

Developmental Differences

- Immature Immune System
 - have less ability to wall off an infection and keep it in one place in the body, less ability to fight off infection
- Bone Structure/Function
 - More flexible/porous: more incomplete fractures in kids than adults
 - Periosteum stronger/tougher: incomplete fx
 - Epiphyseal growth plates: fx to a growth plate is a big deal in a kid, leads to growth probs
 - Faster healing: d/t rich blood supply to bones
 - Remodeling ability: bones grow until about age 20
 - Cartilage is soft, lots of cartilage on ends of long bones b/c still growing

Epiphyseal Growth Plate

- Layer of cartilage between epiphysis and metaphysis
- Controls long bone growth
- New cartilage converted to bone
- Disruption affects growth
- This area is more vulnerable than injury; even muscles and tendons can be stronger than bones; under pressure, the growth plate can “slip”.

Infections

- Osteomyelitis
 - Rich vascular supply
 - Hematogenous origin 80-90%
 - 1/3 have history of minor trauma
 - Metaphysis long bone most common
 - Risk joint involvement
 - More common in kids ?? years of age (not in slides, and I didn't catch what she said)
 - More common in males > females
 - Often follows URI and minor trauma to the bone (fell down and bruised)
 - More common in the long bones...big concern if it gets into the joint
 - Patho: Infection goes into bone, causes inflammation and swelling, then you get decrease in blood flow to the cells and this leads to necrosis in the bone.
- Osteomyelitis: Clinical manifestations:
 - Fever, pain, reluctance to use extremity
 - Infants: irritable, poor feeding, diarrhea, afebrile
 - Older children: localized pain, swelling, heat, erythema, fever
- Osteomyelitis: Diagnosis
 - History and physical will lead us to being concerned
 - Blood/aspirate culture at the bone
 - C-Reactive protein (CRP) (one of the most sensitive indicators to see if tx is working)
 - 98% elevation, peak 2days, norm 7-10days
 - ESR
 - 90% elevation, peak 3-5 days, norm 3-4 weeks
 - Xrays/Scans to see if bone is broken; will probably be normal for a couple of weeks until bone necrosis sets in
- Osteomyelitis: Treatment
 - IV antibiotics after cultures (3-4 weeks); more recent research says that child can switch to PO abx if the organism is responding
 - Splinting/immobility during the acute phase; helps pain and shedding of bacteria
 - Monitor neurovascular/skin
 - Manage pain; it is very painful; NSAIDS are the mainstay + narcotics for breakthrough pain
 - Follow CRP to see if tx is working
 - Possible surgical intervention; organism can be encapsulated b/c body has walled-off the infection; need to go in and do an I & D to cut out the infection; may have a drain and you can irrigate abx directly into bone
 - Family education: importance of antibiotics

Congenital Defects

- DDH (Hip Dysplasia) not talking about this, b'c more of an OB thing.
- Clubfoot, not talking about this, b'c more of an OB thing
- Osteogenesis Imperfecta

Osteogenesis Imperfecta

- Genetic disorder that results in alteration of collagen (not enough or bad quality); four different types of OI; causes variations in the ability to make strong bones; the most common type we see in peds is the type that has a decreased production of collagen. These kids have a lot of fractures up and through puberty. Generally OK after this as their collagen needs are not as high after puberty.
- Boys = Girls
- Clinical Manifestations:
 - Fractures with no good explanation
 - Blue sclerae; has to do with collagen in sclera (skim milk blue)
 - Thin, soft skin
 - Large anterior fontanel
 - Weak muscles
 - Soft bones
 - Small stature
 - Conductive hearing loss (bones in the ear are affected)
- 4 Types with variable presentation
- Diagnosis occurs generally with fracture
- Medical management = treat fractures, prevent deformities
- Nursing care
 - education (some kids need braces)
 - prevent fractures (may need a rod in the femur)
 - maintain normal growth and development (swimming is good!)
 - family support
 - nutrition counseling (don't want child to be overweight b/c this causes more stress on bones)

Muscular Dystrophy

- Progressive, degenerative, muscle disorders that cause muscle wasting. There are several types, the most common is Duchenne.
- Duchenne = absence of a particular type of protein, causes degeneration of skeletal muscle; child is perfectly normal and then around early toddler/preschool age they start to get symptoms.
 - first symptoms: fall frequently, get easily tired, persistent "toe walking"
- Onset: 2-6 yrs with rapid progression
- By 5-6 yrs, Gower's sign (compensating for lower limb weakness...have to get up from seated position using upper body strength rather than leg muscles)
- Diagnosis: s/s, muscle biopsy (looking for a higher concentration of fat than one would expect...the fat has replaced muscle), EMG (tests muscle reactivity), NCV (nerve conduction velocity...trying to determine if problem is in nerve or muscle response...will find that the nerve conduction is fine, but the muscle is not), blood enzymes (early in the disease the enzymes increase, then decrease later in the disease b/c there is less muscle to break down)
- Treatment: supportive; this cannot be cured :-(); genetic counseling with family; counsel family; refer family to support group
- Muscular Dystrophy Nursing Issues: (promote independence and provide support!)
 - Coordination of care; many health professionals involved
 - Respiratory/cardiac monitoring; muscles of respiration get involved as disease progresses; become vent dependent; heart becomes involved in late stages; this is sad!
 - Nutrition
 - Activities to promote mobility; this is a key component to promoting quality of life; assistive devices; get kids on electronic wheelchairs early on so they can move (buckle them in!)
 - Family education/support

Acquired Defects (these are more fixable!)

- Scoliosis
- Legg-Calve-Perthes
- Slipped Capital Femoral Epiphysis
- Osgood-Schlatters

Growth-Related Disorders: Scoliosis

- General Info about Scoliosis
 - Lateral curvature of spine over 10-degrees
 - Incidence: 100 per 1000, but only 2 per 1000 require treatment
 - Develops between 9 and 12 yrs.
 - Male > female, female more likely to progress to needing surgery
 - Causes: Unknown? (idiopathic) or associated with other congenital/neuromuscular disorder
 - Why do we care: mobility, pulmonary (a big issue)!
- Scoliosis: Signs/Symptoms
 - Thoracic location most common
 - Unequal shoulder/hip level, one prominent scapula, curved spinal column, truncal asymmetry
- Scoliosis Dx and Tx
 - Usually discovered during routine school screening or physical exam
 - Treatment depends on physiologic age, magnitude and location, and potential for progression
 - Treatment: Observation, Bracing or Surgery
 - What we do depends on age of the child, the particular type of curve (don't have to memorize the types)
 - Mild curve with decreased risk for advancing (10-20 degree curve): exercises are prescribed and observation q 3 months via X-ray. This does not push the spine back straight...it stops the progression.
 - Moderate curve (20-40 degrees) get bracing. They are very effective if they are work 23 hours a day. The Milwaukee brace is the most effective, but does not have high compliance. There is another brace (TLSO brace) that is 80% effective if worn 23 hours a day, but it has higher compliance b/c less obtrusive.
 - Teach family to check skin for skin breakdown; if there is an area of breakdown we teach them to come back in and get brace adjusted (don't just put something in there to relieve the rubbing)
 - Severe (> 40%) gets surgery...Instrumentation and/or Spinal Fusion
 - Anterior or posterior approach or both
 - Most common: posterior spinal fusion, instrumentation and bone grafting
 - Different types of instrumentation, some require post-op bracing
 - Post-op Nursing Issues
 - Need to know type of surgery
 - Need to know which direction they went in if going in anterior, then that's through the thoracic cavity so will have pulmonary issues and probably a chest tube; if go in posterior, then not as many issues??
 - Need to know mobility restrictions...will be different for each case
 - Respiratory: standard issues such as atelectasis and immobility b/c they are on BR for 48 hours; plus pain for which they get narcotics and antispasmodics...these all contribute to respiratory issues, may even need to be on O2 for a period of time.
 - Pain; at incision and donor site; for severe pain, consider PCA and muscle relaxants
 - Altered Skin Integrity
 - Incision, Inspect skin/dressing each shift
 - Will often have a JP drain
 - Turn every 2 hours
 - TLSO: assess pressure areas, monitor fit; will wear this post-op for about a year or so
 - Impaired Mobility
 - Spinal precautions/Logroll every 2 hours, bed flat as ordered
 - Range of motion
 - Early mobilization
 - DVT prevention
 - Potential for Injury

- Altered neurovascular status: assess extremities every 2hrs X 24hrs, then every 4 hours
- Altered fluid status
 - Strict I&O, expect post-op fluid shifts; watch urine output (want 1ml/kg/hr); will give 20ml/kg fluid bolus if needed; this shift occurs first 24-48 hours; then diuresis occurs
 - Urinary retention (Foley X 48 hrs)
 - Expect some paralytic ileus (NG tube)
- Monitor for complications
 - Respiratory
 - Bleeding/anemia (large blood loss)
 - Neuro: spinal cord injury
 - GI: superior mesenteric artery syndrome; typically happens later (around 6-12 days postop). The duodenum gets compressed between mesenteric artery and the aorta which leads to a bowel obstruction. This is a risk when you rearrange the internal organs, also closely associated with a rapid weight loss after the surgery. Nutrition is important! SS= Increased, sharp abd pain, N/V; position pt left lateral cubitus? or on their stomach

Slipped Capital Femoral Epiphysis

- The head of the femur slips on the growth plate (see slide for picture)
- Incidence:
 - Boys > girls
 - 10-16 y/o
- Associated factors:
 - Obesity (more pressure on the bones)
 - Local trauma
 - Endocrine disorders: hypothyroid, pituitary disorders that r/t delayed puberty
 - Late maturation
- S&S
 - Gradual onset
 - Pain: hip, groin, knee (ROM will hurt!)
 - May limp
- Diagnosis
 - Hx/Sx
 - X-ray (will see the slipping at the femoral head)
- Two categories: Stable vs Unstable
 - Unstable if it has slipped so much that child cannot bear weight
- Treatment for SCFE
 - Pin it just as it is (in situ pinning) to stabilize on the femoral head
 - Pre-op on bedrest b/c don't want it to move anymore than it already has
 - Then they hope that the femoral head stays nice and vascular and continues to grow
- SCFE: Nursing Care
 - Pre-op: Dx --- OR (non weight bearing)
 - Post-op:
 - WB restrict (will be on crutches, so will need teaching for that)
 - Pin care (potential site for infection)
 - Pain (NSAIDS + narcotics for breakthrough)
 - NV status
- Follow up:
 - Watch for avascular necrosis/ chondrolysis

Legg-Calve-Perthes Disease

- The head of the femur loses its blood supply; the head starts to collapse and the joint stops working
- Incidence:
 - Boys>girls
 - 4-8 years old

- Blue eyed, fair skin, short stature
- Skeletal age less than chronological age (late maturing boys)
- S/S
 - % pain at hip and knee, increases with activity, insidious onset; child will start out complaining of leg pain at the end of the day
 - limping
- Dx
 - X-ray shows some deformity of femoral head
 - MRI will show clearer picture; the definitive dx
- Pathophysiology (is self-limiting if body is in position to heal itself)
 - Aseptic necrosis for several weeks; joint doesn't work well; pain
 - Revascularization for next 6-12 months
 - New bone formation for the next 1-2 years; the issue is that it has to be placed up into the joint so that it forms the way we want it to; this is where the medical intervention comes in
 - Regenerative phase - ?
- Medical Treatment for LCPD
 - Goals:
 - Decrease hip irritability
 - Hip mobility; want the hip to work!
 - Prevent collapse ball
 - Regain sphere
 - Initial: Rest & NWB
 - Conservative: immobilize w/ cast or brace; this is a loooooong period for decreased mobility; nurse needs to help family deal with brace
 - Surgical: osteotomy; another path of treatment instead of wearing the brace for years; they cut the femur and reorient the head up into the pelvis and then hold it there surgically; decreased immobility restriction of only 4 months.
- Nursing Care
 - Pain management (NSAIDS + narcotics)
 - Mobility
 - Skin
 - Home care
 - Nutrition (protein + Vit C); etc..
- Long term Treatment
 - Teach family there is a risk of degenerative arthritis

Osgood Schlatters

- 9-16 y/o who play sports; usually occurs during a growth spurt
- There is a fracture at the tibial something or other growth plate. Causes inflammation and bump on the tibia and it hurts.
- Knee pain
- Treatment is RICE
- Prevention: have kids warm-up before sports or activity

Orthopedic Injuries: Fractures

- Spiral fracture is often associated with child abuse (twisting mechanism)
- Greenstick fracture is much more common in kids..doesn't

Salter-Harris Classification of Epiphyseal Injuries

- Type 1-Type 5; the type of fracture it is in relation to the growth plate; know that when something extends through the growth plate (Type 3-Type 4)...these are the type of fractures that need to be placed close together...very important for growth. These kids are going to OR for an open-reduction. Type 5 is a crush injury of the growth plate

Orthopedic Injuries: Fractures

- Stages of bone healing
 - Inflammatory, callus, bone, remodeling (up to approx 21 yrs)
- Faster healing than adult
- “Bayonet” alignment
 - End-to-end causes overgrowth and the bone ends up longer than the one on the other side; so if the bone is broken at the shaft then the ends are overlapped a bit, initially looks like it’s not set right.
- Femur Fracture Healing
 - Neonate 2-3 wks
 - Young child 4 wks
 - Older child 6-8 wks
 - Adolescent 8-12 wks
 - Adult 10-16 weeks
- Treatment of Fractures
 - Principles:
 - Reduction of fracture to realign bones
 - Immobilization decreases pain, prevents rotation, maintains position
 - Maintain alignment until callus well established (traction, casting, rodding)
 - Closed vs. open reduction (most kids bones can be reduced via closed reduction)
 - Casts
 - Traction: Skin vs. skeletal
- Spica Cast in Femur Fractures (picture)
 - Nutrition (small meals)
 - Respiratory (positioning)
 - Skin (assessments frequently)
 - Mobility
 - Transportation via car
 - Teach parents how to move child and reposition
 - Teach parents what type of toys
 - Teach parents what to do about itching (cool air sometimes works)
- Humerus fractures
 - Often in supracondylar portion; tends to be through growth plate
 - May require open reduction/casting (often needs surgery)
 - Potential complications (high degree of complications if not done right!)
 - Volkmann’s contracture
 - Traumatic nerve injury
 - Angulation deformity
 - Elevate above level of heart
 - Watching CSM, swelling, pain

Cast Care: Psychosocial considerations

- Child comes to see cast as part of body
- Immobility/change of routines is threatening
- Child may fear cast removal tool because it is loud, vibrates, and produces heat—need appropriate preparation

Spica Cast Care

- Do not lift by bar between legs
- Turn/reposition frequently
- Pay attention to alignment
- For diapered children:
 - Use plastic to tuck into cast
 - Use two diapers- small inside, large over outside
 - Tuck diaper into cast
- Clothing: shorts can be split down sides and Velcro attached

Traction Care: Nursing Issues

- Understand purpose/function of traction
- Maintain traction
 - Not to be d/c'ed without MD order
 - Do not lift up on weights or hold them
 - No knots in rope length, knots securing rope to weights/devices need to be secure
 - Pulleys should work freely
- Nursing Issues of Traction Care
 - Maintain alignment
 - Prevent skin breakdown
 - Prevent pressure
 - Observe for irritation with skin traction
 - Pin care– per hospital policy
 - Prevent complications of immobility and pain meds

Pediatric Orthopedic Nursing Care Issues

- Developmental/Psychosocial needs must be addressed; immobility is a huge issue for kids
 - Sensory deprivation/social isolation
 - Regression
 - Normalize routines/environment
- Pain
 - Due to incision/injury/inflammatory process
 - Use of opioids and NSAIDs
 - May need muscle relaxants for muscle spasms
- Nutrition
 - Necessary for healing
 - Small, frequent meals
 - Food from home
 - Social atmosphere
 - Poor oral intake d/t effect on child of hospitalization
- Casts/Traction/Orthotics (always watch for complications!)
 - Monitor for signs of infection, compression, skin breakdown, CSM distal
 - Correct application
 - Care of devices
 - Patient monitoring
 - Documentation
- Monitor for complications
 - Circulatory impairment
 - Compartment Syndrome (the only difference between adults and kids is in the assessment)
 - Superior Mesenteric Artery Syndrome (mentioned previously)
 - Infection
 - Immobility (respiratory, cardiovascular, musculoskeletal, GI, urinary, skin)

Compartment Syndrome

- Fascia fails to expand to accommodate bleeding, swelling, or pressure
- Kids have smaller compartments, so don't need as much stimulus to make this happen
- Irreversible damage can occur in 4-5 hours
- Treatment: relieve pressure, may require fasciotomy or bi-valve the cast
- Signs/symptoms
 - Pain persisting after fracture reduction
 - Pain persisting after analgesics
 - Pain on passive stretching of compartment (difficult to assess)
 - Pallor is a late sign

- Progressive muscle weakness distal to injury; paralysis
- Sensory deficits distal to compartment; parasthesia (tingling)
- Palpable pulses distal to injury despite presence of other symptoms
- Assessing children for compartment syndrome
 - Ability to verbalize
 - Assessing sensation/motion
 - Pain

Discharge Issues

- Patient/Family Education
- Nutrition
- Positioning
- Signs/symptoms
- Home care
- Auto restraint safety

Pediatric Trauma

- Leading cause of death in children > age of 1 yr
- Falls, **Blunt Trauma**, Motor Vehicle Crashes (passenger or auto vs. pedestrian), other (penetrating)
- Injuries: head, spinal cord, intra-abdominal, orthopedic (the injuries tend to involve multiple systems)

Pediatric Trauma: Phases of Care

- Emergent– ABC's (what is going to kill them in the next hour?)
- Acute– specific injuries
- Rehabilitation
- ****Important!! History and mechanism of injury****

Developmental vulnerability of children

- Organs in closer proximity to each other and to body surface, results in multiple organ injuries
- Bony thorax more pliant, can have pulmonary contusion w/o rib fractures
- Swallow air w/ crying, leads to gastric distention and compromised ventilation d/t diaphragm not extending well
- Circulating blood volume, small loss can be significant (80ml/kg is the general blood volume for kids)
- Thin skin, vulnerable to hypothermia
- Cerebral hyperemia in response to cerebral edema (lose autoregulation with head injury)
- Increased risk for increased ICP

Trauma: Mechanism of Injury

- Tends to be developmentally related
 - Infants/toddlers: abuse or falls
 - Preschoolers: get out in front yard and run out into street to get hit by car
 - Adolescents: have car accidents, also sports injuries

Trauma: Head Injury

- Injury (GCS<8 = major brain injury)
 - Primary—occurs at impact, coup/contrecoup, shearing; prevention is helmets, seatbelts
 - Secondary – d/t brain/body's response to trauma: hypoxia/hypercarbia/hypovolemia; kids need a continuous supply of oxygen and glucose. Anything that diminishes that supply will greatly increase the injury. Provide aggressive support of ABCs, maintain oxygenation, treat ICP.
- Skull fractures
- Intracranial Hemorrhage
- Cerebral Injury

Trauma: Head Injury

- Depressed skull fracture; direct hit to head in very small area; pushes bone in

- May require surgery
- “ping-pong” fracture
- If fracture is depressed more than 50% the width of the bone, they’ll go to surgery and get it fixed; otherwise just watch
- “Growing skull fracture” is something unique to babies. They get a little skull fracture, and the meninges start to herniate up through the fracture and start to pull it apart like a zipper. Will follow up in 6 weeks with another x-ray to see if the fracture is growing; if so, surgery!
- Basilar skull fracture
 - Battle’s sign (bruising at mastoid) or raccoon eyes; bruising takes a while to show up
 - CSF leak from ears/nose (check for halo sign and glucose)
 - Blood behind tympanic membrane
 - Very worried about tearing of the meninges d/t spiky, thin bones (if meninges torn then we worry about infection)
 - Worried long-term about cranial nerves
 - Watch for signs of infection (temp, LOC, persistent vomiting, nuchal rigidity, pupil changes)
- Epidural hematoma (bleeding into the head)
 - “over” the dural area; most of these vessels are arteries so you get a lot of bleeding really fast
 - Most common in temporoparietal area (big artery here)
 - Surgery if expanding
- Subdural hematoma
 - the vessels under the dura tend to be venous, so slower bleed
 - Increased risk seizures (blood is irritating to the brain)
 - May be acute/chronic
 - May require drainage
- Head Trauma: Treatment
 - Assessment: Hx, PE, ABCDE, serial neuro exams
 - Aggressive support ABC’s
 - Manage ICP
 - Abuse? work up to include
 - Ophthalmology exam
 - Bone scan (looking for old fractures)
 - Assess for deficits cranial nerve function; do this outpatient basis b/c easier to do once crisis has passed
 - Long term follow up; tell teachers and coaches

Concussion

- Symptoms
 - Physical: worst headache ever, dizziness, N/V, vision changes, drowsy
 - Cognitive: memory loss of event or right before event; repetitive questioning
 - Emotional
 - Behavioral
- Management of Concussion
 - Assessment; CT scan
 - Patient/family education; child should rest; watch child for neuro signs; should not return to play until child has no symptoms at rest and no headache at initiation of activity.

Spinal Cord Injury

- Child move head at C1-C2, so this is the weakest part of the neck...leads to high spinal cord injuries
- Always a concern with trauma
- Spinal precautions until injury ruled out
- SCIWORA (spinal cord injury without radiographic abnormality) = bones aren’t broken, but cord is damaged
- Most SCI in children d/t compression, edema
- Treatment: ABC, early fusion, immobilization in halo jacket

- After initial phase, care focused on preventing complications and achieving optimum rehabilitation

Cervical/Spinal Precautions

- Cervical vs. thoracolumbar/lumbar vs. full spinal
- Cervical collar fit/adjustment; difficult to fit kids d/t varying sizes
- Skin inspection/care if child wearing collar; this is a two person job!
- Positioning
- Patient/family education

Trauma: Thoracic Injuries

- Thoracic
 - Pulmonary contusion d/t soft chest wall; can develop respiratory symptoms over next 24-48 hours even if they show up and seem fine initially. Watch RR, WOB, O2 sats, breath sounds
 - Pneumothorax: really hard to hear a small pneumo; watch for increased WOB
 - Hemothorax: can hear this, will sound dull. If child is in hypovolemic shock and the blood is not going out and the belly is soft...think of the chest!
- Traumatic Asphyxia
 - Typically thing you'll see with this is the toddler that runs out behind dad's car and drives back over them...the child sees the car coming, takes a deep breath full of air...car runs over chest and the lungs pop...get bilateral pneumothorax. The blood in the chest is going to go out of the chest via the path of least resistance (up the SVC and into the facial veins). These kids come in and do well if they get very rapid EMS (needle decompression), but are black and blue throughout the whole face/head area. Brain is fine though! Long-term they have significant pulmonary contusion and some level of ARDS.
- Intra-abdominal Injury
 - NPO; admit child to hospital and make them NPO until you know what's up
 - Serial labs, H/H, amylase, lipase
 - Serial abdominal assessment (look for signs of peritoneal irritation...rigid, distended abdomen)
 - Less surgical intervention with these...more watching.
- Seat-belt injury
 - Kids often just use the lap belt, leading to a seat-belt injury caused by an acute flexion over the belt
 - Chance fracture (lumbar spine fracture)
 - Intestinal perforation or duodenal hematoma
 - "seat belt sign +" (how it looks when it makes a mark on the abdomen)

Trauma: Nursing Care Issues

- Assess/monitor ABC's
- Treat pain
- Promote recovery
- Prevent complications
- Facilitate coping and development

Hockenberry, Marilyn J.. *Wong's Essentials of Pediatric Nursing*. Seventh Edition ed. St. Louis: Mosby, 2005. Print.

Parsh, B. (2010, April 9). Pediatric Ortho/Trauma. Pediatric Nursing. Lecture conducted from CSU Sacramento, Sacramento

Sampson, J (2010, April 9). Pediatric Ortho/Trauma. Pediatric Nursing. Lecture conducted from CSU Sacramento, Sacramento.

Tobar, K. (2010, April 9). Pediatric Ortho/Trauma.. Pediatric Nursing. Lecture conducted from CSU Sacramento, Sacramento.