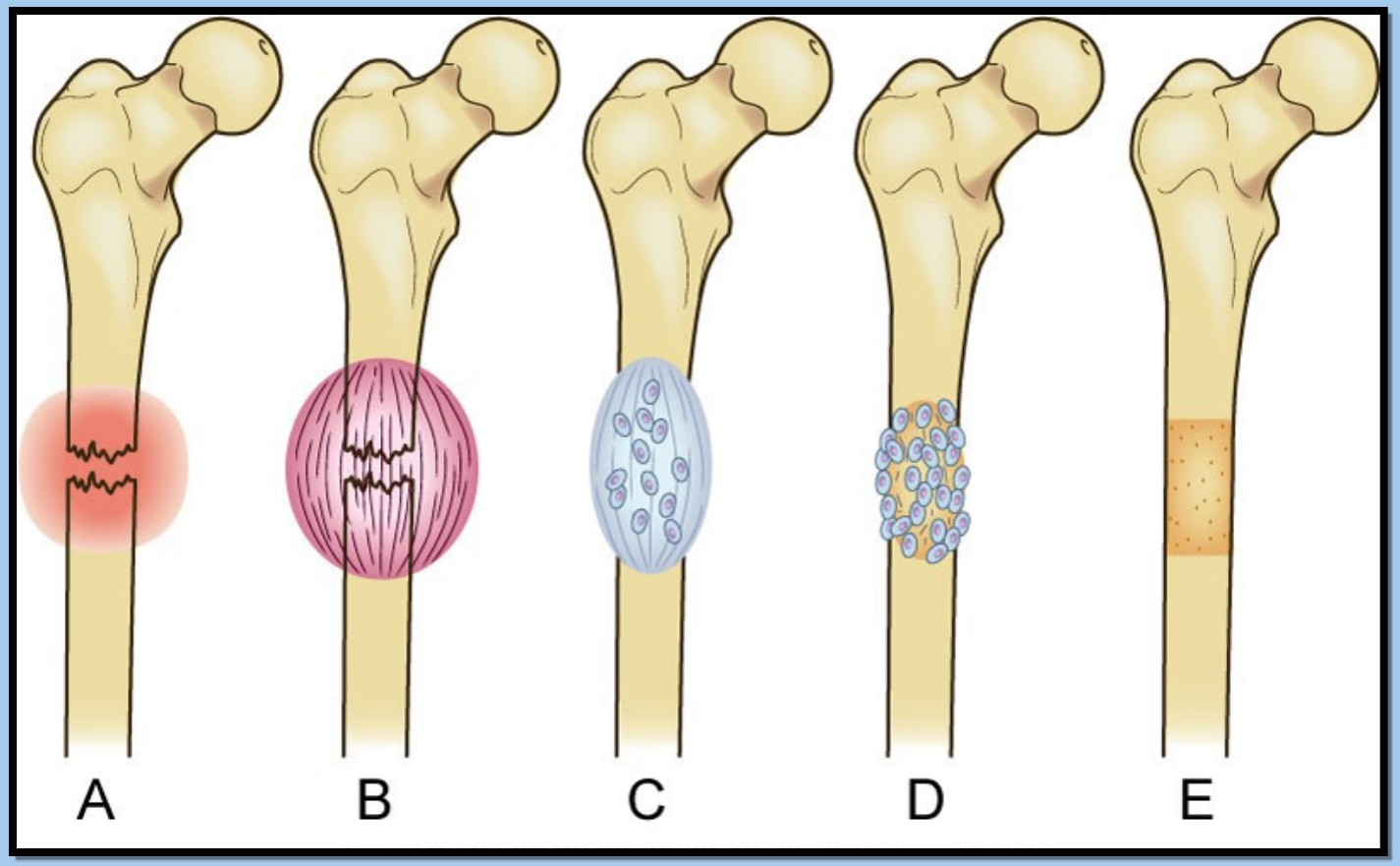
# Bone Healing Stages

3. Callus Formation
   - Osteoclasts destroy old bone & new bone formed by osteoblasts
   - Collagen strengthens
   - Occurs 6-10 days after the injury
4. Ossification
   - Formation of new bone ≈ 3-10 weeks

# Bone Healing Stages

5. Consolidation
   - ↓ distance between bone fragments until closed
6. Remodeling
   - Excess cells reabsorbed & union complete

# Stages of Bone Healing



# Bone Healing

- **Factors That Enhance Bone Healing:**
  - Immobilization of fracture fragments
  - Maximum bone fragment contact
  - Sufficient blood supply
  - Proper nutrition
  - Exercise – weight-bearing for long bones
  - Electric stimulation across fracture

# Bone Healing

- **Factors That Inhibit Bone Healing:**
  - Excessive local trauma (edema)
  - Bone loss (OP)
  - Inadequate immobilization
  - Space between bone fragments
  - Infection
  - Tobacco use
  - Poor nutrition
  - Age
  - Corticosteroids
  - Denervation

# Healing Time of Fractures

- Flat bone fractures (pelvis, scapula) heal rapidly.
- Epiphysis (cancellous bone) fractures heal more quickly than diaphysis (compact) fractures.
  - Femoral shaft fracture: 18 weeks
  - Pelvic fracture: 6 weeks
  - Proximal humerus fracture: 3-6 weeks
  - Scapula: 10 weeks

# Interprofessional Care

- **Overall Goals of Treatment**
  - Anatomic realignment of bone fragments (reduction)
    - "Setting the bones"
  - Immobilization to maintain alignment (reduction) until healing occurs
  - Restoration of normal function or near-normal function

# Collaborative Care

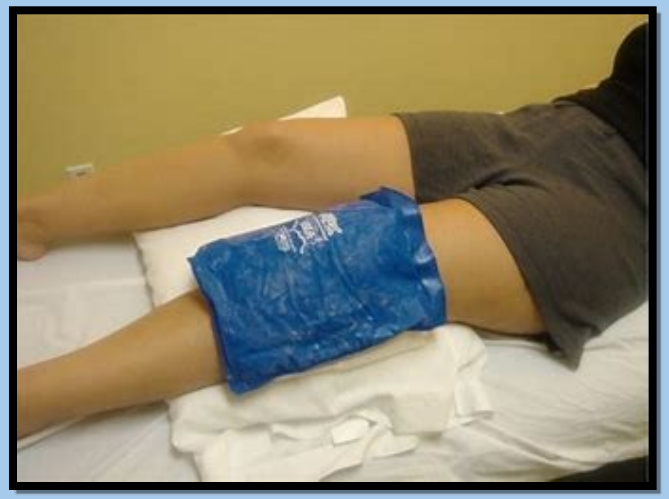
- **Drug Therapy**
  - Muscle relaxant
  - Bone penetrating ABX
    - Cephalosporins
  - Tetanus and diphtheria toxoid
    - Given for open fracture when immunization is unknown

# Nutrition Therapy

- Optimal soft tissue and bone healing
  - Increase protein (1 g/kg of body weight)
  - Increase vitamins (B, C, D)
  - Increase calcium, phosphorus , and magnesium
  - Increase fluid (2000 to 3000 mL/day)
  - Increase fiber
    - Body jacket and hip spica cast patients: six small meals a day

# Immediate Fracture Management

- Immobilize the area by splinting
- Elevate the body part
- Apply cold packs or ice
- Assess for Δ in neurovascular status
- Assess for signs of shock
- Administer analgesics



# Fracture Reduction

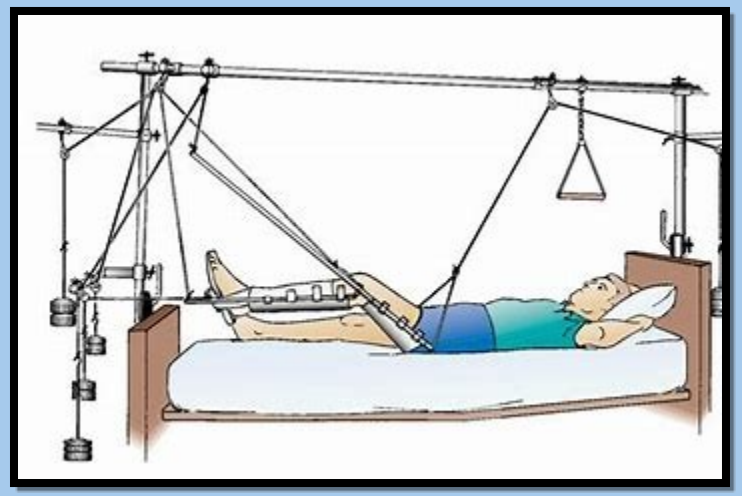
- **Closed Reduction**
  - Non-surgical, manual realignment
    - *Manual manipulation of the bones to their correct position*
  - Can do under local anesthetic, conscious sedation, or general anesthesia
  - No incision!
  - Usually traction → reduction → cast

# Fracture Reduction

- **Open Reduction**
  - *Correction of bone alignment through a surgical incision*
  - May use internal fixation
    - Wires, screws, pins, plates, rods, or nails
  - Risk for infection
  - Early mobilization
- **ORIF:**
  - **O**pen **R**eduction, **I**nternal **F**ixation

# Fracture Reduction

- **Traction**
  - Skin traction → short term
  - Skeletal traction → longer time period



# Fracture Immobilization

# Fracture Immobilization

- **Casts**
  - Temporary circumferential immobilization device
  - Allows patient to perform many normal ADLs while maintaining immobilization
  - Incorporates joints above and below fracture for stabilization during healing
  - Common treatment following closed reduction

# Casts

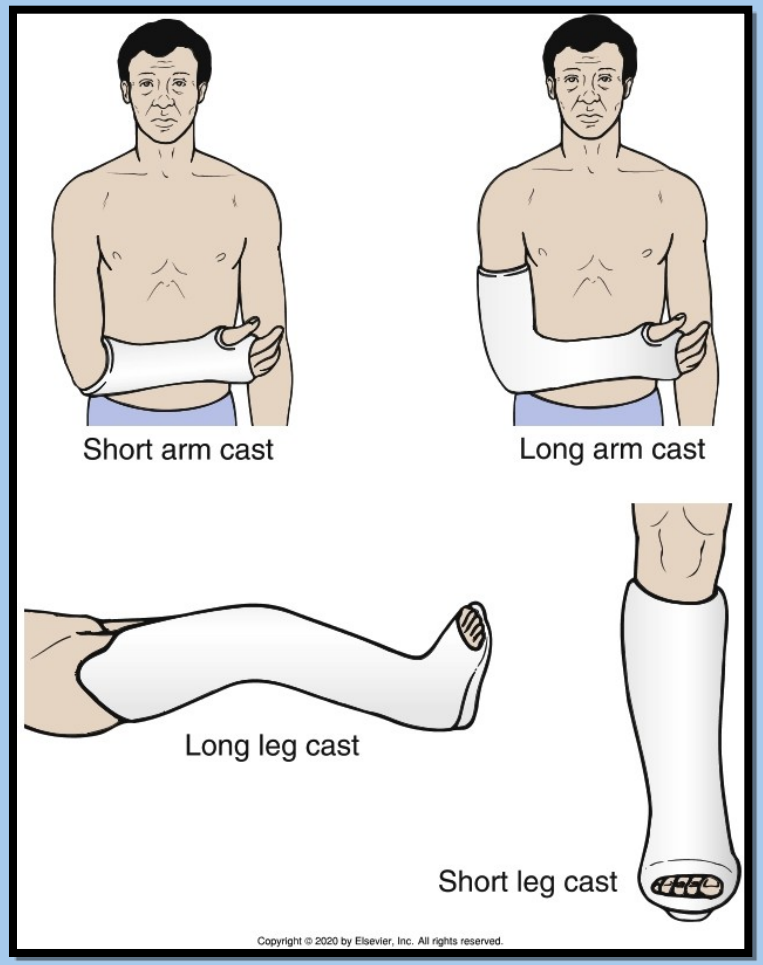
- **Types:**
  - Short / long arm casts
  - Short / long leg casts
  - Body jacket cast
  - Walking Cast
  - Hip spica cast

- **Two most common materials:**
- Plaster of Paris
- Fiberglass

# Synthetic Casting Materials

- Lightweight, stronger, more waterproof
- Early weight bearing
- Activated by submersion in cool or tepid water, then molded to fit body part

# Common Types of Casts



# Fracture Immobilization

- **Casts**
  - Cast Application
    - Clean skin & assess for lacerations or lesions – dry completely
    - Wrap area with cotton padding or stockinette
    - Plaster rolls submersed in warm water until no bubbling occurs
    - Plaster or fiberglass applied
    - After application, place on pillow & reposition q 2-3°
    - Allow to air dry

# Fracture Immobilization

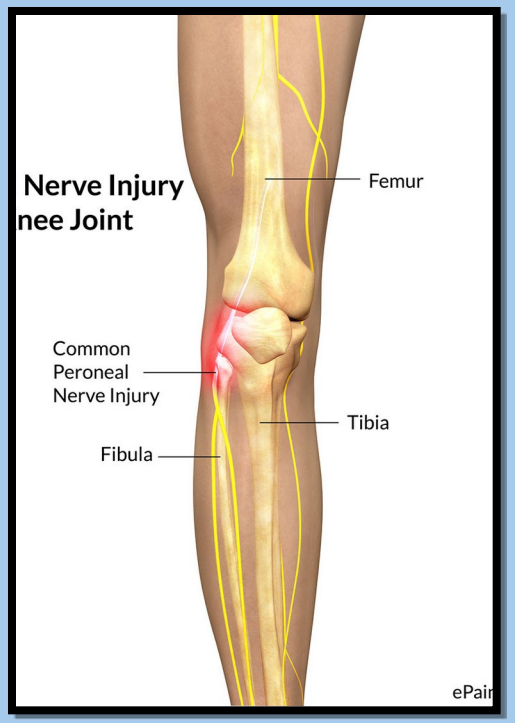
- **Casts**
  - Cast Application Cont'd…
    - Handle a damp cast with palms of hands, do not touch with fingertips!
    - Once cast is dry, finish the edges to prevent skin irritation
      - Trim and smooth edges

# Fracture Immobilization

- **Casts**
  - Cast Care:
  - Skin care – maintain good skin integrity – prevent breakdown!
    - Inspect skin at edges of cast & underlying the cast for redness or irritation
    - Don’t use powders
    - No lotions
    - No scratching in the cast

# Fracture Immobilization

- **Casts**
  - Risk for Neurovascular Compromise
    - Need a baseline – do bilateral assessment before cast application
    - Be aware of nerves and vessels in the casted area (peroneal, ulnar)
    - Teach S/S of Compartment Syndrome



# Fracture Immobilization

- **Casts**
  - Drainage on the Cast:
    - May have with an open wound or surgery prior to cast application
    - Wet plaster – drainage is absorbed & spreads rapidly
      - Amount you see is not equal to amount draining
    - 24-72° after trauma - ↑ risk for drainage
    - Concerned if bright red drainage on cast

# Fracture Immobilization

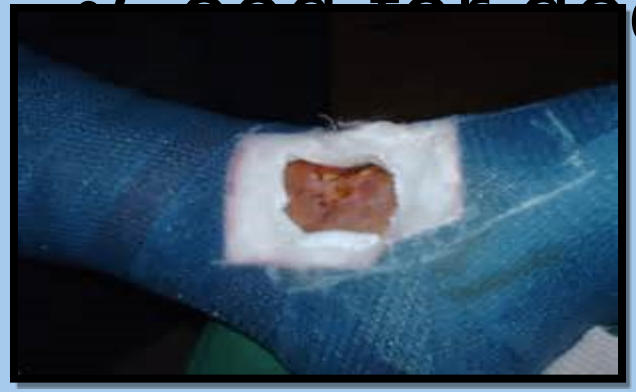
- **Casts**
  - Edema of the extremity:
    - raise leg, raise foot of bed
  - Pressure areas under cast
    - ↑ pain
    - Infection under the cast – ✓ for odor, temp, pain, burning, drainage

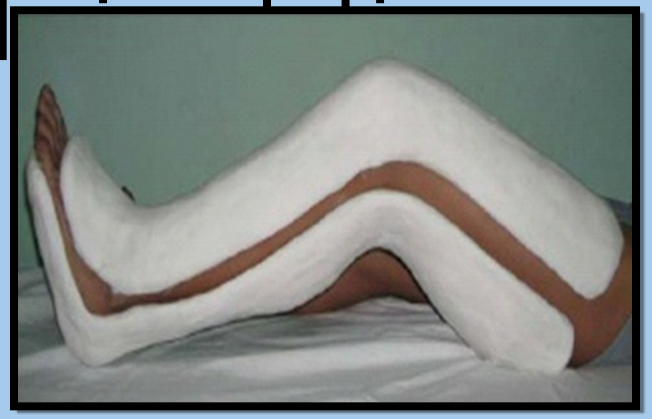
# Fracture Immobilization

- **Casts**
  - Maintain a clean, dry cast
  - Mobility
    - Full ROM of all other joints
    - Isometric or muscle setting exercises
      - No joint movement, tighten muscle & relax
      - Prevent venous stasis & atrophy
      - Weight bear with MD order

# Fracture Immobilization

- **Casts**
  - Windowing = cut in dry cast to inspect the skin, wound, or remove drains
  - Bivalving = splint along both sides
  - Good for decreased

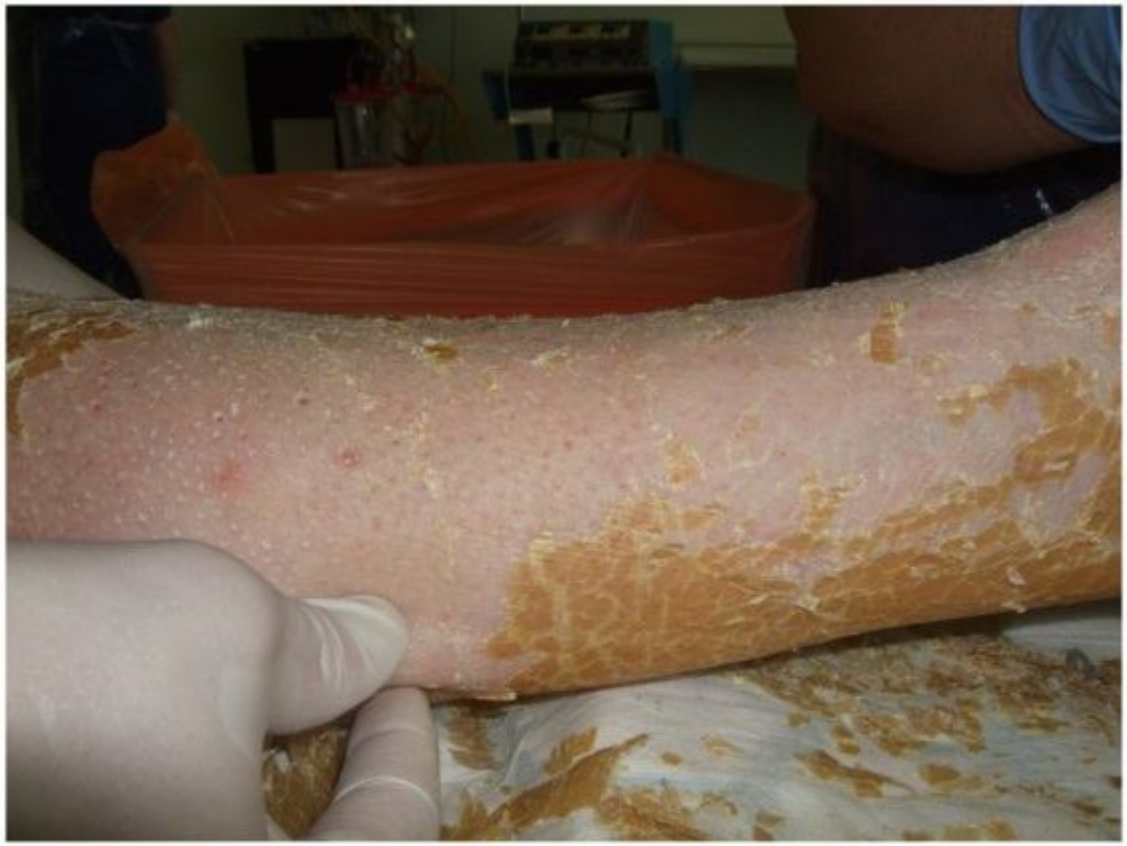




# Fracture Immobilization

- **Casts**
  - Cast removal:  electric cast saw
    - Not painful
    - Very noisy, can be frightening
    - Skin is often sensitive – covered with yellow/brown scales or crusts of dead skin
    - Muscle may be flabby/weak
    - Altered balance after the extra weight from the cast is removed
      - Gently soak & wash the skin
      - Pat dry
      - Mineral oil to remove dried skin

Medscape



Source: J Med Case Reports © 1999-2011 BioMed Central Ltd

# Fracture Immobilization

- **Sling**
  - To support and elevate arm
  - Contraindicated with proximal humerus fracture
  - Ensure axillary area is well padded
  - No undue pressure on neck
  - Encourage movement of fingers and non-immobilized joints

# Fracture Immobilization

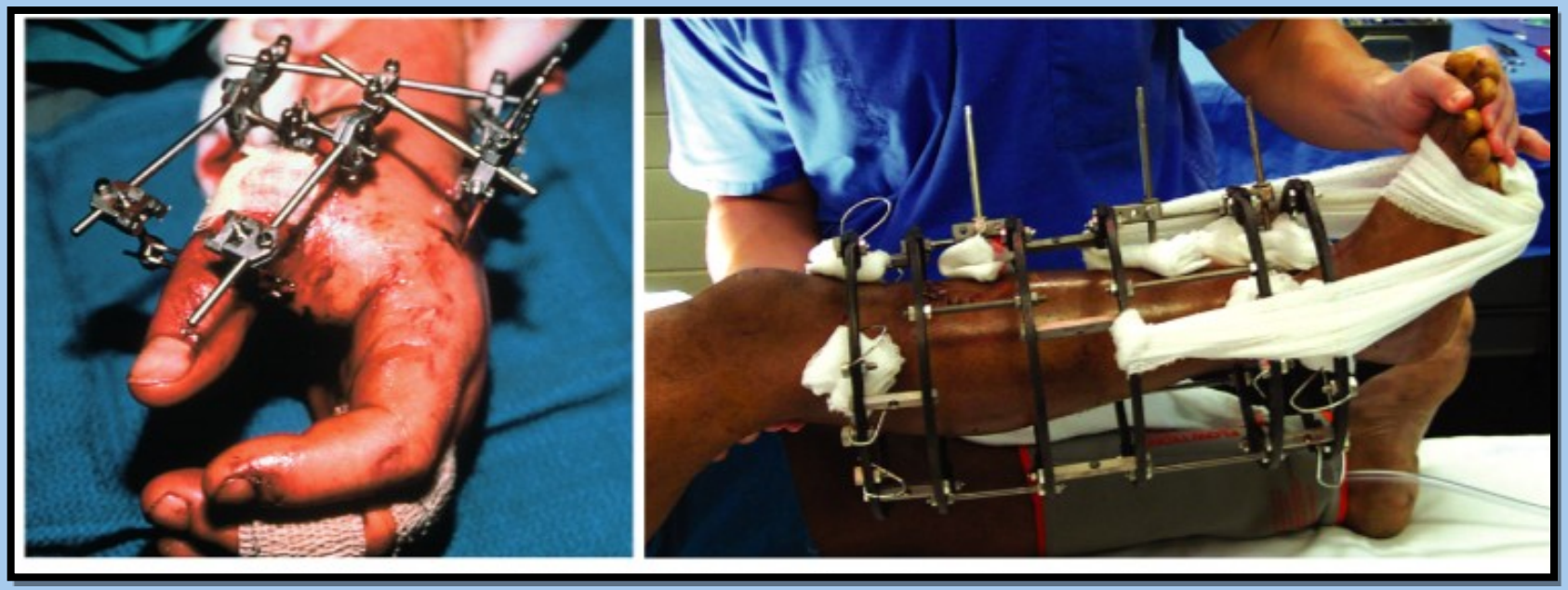
- **Knee Immobilizer**
  - Easy to apply and remove
    - Permits close observation of the affected joint for signs of swelling and skin breakdown.
  - Depending on the injury, removal of the splint or immobilizer
    - Facilitates ROM of the affected joint
    - Faster return to function.


(From Maher AB, Salmond SW, Pellino T, editors: *Orthopedic nursing*, ed 3, Philadelphia, 2002, Saunders.)

# Fracture Immobilization

- **External Fixation**
  - Pins and wires that are inserted into the bone & attached to external rods
    - Used to compress fx fragments & immobilize reduced fx's when a cast and traction are not appropriate
    - Hold fragments in place
    - Used to treat complex fx's with associated soft tissue trauma
    - Applied to save extremity that may gave required amputation

# External fixation for a wrist and a tibia-fibula fracture



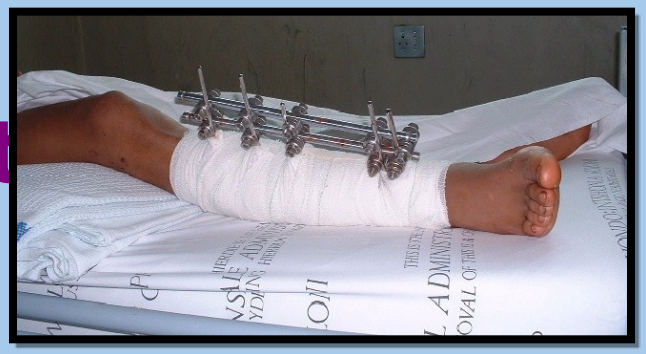
# Halo Vest

- Ted Beneke – “Breaking Bad”

# Fracture Immobilization

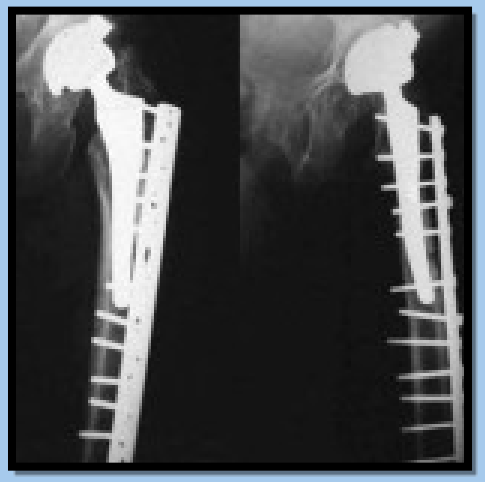
- **External Fixation**
  - Assess for S/S infection & pin loosening
    - Sterile drgs may be placed over entry & exit sites of pins or may be left uncovered to observe
  - Pin Site Care
    - Attached directly to the bones
    - Depends on MD preference
    - Keep skin areas around pin sites clean & dry
    - Directly remove the exudate with water, rinse with sterile NS, dry with sterile gauze, may use antibiotic ointment

# Fracture Immobilizat



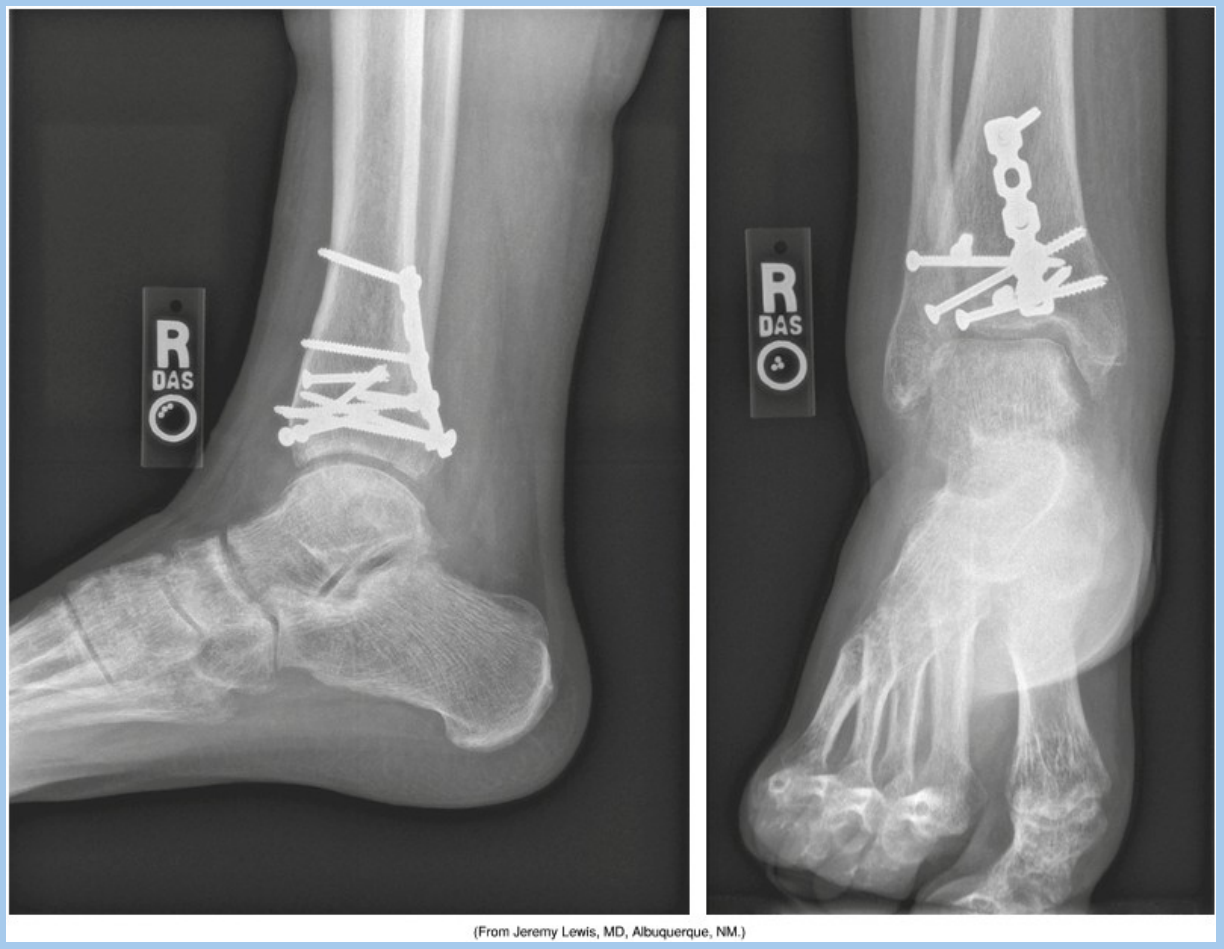
- **External Fixation**
  - Pt with an external fixator on the lower leg can be OOB in a wheelchair or even ambulate without wt. Bearing on the affected limb
  - Nursing care is the same as pt in cast or skeletal traction, except that these pts are mobile earlier

# Fracture Immobilization



- **Internal Fixation**
  - Pins, plates, intramedullary rods, & screws
  - Surgically inserted at the time of realignment
  - X-ray eval of alignment and healing

# Views of Internal Fixation Devices




(From Jeremy Lewis, MD, Albuquerque, NM.)

# Fracture Immobilization

- **Traction**
  - Application of a pulling force to an injured part of the body to align, immobilize, or reduce muscle spasms associated with musculoskeletal injuries and disorders.
  - While counter-traction pulls in the opposite direction
  - **<u>Purpose/goals of Traction:</u>**
    - Prevent or reduce muscle spasms & pain
    - Immobilization/realign bone fragments
    - Reduce a fracture or dislocation (Skeletal Traction)
    - Treat a pathologic condition or correct deformities

# Fracture Immobilization

- **Traction**

  Terms to Know:

  - Counter traction
    - Force that counteracts the pull of traction
    - Pulls in the opposite direction
    - Prevents the pt from sliding OOB
      - Ie; usually the pt's own body wt or bed position
  - Suspension
    - Use of traction equipment to suspend a body part

# Fracture Immobilization

- **Traction**

  Terms to Know:

  - Balanced Suspension
    - Weights used to suspend the part correctly & continuously
    - Often used with traction to allow pt to move in bed

# Fracture Immobilization

- **Traction**

  Three Types of Traction:

  1. Manual = hands are used to exert a pulling force on the bone that is to be realigned
     - Used for stable fx's or dislocations prior to splinting or casting or tx application

# Fracture Immobilization

- **Traction**
  2. Skin Traction = strips of tape or special traction strips are applied directly to the skin
     - Pull of the weights is transmitted indirectly to the involved bone
     - Used for fx's which require only a moderate amount of pulling force for a relatively short period of time (48-72 hrs)
     - Need careful skin assessment!

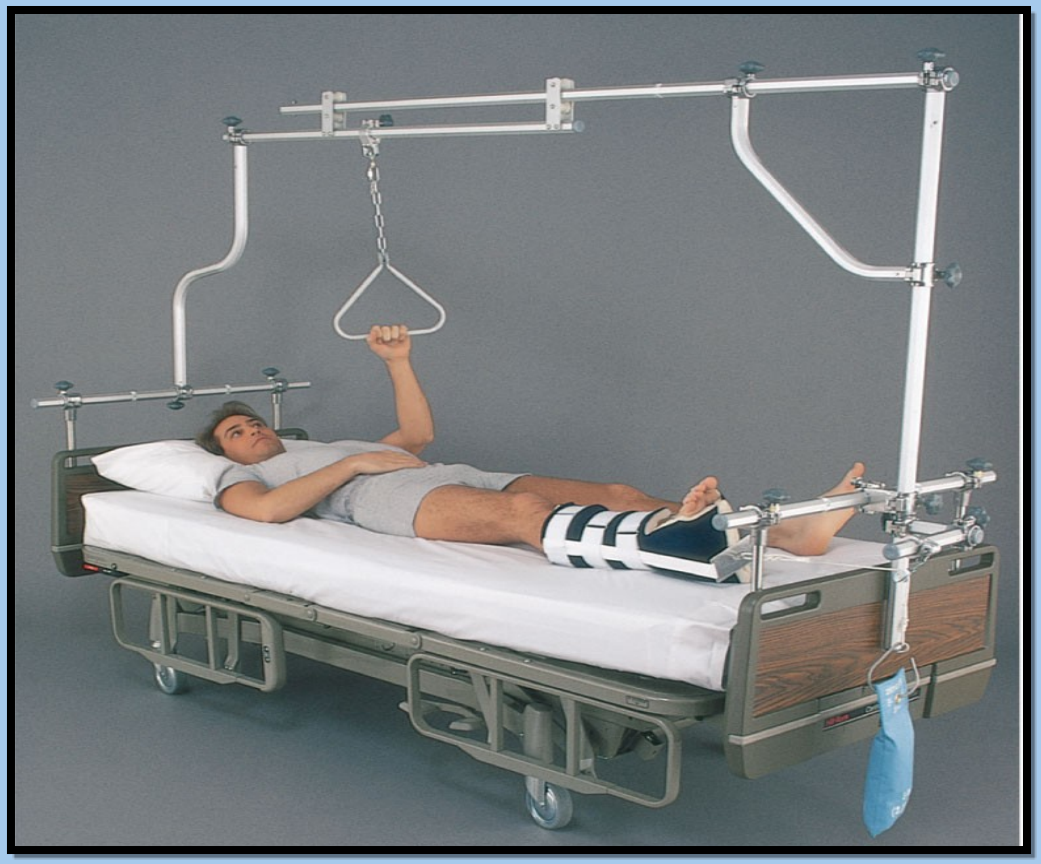
# Fracture Immobilization

- **Traction**
  - *Types of Skin Traction:*
    - Buck's & Hare Traction
    - Russell's traction
    - Cervical traction
    - Pelvic traction

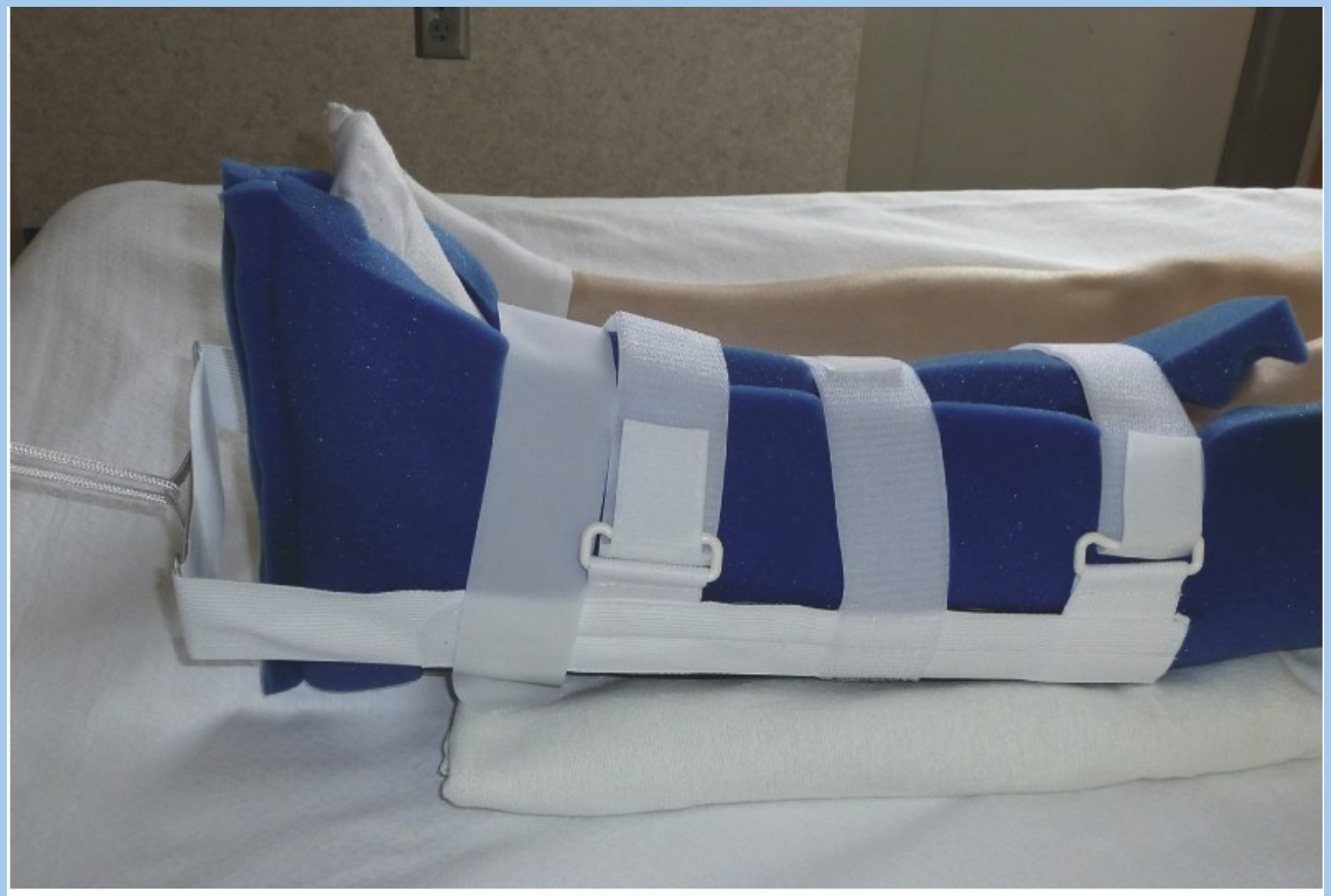
# Fracture Immobilization

- **Skin Traction**
  - 1. Buck's = simplest form of skin traction
    - Straight pull on the affected extremity
    - Used to relieve muscle spasms & immobilize a limb temporarily
      - fx hips, or femur fx's prior to OR
    - Buck's boot used mostly
    - Counter-traction maintained by keeping HOB flat
    - Perform active ROM on extremity not in traction

# Buck's traction with a hook-and-loop fastener (Velcro) boot



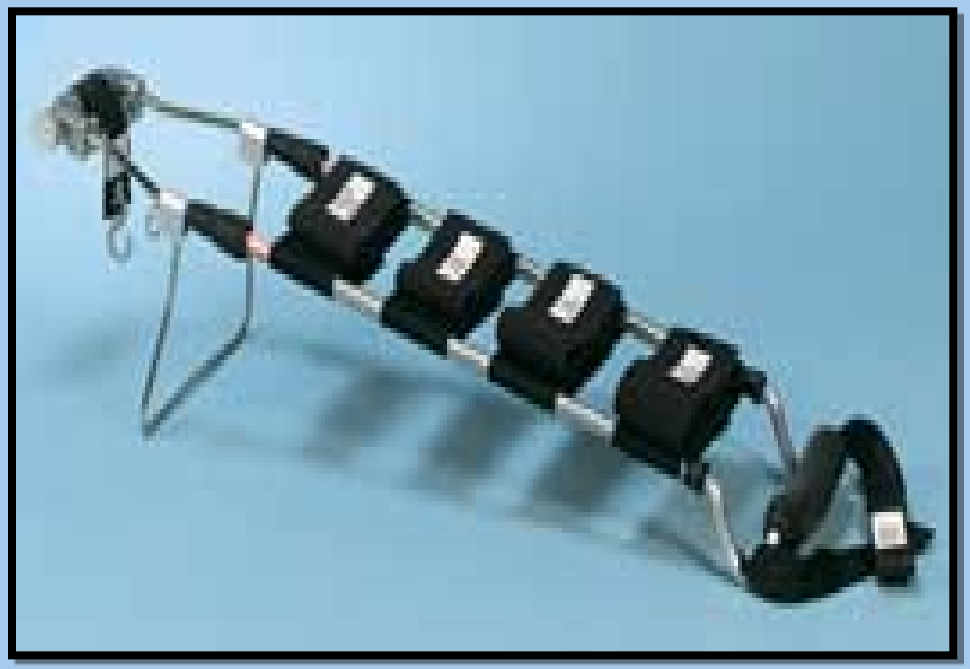
# Buck’s Traction Boot



(Courtesy Mary Wollan, RN, BAN, ONC, Spring Park, MN.)

# Skin Traction

- **2. Hare Traction** → fractured femur

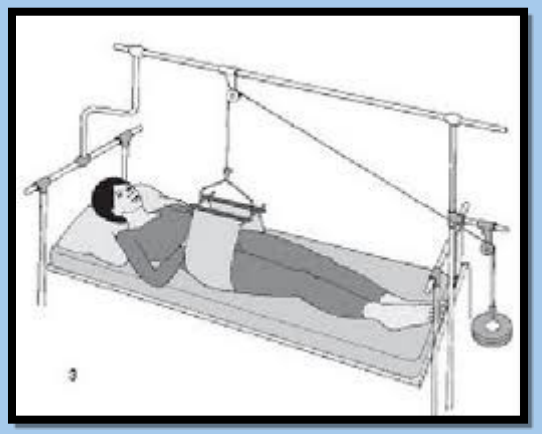


# Fracture Immobilization


- **Skin Traction**
  - 3. Cervical = head holter used to apply tx to cervical spine
    - Used for relief of neck pain, whiplash, dislocations, and minor cervical fx's
    - Assess skin on chin & under holter

# Fracture Immobilization

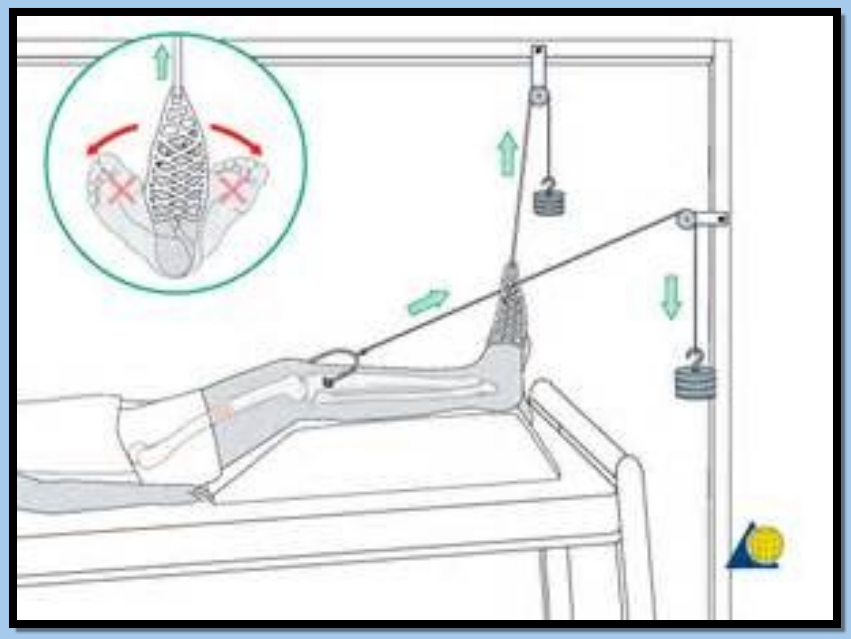
- **Skin Traction**
  - 4. Pelvic = disposable belt with straps that attach to cords & weights to exert pull on the lower back
    - Used for pain relief from muscle spasms and minor fx's of the lower spine

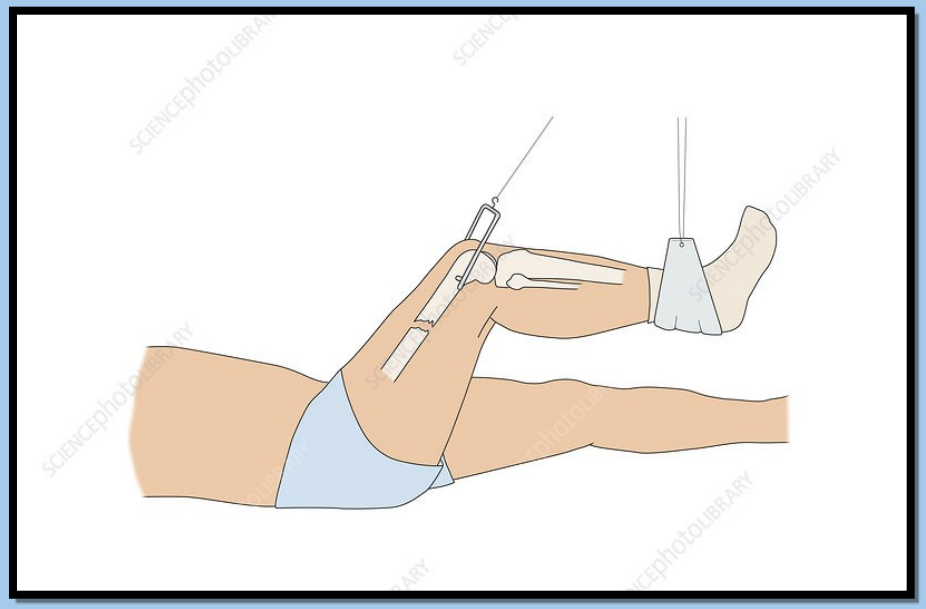


# Fracture Immobilization

- **Traction**
  3. Skeletal Traction = traction force is applied directly to the bone using pins, wires, or screws
     - Use tongs for cervical tx, applied directly to the skull
     - Used for fx's requiring ↑ pulling force, over extended periods of time
     - Used for fx's of the tibia, femur, humerus, cervical spine, & unstable fx's
     - You do not remove the weights!

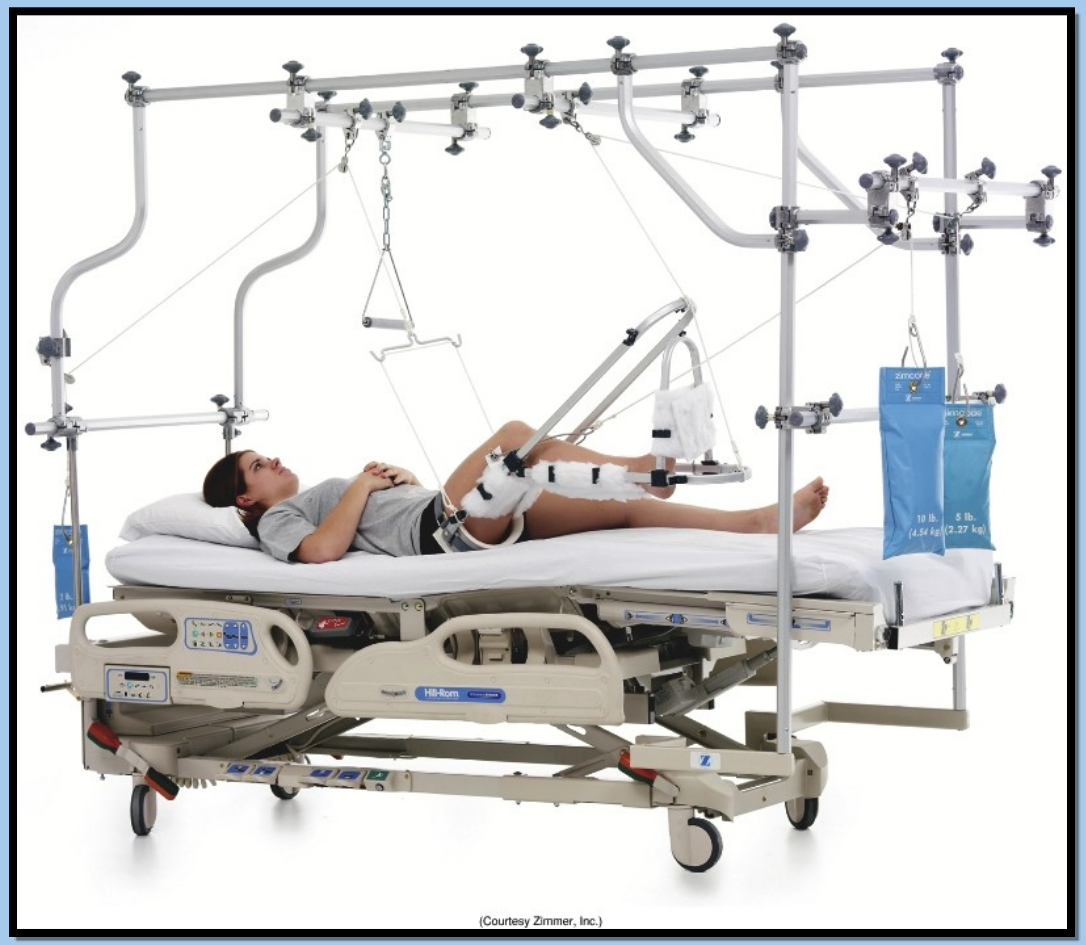
# Skeletal Traction





- Must maintain adequate countertraction with skeletal traction.
- Countertraction is provided by the patient’s body weight or by raising/lowering parts of the bed

# Balanced Suspension Skeletal Traction



# Fracture Immobilization

- **Traction**
  - *General Principles of Traction: **
    - Do not re-use the traction cord
    - Assess area –skin traction can not be applied over a wound
    - Avoid pressure over bony prominences
    - Keep weights *hanging free*
    - Don’t add/remove weight without MD order
    - Don’t allow weights to hang over a patient or on the bed
    - Make sure ropes are in the pulleys & knots are free from pulleys!!!
    - Keep bed linens from interfering with traction

# Fracture Immobilization

- **Traction**
  - Nursing Care
    - Assessment: skin, N/V, pain, activity, nutrition, elimination
    - Planning: set goals with pt
      - NV Compromise
      - Anxiety
      - Pain
      - Impaired Physical Mobility
      - Immobility Complications
      - Knowledge Deficit
      - Self-Care Deficit

# Fracture Immobilization: Traction

- Nursing Care
  - Implementation:
    - Position
    - Make sure counter-traction is in place
    - Avoid friction
    - Make sure traction is continuous
    - Maintain correct line of pull
    - Prevent venous stasis
    - Maintain neuro-vascular status
    - Skin care!
    - Isometric & isotonic exercises
    - Promote ADL’s

# Secondary Management for Compound Fractures

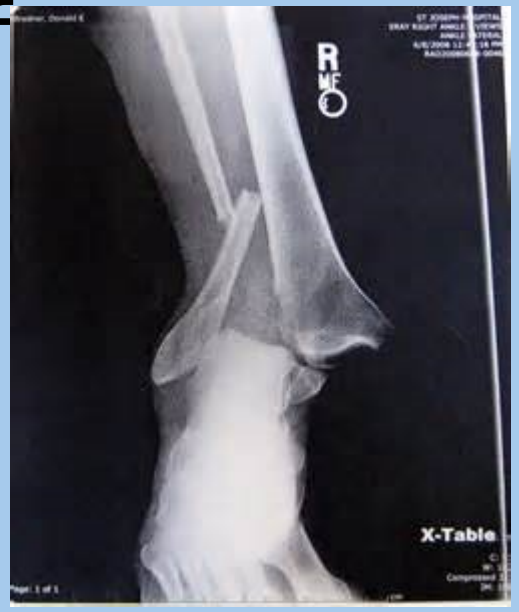
- Surgical Debridement
- Tetanus toxoid
- Wound culture
- Wound packing

# Secondary Management for Compound Fractures

- IV antibiotics
- Assess for S/S of infection
- Reduction of a fracture
- Immobilization of a fracture
- Treat any complications

# Fracture Diagnosis

- History
- Physical Exam
  - Signs & symptoms of Fracture
- X-ray

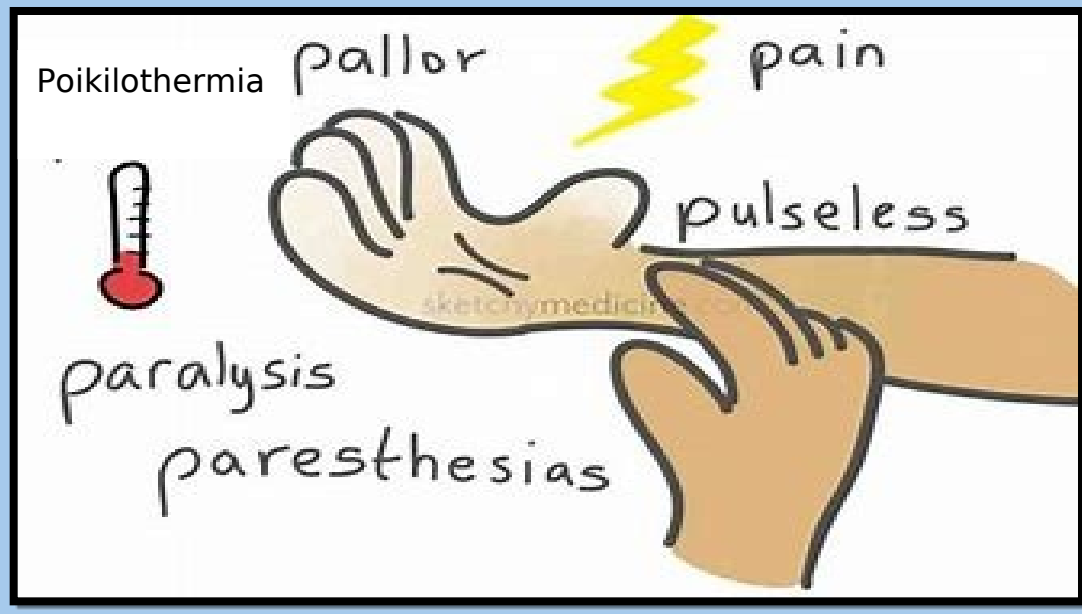


# Nursing Assessment

- Brief history of the accident
- Mechanism of injury
- Special emphasis focused on the region distal to the injury site

# Neurovascular Assessment

- Color
- Temperature
- Capillary refill
- Peripheral pulses
- Edema
- Sensation
- Motor function
- Pain



# Nursing Diagnosis

- R/F Peripheral Neurovascular Dysfunction
- Acute Pain
- R/F Infection
- R/F Injury
- Anxiety
- R/F Impaired Skin Integrity
- Impaired Physical Mobility
- Ineffective Therapeutic Regimen Management
- Self Care Deficit
- Deficient Knowledge

# Nursing Management

- **Planning:  Overall Goals**
  - Physiologic healing with no associated complications
  - Pain relief
  - Achieve maximal rehabilitation potential

# Nursing Management

- **Implementation:**
  - Acute Intervention
    - **Pre-operative Management**
      - Skin preparation
      - Assess last oral intake
      - Monitor VS, need baseline NV assessment
      - Obtain consent
      - Administer prescribed meds
      - Explain all post-op treatments
      - Pain relief

# Nursing Management

- **Implementation:**
  - Acute Intervention
    - Post-Operative Management
      - Monitor VS – maintain patent airway!
      - Frequent NV assessments – assess cast & skin too
      - Pain relief – analgesics, cold compresses, elevation
      - Encourage participation in ADL's
      - Maintain mobility and muscle tone

# Nursing Management

- **Implementation:**
  - Acute Intervention
    - Post-Operative Management Cont'd..
      - Teach care of devices –pin care
      - Prevent skin breakdown
      - Ambulation – usually started in mobility training when able to sit in bed & dangle feet over the side
      - Assistive devices
      - Counseling and referrals

# Nursing Management

- **Implementation:**
  - Acute Intervention
    - **Other measures:**
      - Activity
      - Maintain ↑ fluid intake
      - Diet high in bulk

# Nursing Management

- **Implementation:**
  - Ambulatory & Home Care
    - **Cast care**:
      - Frequent NV assessments
      - Teach signs of complications
      - ↑ extremity above level of heart
      - Exercise joints above & below cast

# Nursing Management

- **Implementation:**
  - Ambulatory & Home Care
    - **Psychosocial Problems:**
      - Assist pt to adjust to any problems caused by the injury
      - Address complaints of extreme pain, unrelieved by elevation, analgesics, or repositioning
      - Assess any complaints of heightened or ↓ sensation/parasthesia distal to the injury, or due to an external fixation device

# Nursing Management

- **Evaluation:**

  -Expected Outcomes

  •Normal NV assessment

  •Tolerable or no pain

  •No evidence of infection

  •No evidence of skin breakdown

  •Crutches used correctly

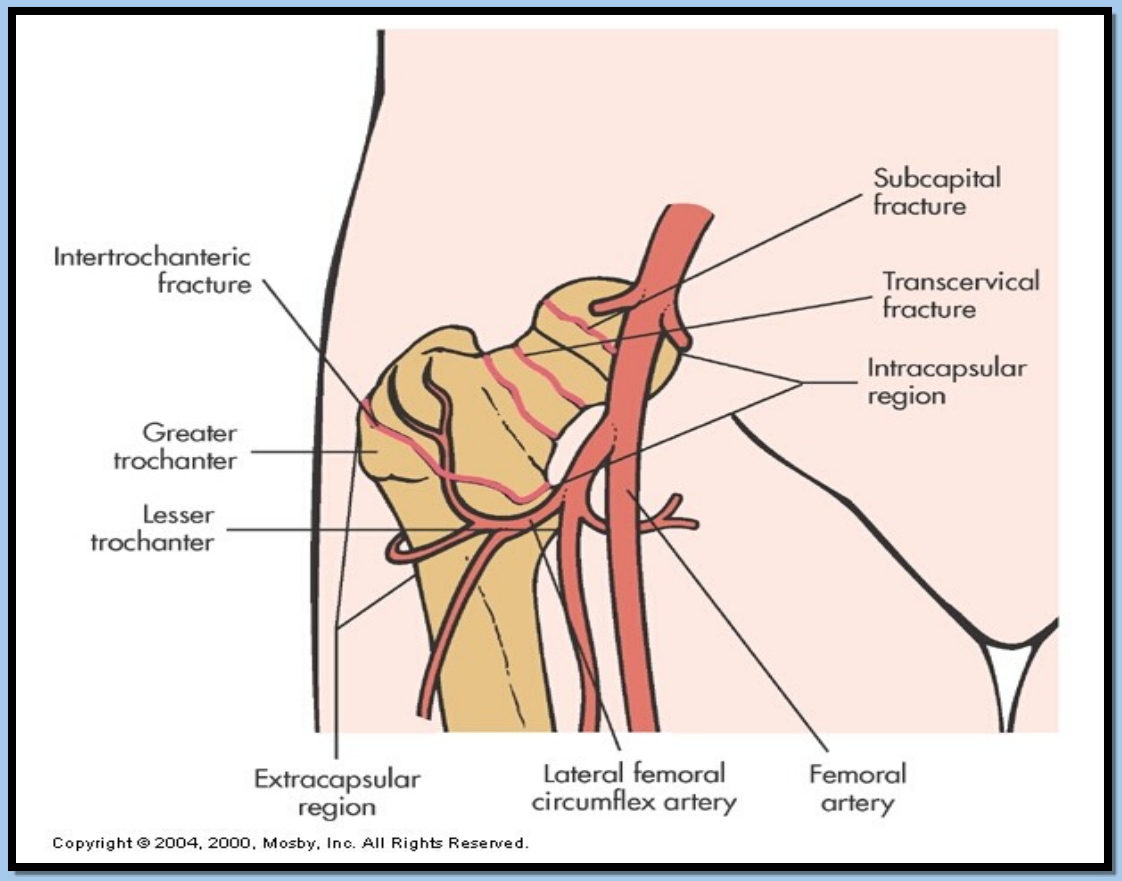
  •Minimal loss of muscle bulk of affected extremity

# Fractures of Specific Bones

# Hip Fractures

- Most common fx seen in the hospital
- Occurs more frequently in women than men due to osteoporosis & an ↑ life expectancy
- ****2 Categories****
  - Intracapsular = occurs within the hip joint & capsule
  - Extracapsular = inter-trochanteric fx

# Hip Fractures



# Hip Fractures

- **S/S of a Hip Fx:**
  - Severe pain at the fx site
  - Inability to move the leg voluntarily
  - External rotation of the leg
  - Shortening of the leg
- **Diagnosis:**
  - X-Ray plus the S/S

# Hip Fractures

- **Nursing Diagnosis:**
  - Pain
  - Impaired Physical Mobility
  - High Risk Peripheral NV Compromise
  - Anxiety
  - HR for Thrombophlebitis, Impaired Skin Integrity, Respiratory Complications, GI Function, GU Function
  - Knowledge Deficit
  - Impaired Home Maintenance

# Hip Fractures

- **Medical Management**
  - Bucks traction can be applied prior to surgery.
  - Choice of fixation device depends on the location of the fx, potential of avascular necrosis, & surgeon's preference

# Hip Fractures

- Open Reduction Internal Fixation (ORIF) → Extracapsular fx's (intertrochanteric)
  - Use of intramedullary rod, pins, and screws to stabilize & reduce the fx.
  - Advantage = early ambulation.
  - Risk hip dislocation & subluxation post-op
  - Hip precautions:  avoid hip adduction & rotation

# Hip Fractures

- **Medical Management:**
  - Prosthetic Implant (Hip replacement) – to replace the femoral head & neck
    - Used for Intracapsular fx's
    - Implies some position restrictions for up to 2 months
    - Partial wt. bearing restrictions for up to 2 months
    - Same hip precautions post-op (avoid adduction & rotation)

# Hip Fractures

- **Medical Management:**
- Closed reduction, Buck's traction, and pain management only if pt's general medical condition precludes surgery (Not candidate for Sx)
- **Nursing Management:**
  - Same interventions as with all other fractures
  - Assess NV status – frequent VS immediately post-op!
  - ✓ dressing & drains frequently.

# Hip Fractures

- **Nursing Management**
  - Special restrictions (Hip Precautions):
  - No hip flexion beyond 90° for 10 days-2 months
  - No adduction of the affected leg beyond midline for 2 months
  - No hyperextension
  - No Internal rotation

# Hip Fractures

- **Nursing Management**
  - **Special restrictions:**
    - These positions are avoided with an abduction splint & pillows between the legs
    - Carefully monitor pt's position during transfer – get pt OOB on their operative side
    - Sling back chair for transfer to PT
    - Avoid elevation of the leg above hip level

# Hip Fractures

- **Nursing Management**
  - Post-op anti-coagulant therapy
    - Monitor PT or PTT times & administer the appropriate med & dose
  - Maintain Anti-embolism stockings or EPC's
  - Coughing and Deep Breathing
  - Encourage leg exercises with the unaffected leg & foot pumps with the affected leg
  - Maintain skin integrity – turning & meticulous skin care

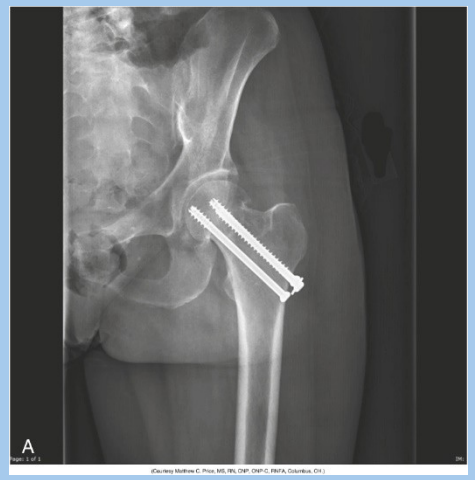
# Hip Fractures

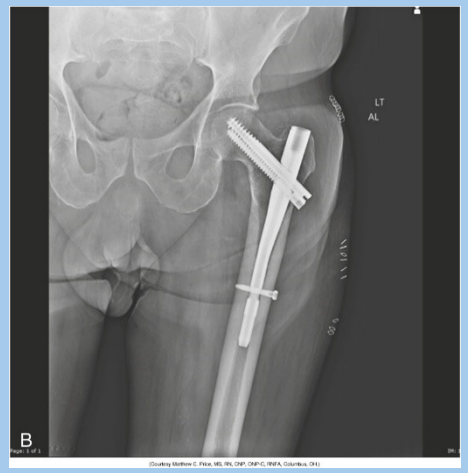
- **Nursing Management**
  - Administer pain meds prior to PT
  - Teach the use of overhead trapeze
  - Monitor bowel elimination & UO
  - Ambulate when permitted & with assistance
  - Maintain a sterile drsg & use aseptic technique when changing it

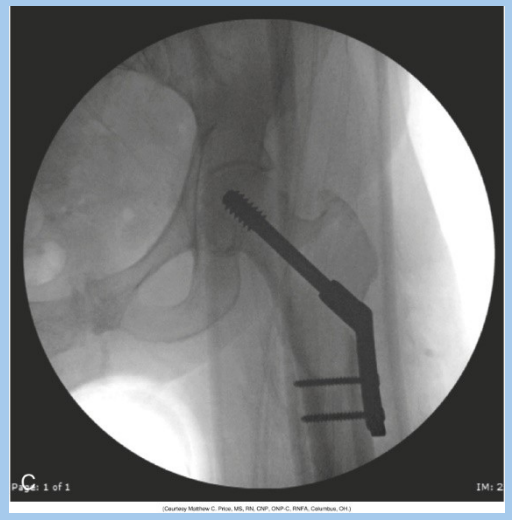
# Hip Fractures

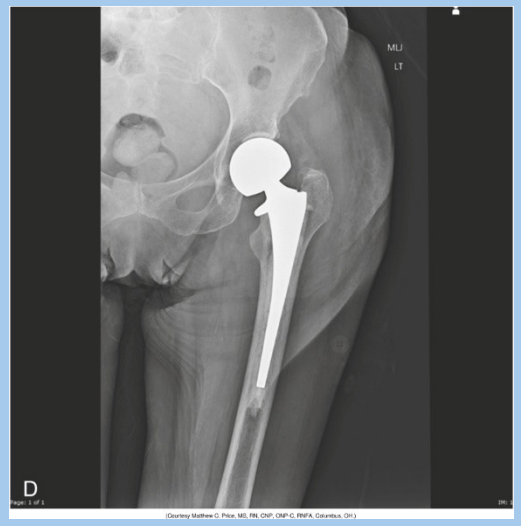
- **Nursing Management**
  - Drains are placed in the wound to prevent formation of hematomas
    - Need constant suction applied
    - Note amount & type of drainage
  - Do not turn on the affected hip
  - Raised toilet seat
  - Lifelong need for abx prophylaxis to protect the prosthesis from bacteremic infection

# Types of Surgical Repair for a Hip Fracture



# Colles Fracture

- Fracture of distal radius
- Fall on an outstretched hand
- Wrist appear deformed , see a hump when viewed from the side
- Major complication is vascular insufficiency from the edema
  - Need to ↓ edema & and do frequent NV assessments
- Takes 6-8 weeks to heal for an adult
- TX: Closed reduction w/ splint or cast, may need ORIF if displaced

# Colles Fracture

# Facial Fractures

## Nursing Management

- Check for loose teeth
- Do not insert an NG tube
- Maintain a patent airway!!
- Oral hygiene q2°
- Wire cutters available
- No straws or nose blowing
- Soft toothbrush & rinsing
- Monitor for infection & pain

# Clavicular Fractures

- Frequently broken bone in children and young adults
  - Usually the result of a fall
  - May occur from direct trauma to bone
- 85% are midshaft fractures
- Common manifestations
  - Pain at fracture site
    - Obvious deformity may/may not occur
  - Limited shoulder ROM

# Clavicular Fractures

- Surgery done if fracture is open
- Comfort measures
  - Splinting
  - Ice
  - Analgesics
- PT
  - Early ROM
  - Strength exercises
- Usually heal without complication

# Pelvic Fracture

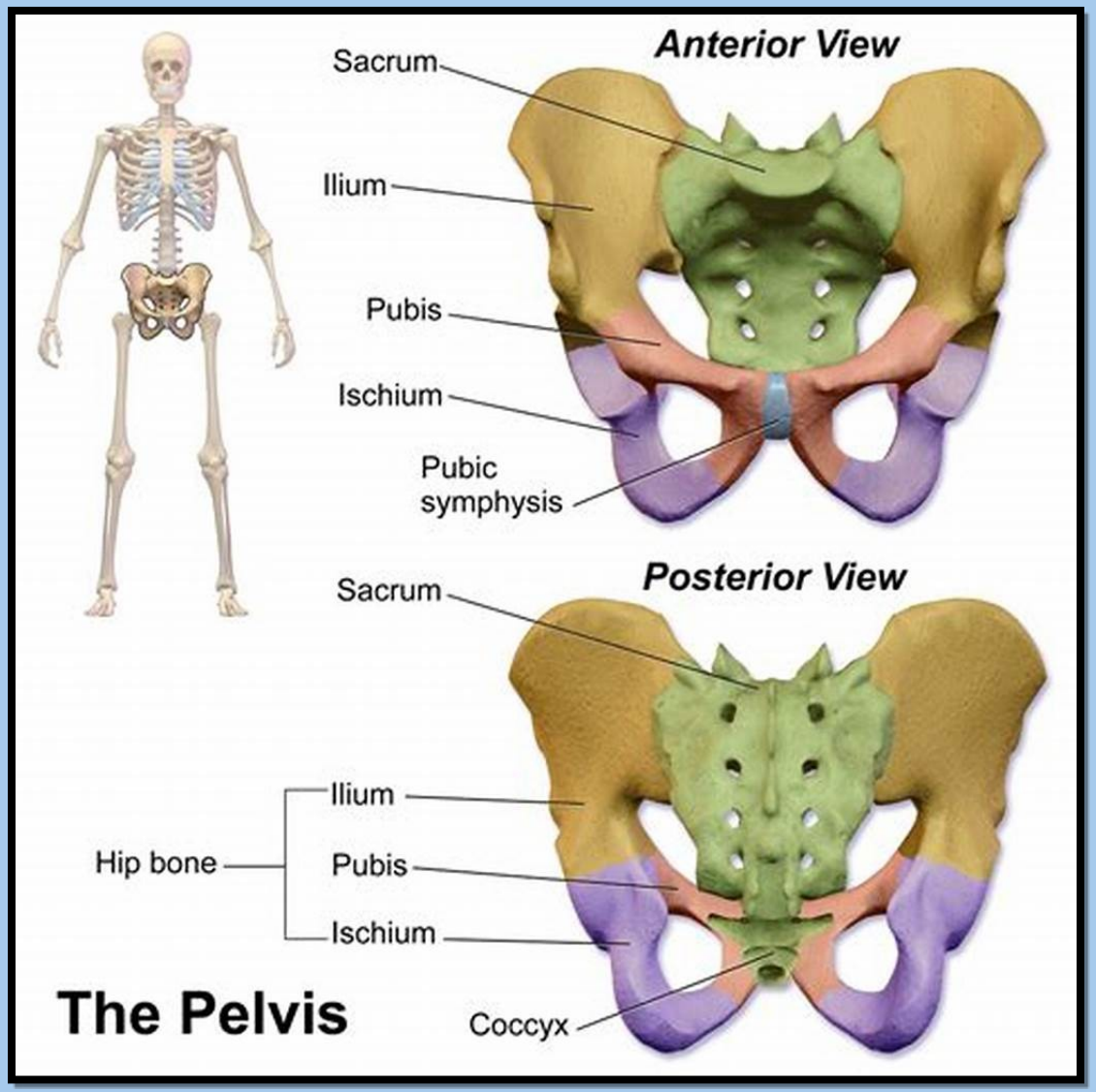
Minor to life-threatening
- Depends on mechanism of injury, vascular damage
- 3% of adult fractures

- High mortality rate
  - May have intraabdominal injury, compartment syndrome, paralytic ileus, sepsis, FES, or VTE

- Symptoms
  - Abdominal swelling, tenderness, deformity, unusual pelvic movement, and bruising
  - Also check lower extremities

# Pelvic Fracture

- Diagnosis
  - X-ray and CT scan
- Treatment
  - Stable, nondisplaced—require little intervention
  - Complex, displaced—external fixation or ORIF
- Nursing
  - Careful handling/moving
  - Assess bowel and bladder elimination
  - Regular distal neurovascular assessment
  - Back care


Anterior View
Sacrum
Ilium
Pubis
Ischium
Pubic symphysis
Posterior View
Sacrum
Hip bone
Ilium
Pubis
Ischium
Coccyx
The Pelvis

# Complications of Fractures

# Complications of Fractures

- Majority heal without complication
- Medical emergencies needing immediate attention required with
  - Open fractures with severe blood loss
  - Fractures that damage vital organs
- Death is usually the result of
  - Damage to underlying organs and vascular structures
  - Complications of fracture or immobility

# Complications of Fractures

- Direct
  - Bone infection
  - Bone nonunion or malunion
  - Avascular necrosis
- Indirect
  - Compartment syndrome
  - VTE
  - Fat embolism
  - Rhabdomyolysis
  - Hypovolemic shock

# Complications of Fractures

- **1. Compartment Syndrome**
- Swelling and increased pressure within a limited space (muscle compartment)
  - Compromises neurovascular function of tissues within that space
    - 38 compartments in upper and lower extremities
    - Associated with fractures with extensive tissue damage and crush injury
    - Most common: distal humerus and proximal tibia
    - May occur after knee or leg surgery or with prolonged pressure (limb trapped under body)

# Compartment Syndrome

- **Arm Compartments:**
  - Deltoid
  - Upper Arm
  - Forearm – One of the most common!
  - Hand
- **Leg Compartments:**
  - Buttock
  - Thigh
  - Lower leg
  - Foot

# Compartment Syndrome

- 2 Basic Etiologies:
  - ↓ Compartment Size
    - Restrictive drsgs
    - Splints
    - Casts
  - ↑ Compartment Content / Volume
    - Bleeding
    - Edema

# Compartment Syndrome:

## Pathophysiology

Decreased Venous Emptying

↓

Increased Capillary Permeability

↓

Edema

↓

Venous Obstruction & Increased Intra-compartmental Pressure

↓

Venous-Arterial Compression

↓

Arterial Occlusion

↓

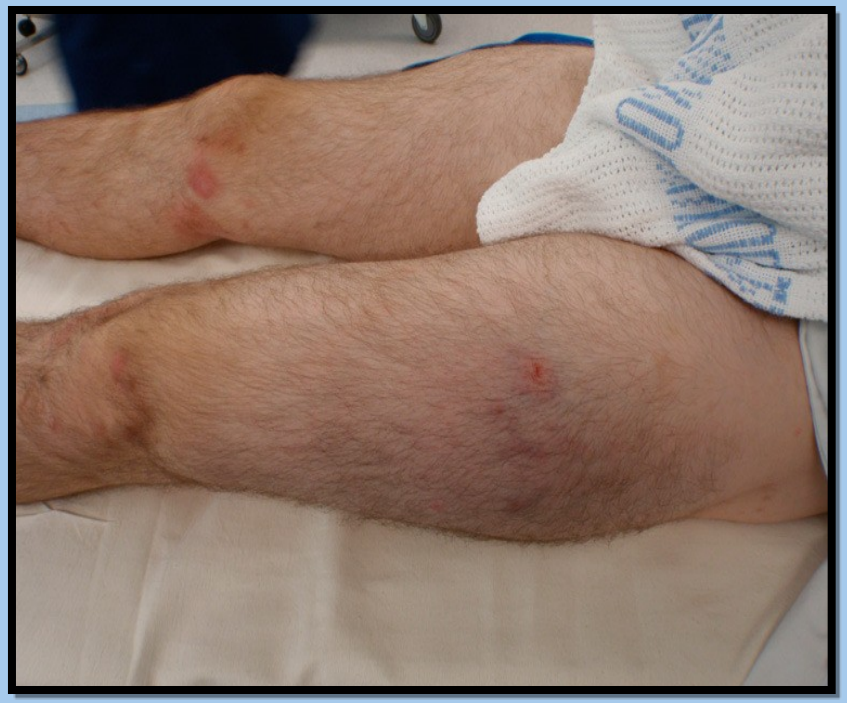
Tissue Death

# Compartment Syndrome

- **Prognosis**
  - Functional changes of muscle in 4°
  - Functional loss of nerves in as little as 4°
  - As time of ischemia ↑, damage is increasingly irreversible
  - Within 4-6° after onset, may have irreversible damage
  - Contractures can develop after 12° of ischemia, extremity may be useless in 24-48°

# Compartment Syndrome

- Clinical Manifestations
- 6 P's!



# Compartment Syndrome

- **S/S:**
  - Early detection is **essential** to prevent permanent deficits!!
  - May occur initially w/ injury or may be delayed several days
  - Pain -(Most distinctive & usually the earliest sign)
    - Out of proportion to magnitude of injury
    - Unrelieved by narcotics or elevation
    - Pain with passive stretch
    - Absence of pain does not rule out CS

# Compartment Syndrome

- **S/S:**
  - Paresthesia getting progressively worse (early sign)
  - Pressure
    - Tense on palpation
    - Direct measurement
  - Paresis progressing to paralysis of the affected limb
  - Pulses, Cap Refill, Color, Temperature are all unreliable indicators
    - Generally not ↓ until late

# Compartment Syndrome

- **Clinical Manifestations**
  - Myoglobinuria – dark reddish-brown urine
    - Injured muscle releases myoglobin into circulation = Myoglobinuria, Renal Failure

# Compartment Syndrome

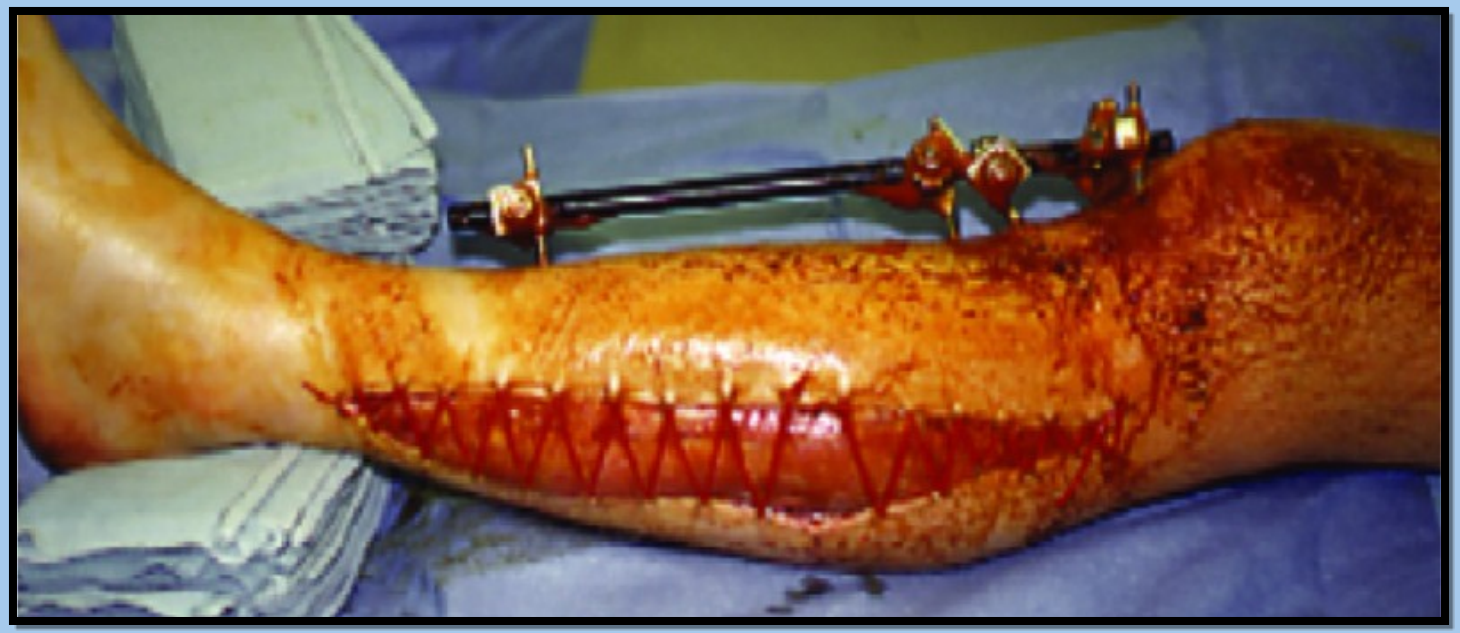
- **Prevention**
  - Elevate & ice application
  - Document NV assessments frequently
  - Teach the patient S/S to look for
  - This is a medical emergency!!
    - **<u>Call the MD!</u>**

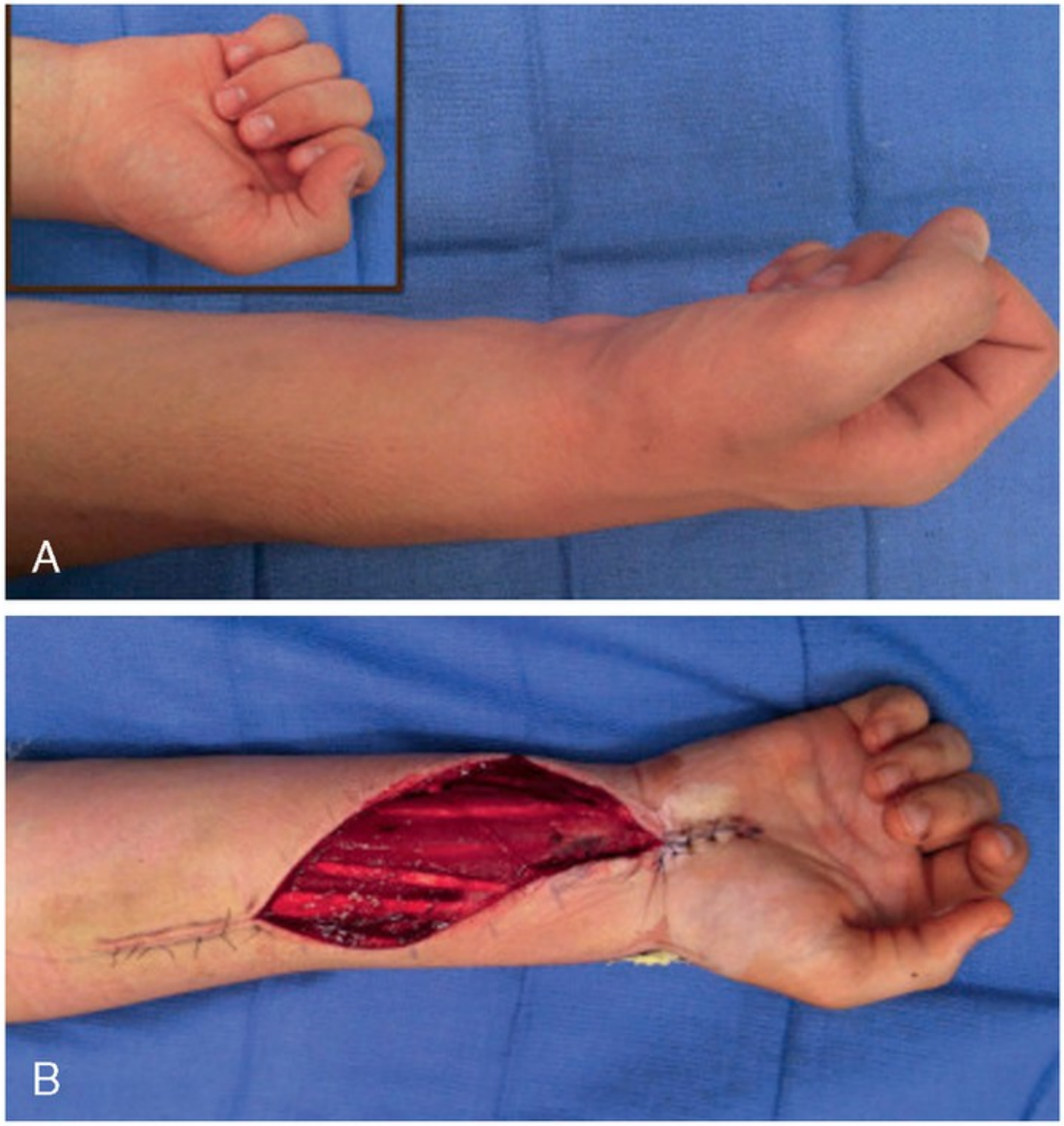
# Compartment Syndrome

- **Treatment**
  - Remove pressure!
    - Constrictive dressing, bivalve cast
  - Elevation, but not > heart level
  - Fasciotomy if S/S don't decrease or pressure remains consistently high
  - Amputation for severe cases

# Compartment Syndrome

- Fasciotomy

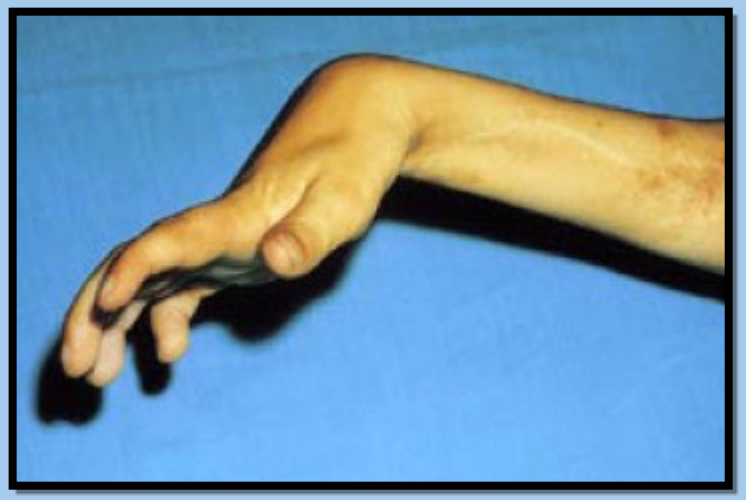





From Stevanovic MV, Sharpe F: *Green's operative hand surgery*, ed 7, Philadelphia, 2017, Elsevier.

# Compartment Syndrome

- **Complications:**
  - Infection
  - Renal Failure
  - Hyperkalemia
  - Metabolic Acidosis
  - Volkman's Contracture



# Complications of Fractures

- **Crush Syndrome**
  - Result of prolonged, continuous pressure on large muscles
  - Muscle tissue disintegrates
  - After pressure is released & circulation restored  myoglobin, K+, and Phos leak into circulation
  - Rhabdomyolysis = myoglobin released from skeletal muscle into the bloodstream.
    - Acute tubular necrosis / renal failure

# Complications of Fractures

- **Artery Damage**
  - Fractures may cause artery damage → lacerated, contusion, or spasms
  - Emergency Treatment:
    - Splint
    - Reduce fx
    - Surgery if needed to ligate the artery

# Complications of Fractures

- **Peripheral Nerve Damage**
  - Can occur at the time of injury or after treatment
  - Prevent by keeping the injured extremities well aligned
  - Keep pressure off peripheral nerves - ↓ edema!

# Complications of Fractures

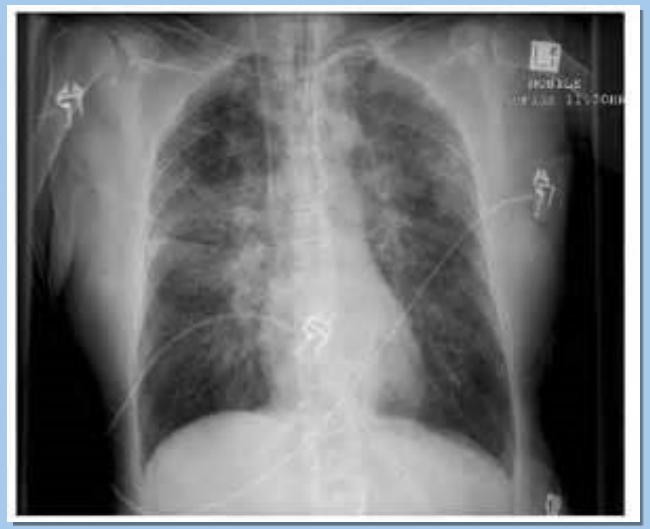
- **Fat Embolism Syndrome (FES)**
  - Characterized by the presence of fat globules in tissues & organs after a traumatic skeletal injury

# Fat Embolism Syndrome (FES)

- **Predisposing factors:**
  - Fractures!
    - Especially of long bones , ribs, tibia, pelvis, multiple fx's, and crush injuries
    - Occasionally seen with TJR
  - Other
    - Burns, pancreatitis, diabetes, alcoholism, osteomyelitis, sickle cell crisis, some poisonings, sepsis, neoplasm, possible genetic predisposition

# Fat Embolism Syndrome (FES)

- **Tissues Most Often Affected:**
  - *Lungs
  - Brain
  - Heart
  - Kidneys
  - Skin



# Fat Embolism Syndrome (FES)

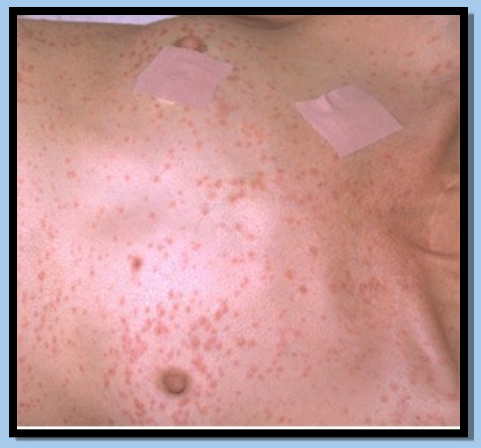
- **Pathophysiology**
  - Mechanical theory
    - Most lodge in the capillaries of the lungs
  - **Complications**
    - Pulmonary, coronary, & cerebral occlusions
    - Pulmonary edema, ARDS, DIC

# Fat Embolism Syndrome (FES)

- **Clinical Manifestations**
  - Usually occur 12-72° after the injury
  - Mental status change is usually 1st sign*
  - Interstitial Pneumonitis
    - Produces S/S of ARDS → chest pain, tachypnea, cyanosis, ↓ $PaO_2$, dyspnea, apprehension, tachycardia
  - Fever > 101

# Fat Embolism Syndrome (FES)

- **Clinical Manifestations**
  - Petechia
    - Late but classic sign!
    - Tiny, red, flat spots located on neck, chest, axilla
  - Rapid & acute course
  - Feeling of impending disaster
  - May become comatose in a short time



# Fat Embolism Syndrome (FES)

- **Diagnostic Studies**
  - ABG's → hypoxia
  - CXR → "snowstorm effect" , pulmonary consolidation
  - Fat in Urine & Sputum
  - ↑ serum lipase & sed rate
  - ↓ Hgb, Hct, RBC, Plt, Ca+, Albumin

# Fat Embolism Syndrome (FES)

- **Prevention**
  - May ↓ incidence by immediate immobilization, minimal manipulation, and adequate support when turning & positioning
  - Assess LOC frequently in high-risk pts
  - Steroids in high-risk pts → investigating

# Fat Embolism Syndrome (FES)

- **Treatment**
  - Most important is Prevention!
    - Immobilize long bone fractures!
  - #1: $O_2$ - high concentration
  - High Fowler's position
  - Symptom Management
  - Fluid resuscitation
  - Reposition as little as possible

# Fat Embolism Syndrome (FES)

- **Treatment**
  - Steroids for lung inflammation & cerebral edema
  - Dextran to improve pulmonary & capillary flow → desludging effect
    - ↓ RBC aggregation
  - Heparin for the lipolytic effect → helps break down the fat
    - May cause hemorrhage at the fx site
  - Analgesics prn

# Fat Embolism Syndrome (FES)

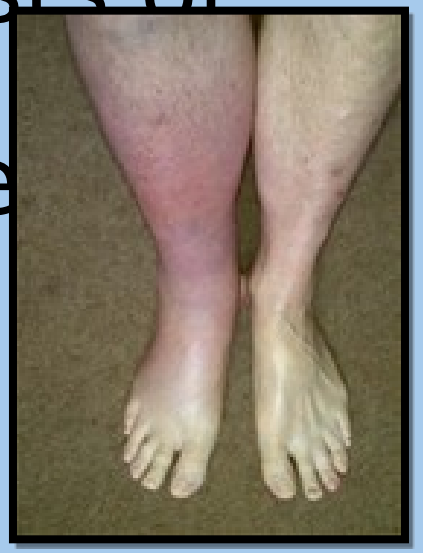
- **Prognosis**
  - Good if identified & treated <u>early</u> before full-blown FES
  - If identified late or left untreated, mortality can be as high as 80%

# Complications of Fractures

- **Venous Thrombosis**
  - Most common complication following trauma of the lower extremity in adults!
  - Most common fatal complication of orthopedic surgery
  - Veins in the lower extremities & pelvis are highly susceptible to thrombus formation after a fracture
    - Especially a hip fracture!

# Venous Thrombosis

- **Precipitating Factors**
  - Vein trauma
  - Venous stasis caused by incorrectly applied casts or traction
  - Local pressure on a ve
  - Immobility
  - Hypercoagulability
  - Dehydration

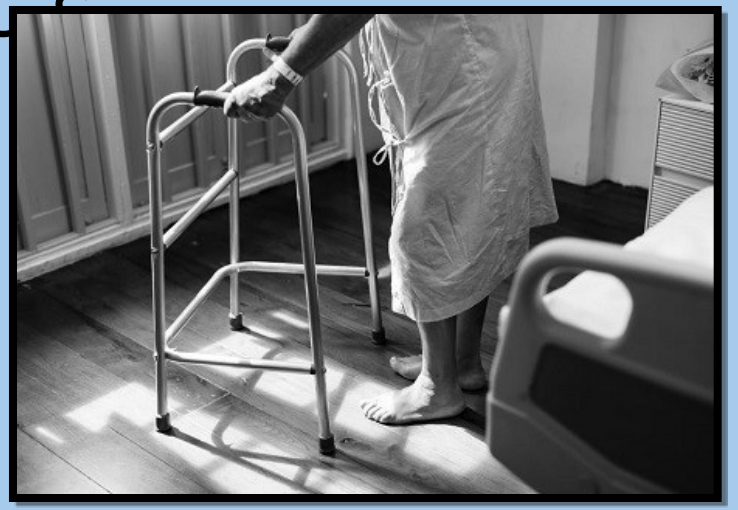


# Venous Thrombosis

- **Clinical Manifestations**
  - Begin 24-48° after the injury, but not apparent for 7-10 days
  - Only 40-50% have clear S/S
  - 1st indication may be a PE with sudden onset
  - Inflammation to the LE & fever
  - Homan's sign is not specific

# Venous Thrombosis

- **Prevention Interventions**
  - Active & passive exercises as appropriate
  - Early ambulation
  - Elevation of lower extremities
  - Elastic stockings or EPC's
  - Adequate hydration
  - Cough & Deep Breath
  - Anticoagulants
  - Dextran



# Complications of Fractures

- **Shock**
  - Average adult blood volume = 4-5L or 70-75ml/kg
  - Bones are very vascular
    - Esp the Femur
    - Longest & strongest bone in the body
    - Can bend 2in. prior to fx
    - Usually has a lot of soft tissue damage
  - Check expanding thigh & S/S Shock

# Shock

- Pelvis also has a rich blood supply
  - Check urine output
  - Can have a massive hidden bleed
    - **Remember…1st sign is probably a Δ in mental status!

# Complications of Fractures

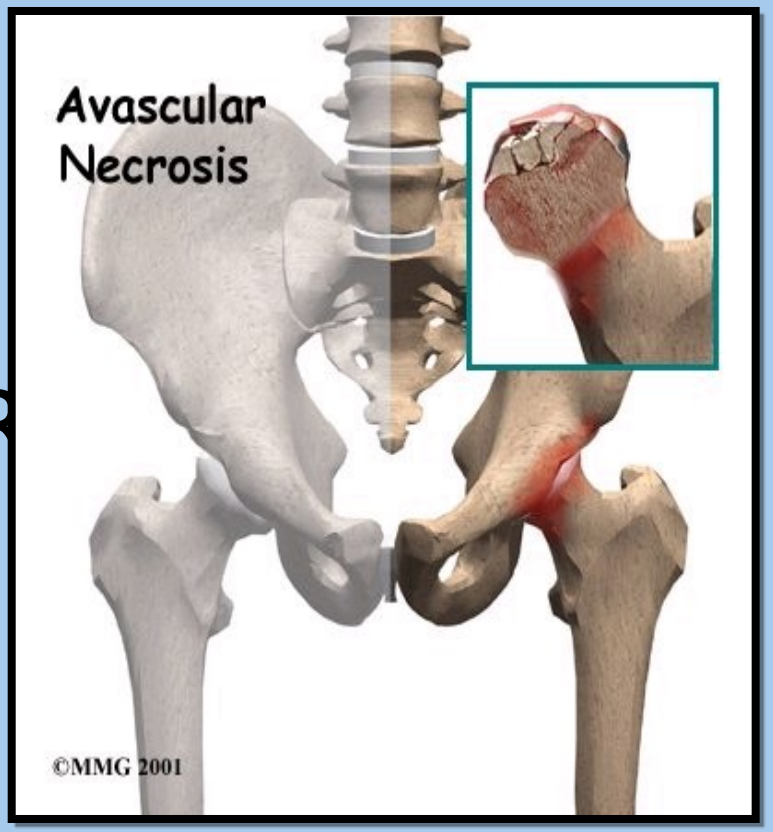
- **Infections**
  - Open fractures & soft tissue injuries have an ↑ incidence
    - Open fractures require aggressive surgical debridement
    - Post-op antibiotics for 3-7 days
  - Need to be immunized if there is an open wound = Tetanus*
  - Osteomyelitis can become chronic
  - Gas Gangrene

# Complications of Fractures

- **Avascular Necrosis**
  - Bone loses its blood supply & dies
  - Etiology:
    - Fractures – esp. femur head & neck, carpals, scaphoid & talus
    - Dislocations
    - Prolonged high dose steroids
    - Chronic renal disease
    - Sickle cell anemia

# Avascular Necrosis

- S & S
  - ↓ Rom & pain
- Treatment
  - May require OR



# Complications of Fractures

- **Kidney Stones**
  - High risk for renal stones due to bone destruction
  - ↑ serum calcium
  - Prevent by ↑ fluids

# Complications of Fractures

- **Complications of Bone Union**

  Delayed Union

  - Fracture healing progressing more slowly than expected; healing eventually occurs
    - Taken > 6 months
  - Causes = inadequate immobilization, infection, multiple bone fragments, tobacco use

# Complications of Fractures

- **Treatment of Delayed Union**
- Electrical Bone Stimulation
- Used to facilitate healing process by
  - Increasing calcium uptake and production of bone growth factors
  - Increasing collagen synthesis
  - Promoting growth of new blood vessels
  - Electrode surgically implanted into fx site
    - Implant the entire device
    - Or external electrodes over skin or cast

# Complications of Fractures

- **Complications of Bone Union**

  Nonunion

  - Complete failure of healing to take place
  - May have motion at the site of fx due to pseudoarthrosis

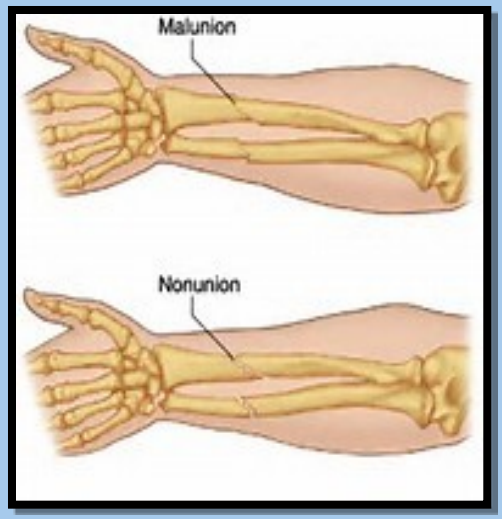
  Treatment = ORIF, bone graft

# Complications of Fractures

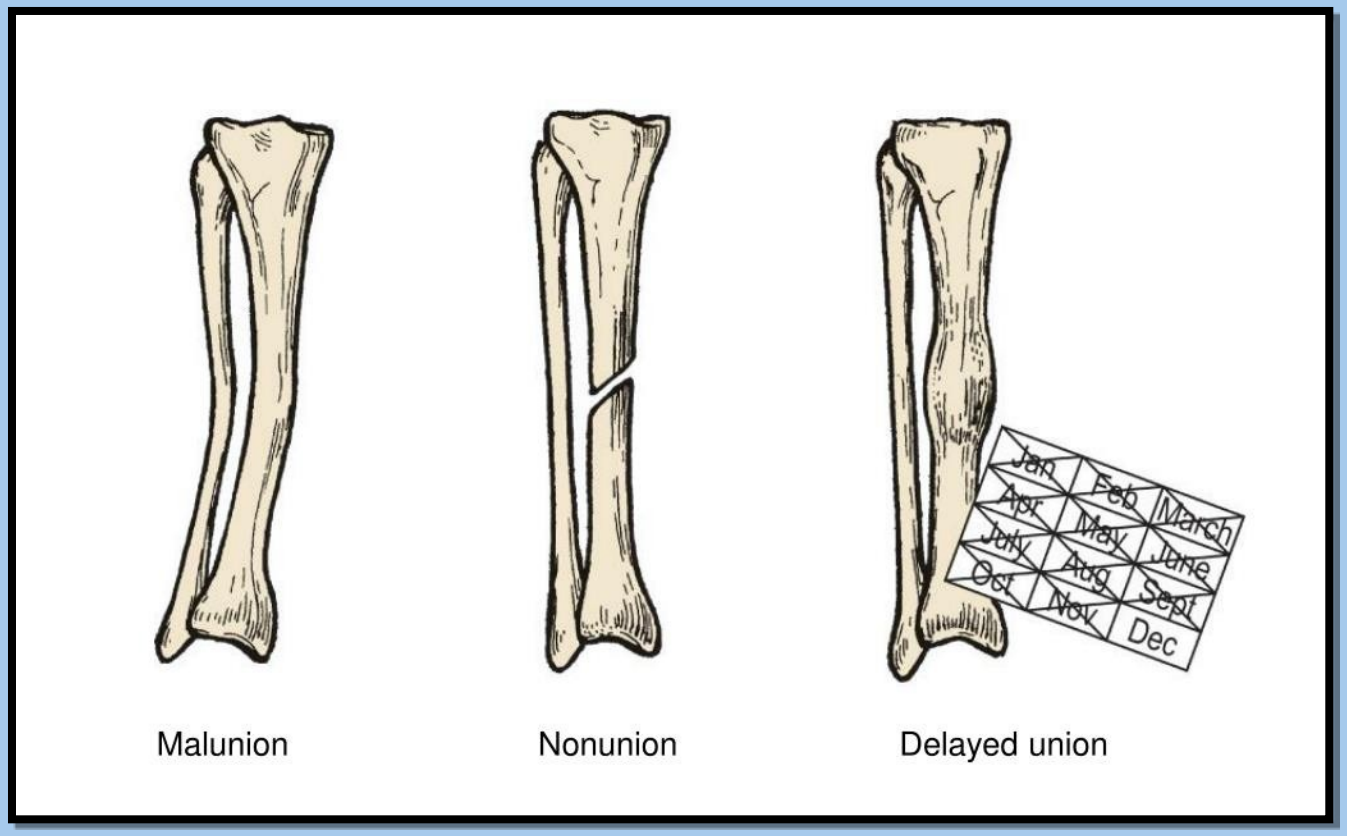
- **Complications of Bone Union**

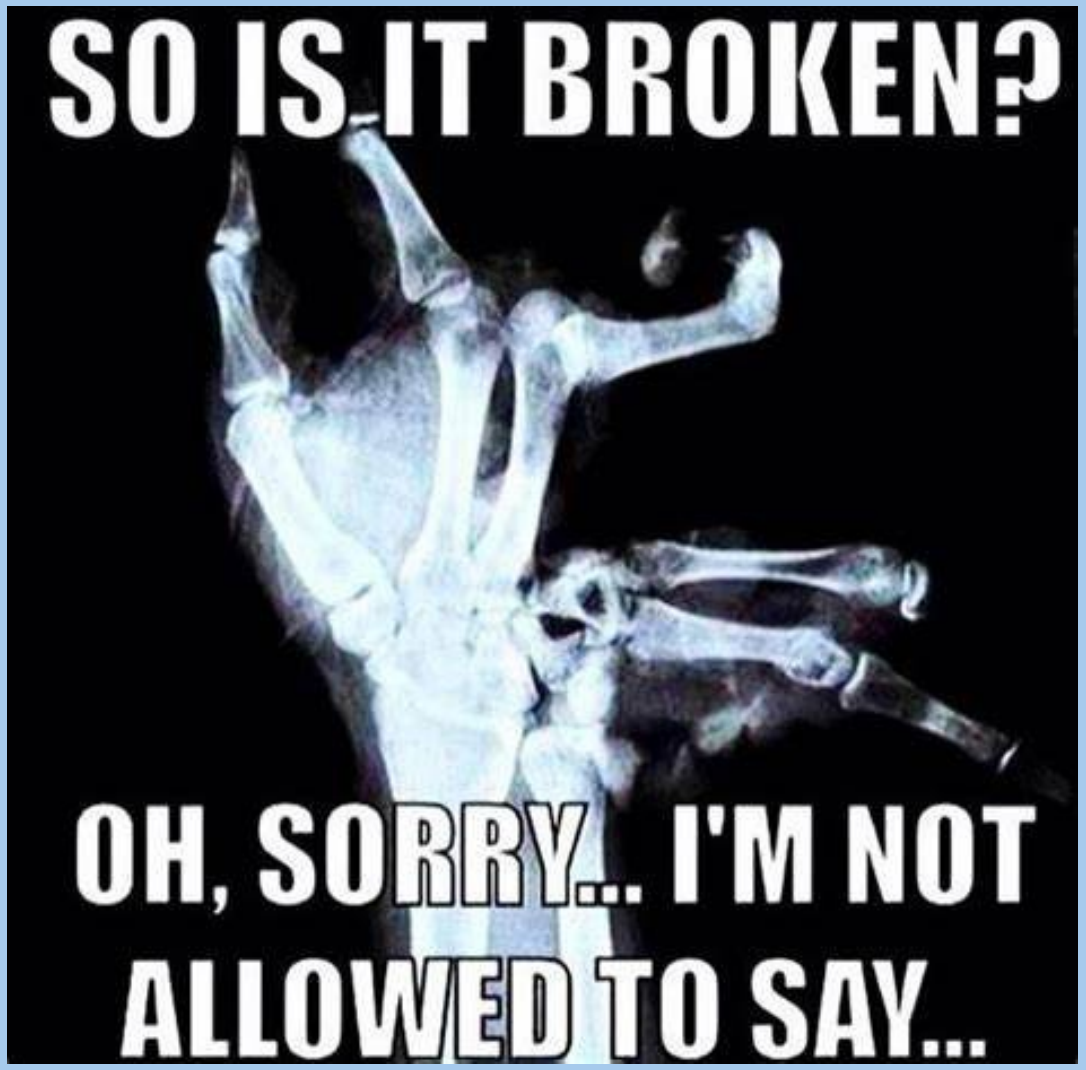
  Malunion

  - Fracture heals in expected time but in unsatisfactory position, which may result in deformity or dysfunction
    - If ↓ function, may re-fracture and ORIF



# Complications of Fractures




SO IS IT BROKEN?
OH, SORRY... I'M NOT ALLOWED TO SAY...