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Management of Pediatric Trauma
Part 1

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Management of Pediatric Trauma Patients: Part 1

Growth and Development, Anatomy and Physiology, Mechanism of Injury, Head, Thoracic, Abdominal, and Musculoskeletal Injuries

Goals

- Identify the three concepts of energy associated with trauma
- Discuss the three types of injury associated with trauma
- Identify the unique characteristics of the different stages of growth and development
- Describe the mechanisms of injury associated with pediatric trauma
- Identify the appropriate interventions for head injury, chest trauma, abdominal trauma, and extremity injuries

Introduction

- Emergency medical services (EMS) systems in the United States were initially developed to care for adults
- They continue to deliver the large majority of their care to adult patients, with children estimated to account for 10% of EMS transports nationally
- Children cannot be treated simply as smaller adults because they pose unique challenges for assessment, pathophysiology, equipment, and medication dosing

Introduction

- Trauma is the leading cause of morbidity and mortality for children in the United States and Canada
- Trauma accounts for roughly 60% of all deaths for children aged 1 through 18 years in both countries
- The most common mechanisms for trauma-related death in children include blunt and penetrating injuries, drowning, strangulation or hanging, and fire
- 2/3 of US pediatric EMS transports are for injury or poisoning

Trauma Overview

- Traumatic injury occurs when the body's tissues are exposed to energy levels beyond their tolerance
- The mechanism of injury is the way in which traumatic injuries occur
- Mechanism of injury describes the forces acting on the body that cause injury

Trauma Overview

- Three concepts of energy associated with injury
  - potential energy
  - kinetic energy
  - work
- Potential energy
  - the product of mass, force of gravity, and height, and is mostly associated with the energy of falling objects
  - a child on the monkey bars has some potential energy because he or she is some height above the ground

Trauma Overview

- **Kinetic energy**
  - **the energy contained in a moving object**
  - **reflects the relationship between the mass (weight) of the object and the velocity (speed) at which it is traveling**
  - **formula: kinetic energy = ½mv2**
  - **energy cannot be created or destroyed, only converted**
  - **passengers in a vehicle involved in a motor vehicle collision (MVC) have kinetic energy because they were traveling at the same speed as the vehicle**
  - **their kinetic energy is converted to the work of bringing them to a stop, which results in possible injury**

Trauma Overview

- **Work**
  - **force acting over a distance**
  - **when the child on the monkey bars falls and hits the ground, the kinetic energy is converted into work**
  - **the work of bringing the body to a stop and thereby fracturing bones and damaging tissues**

Growth and Development

- The mechanisms of injury in pediatric trauma are based on the developmental milestones in a child's development so practical knowledge of pediatric anatomy and physiology and the child's response to injury is of upmost importance in treating the traumatized child
- When children are injured, you may have more than one patient to treat
- Family members, especially the parents or primary caregivers, often need help or support

Growth and Development

- Infants: 0-2 months
  - dependent on caregivers to meet their needs
  - spend most of their time sleeping and eating
  - understand and experience the world through their bodies
  - being held, cuddled, rocked, or comforted with familiar touch and smells soothes infants and develops their sense of trust
  - infant's relationship with primary caregivers is critical for their sense of well-being
  - hearing is well-developed at birth so calm, reassuring talk is helpful

Growth and Development

- Infants: 2-6 months
  - can recognize their caregivers
  - can sit if propped up
  - have almost no head droop while in sitting position
  - raise head 90° when placed on stomach
  - able to roll from front to back
  - able to grasp rattle with both hands
  - able to place objects in mouth
  - demand attention by fussing

Growth and Development

- Infants: 6-12 months
  - can reach for objects
  - can sit for long periods
  - crawl and even walk
  - can pick up small objects using their thumb and index finger
  - can place objects in their mouth
  - exposed to more physical dangers than before
  - may develop an attachment to toy or object
  - may experience separation anxiety and cling to their parents

Growth and Development

- **Infants: physiologic characteristics**
  - **breathe predominately using abdominal muscles**
  - **any pressure on the diaphragm from above or below can impede respiratory effort**
  - **circulating blood volume is approximately 90 ml/kg**
  - **volume losses that may be perceived as insignificant can cause circulatory compromise**
  - **the autonomic nervous system is not fully developed**
  - **the infant's ability to control body temperature in response to environmental changes is limited**

Infant Assessment

- **Approach the infant slowly, gently, and calmly – loud voices and rapid movements may frighten the infant**
- **Assess the infant while he or she is held by the caregiver whenever possible to decrease the chance of separation anxiety**
- **Although separating a two-week-old infant from a parent will not cause distress, an older infant in stable condition will be most calm in a parent's arms**
- **Decide the order of your examination based on the infant's activity level, such as obtaining a respiratory rate and auscultating lung sounds while the infant is calm and quiet**

Growth and Development

- Toddlers: 12-18 months
  - begin to walk and explore their environment
  - able to open doors, drawers, boxes, and bottles
  - curious and have no sense of danger, making them vulnerable to serious injury
  - begin to imitate the behaviors of older children and parents
  - knows major body parts when you point to them
  - anterior fontanel is closed by 18 months

Growth and Development

- Toddlers: 18-24 months
  - may have a vocabulary of 10-15 words
  - begin to understand cause and effect
  - begin to run and climb
  - strive for independence; their favorite word is no
  - fear separation from caregivers and loss of control
  - have a special object, such as a blanket or teddy bear
  - imitates health behaviors of primary caregivers

Toddler Assessment

- Begin with observation of the child's interactions with the caregiver – vocalizations and mobility assessed using the Pediatric Assessment Triangle (PAT)
- Approach the child gradually, keeping physical contact minimal until the toddler is acquainted with you
- Examine toddlers in stable condition on the parent's lap and allow the child to hold objects that are important to them
- Prepare the toddler immediately before a procedure using simple, concrete age-appropriate terms
- Tell the child when the procedure or assessment is complete

Growth and Development

- Preschoolers: 3-5 years
  - magical and illogical thinkers and have difficulty distinguishing fantasy from reality
  - have many misconceptions about injury and body functions, such as their insides will leak out if they have a cut
  - often take words and phrases literally
  - fears include body mutilation, loss of control, and being left alone
  - strongly identifies with parent of same gender
  - falls are a major cause of injury, secondary to climbing on objects

Preschooler Assessment

- Allow the preschooler to play with or hold equipment that is safe
- Assess the child's level of understanding and correct erroneous or unclear ideas since medical vocabulary may be misinterpreted and misleading, such as "I am going to take your temperature" being interpreted as taking something away – say "I am going to measure your temperature" instead
- Use games to gain cooperation
- Set limits on behavior, but offer choices whenever possible to promote feelings of control
- Respect modesty – only expose what is necessary to complete exam

Growth and Development

- School-age: 6-12 years
  - developing a sense of accomplishment and mastery of new skills
  - usually have smooth and strong motor skills; however, their coordination, endurance, balance, and physical abilities vary
  - older children tend to hide their thoughts and feelings
  - develop a general knowledge of medical intervention, often based on media reports and television shows

School-Age Assessment

- Allow the school-aged child to participate in their care
- Explain procedures simply and allow time for questions
- Can understand the difference between emotional and physical pain
- Provide ongoing reassurance and encouragement
- Keep the child covered as much as possible during their assessment and treatment
- Games and conversation may distract the school-aged patient
- Asking about school will often allow the child to warm up to you
- Ask them to describe their favorite place, pets, or toys

Growth and Development

- Adolescents: 12-18 years
  - a period of experimentation and risk-taking activity
  - have little common sense
  - are acutely aware of their body appearance
  - common fears include changes in appearance, dependency, and loss of control
  - may regress to earlier stages of development when stressed or in pain to seek comfort
  - may experience mood swings, depression, eating disorders, and violent behavior

Adolescent Assessment

- Address the patient during the assessment
- Treat as an adult
- Encourage patient's questions and involvement
- Provide accurate information
- Teen may become alienated and uncooperative if they suspect you of being misleading
- Address concerns and fears about the lasting effects of their injuries, especially cosmetic
- Respect patient's privacy – address the patient without the caregiver present, if possible
- Be aware of scene safety

Anatomy and Physiology

- Head
  - one difference that is obvious on assessment of the infant and toddler is the proportionately larger head, specifically the occipital area
  - special care must be taken when you are positioning the child's airway
  - in seriously injured children, younger than three years, place a thin layer of padding under the back to obtain a neutral position

Anatomy and Physiology

- Head
  - during infancy, the anterior and posterior fontanels are open – fontanels close by 18 months
  - infants and children are especially prone to head trauma, such as during a fall in which gravity takes them head first due to their proportionally larger heads
  - in an injured infant, bulging of the fontanels indicates increased intracranial pressure and sunken fontanels can indicate dehydration or hypovolemia

Anatomy and Physiology

- Airway
  - the most notable differences can be seen when the adult upper airway is compared with that of the neonate and infant upper airway
  - compared with the adult, the neonate and infant nose is softer, with more mucous and lymphoid tissues present

Anatomy and Physiology

- Airway
  - because of the smaller diameter of the nasal passages, it takes much less swelling or secretions to affect airflow – this can easily lead to obstruction since infants are known to be obligate nasal breathers until they reach 2-6 months of age
  - an improperly placed mask can obstruct the airway

Anatomy and Physiology

- Airway
  - during the neonatal and infant stages, the tongue is located closer to the palate by a more superiorly located larynx – this can potentiate airway obstructions
  - the neonate and infant larynx is typically located at C3-4 and may even be as high a C2-3, whereas the adult larynx is located at the junction of C4-5 – this superior position creates a more acutely angled view of the vocal cords during direct laryngoscopy

Anatomy and Physiology

- Airway
  - the neonate and infant epiglottis tends to be longer, floppier, and omega shaped, making the straight laryngoscope blade potentially more effective in viewing the glottic opening
  - the epiglottis also sits at a greater angle to the anterior pharyngeal wall, making visualization of the vocal cords more difficult

Anatomy and Physiology

- Airway
  - most of the cartilaginous structures of the pediatric airway are softer and more pliable than the adult's, increasing the chances of compression and obstruction of the airway when pressure is applied, such as with the Sellick maneuver

Anatomy and Physiology

- Airway
  - the cricoid ring in the neonate, infant, and young child makes the larynx funnel-shaped, as opposed to the cylindrical shape of the adult and adolescent larynx, which allows an uncuffed endotracheal tube to create a relative subglottic seal
  - the costae are more horizontal and contribute less to inspiratory and expiratory efforts, forcing the diaphragm to do most of the work, especially in neonates

Anatomy and Physiology

- Respiratory system
  - the infant's respiratory muscles are primarily composed of type II (fast-twitch) fibers, and have lower stores of glycogen and fat, allowing them to become easily fatigued after short periods of exertion or labored breathing – this emphasizes the importance of rapidly establishing and maintaining the pediatric airway

Anatomy and Physiology

- Respiratory system
  - elevated metabolic rate
  - rate of oxygen consumption is more than double that of adults: 7-9 ml/kg/min vs 3 ml/kg/min in adults
  - lower functional residual capacity: 22 ml/kg on average for toddlers vs 34 ml/kg for the adult
  - the newborn has half the number of alveoli and only 1/20th the surface area available for gas exchange compared with the adult

Anatomy and Physiology

- Cardiovascular system
  - children rely mainly on their heart rate to maintain adequate cardiac output
  - the major cardiovascular complication to be aware of is hypovolemia
  - the initial response to blood loss in children, as in adults, is tachycardia – an infant's heart rate may reach 200 beats/min or more if the body needs to compensate for blood loss due to injury

Anatomy and Physiology

- Cardiovascular system
  - tachycardia is the primary compensatory mechanism for decreased oxygenation
  - children as old as eight have a limited, but vigorous cardiac reserve
  - children have a larger circulating blood volume compared with adults; however, their absolute blood volume is less (70 ml/kg)

Anatomy and Physiology

- Cardiovascular system
  - compensatory mechanisms, such as vasoconstriction, can shunt enough blood from the skin and extremities to keep their vital organs going, even if they have lost nearly 1/3 of their blood volume
    - this can maintain, or even cause, an increase in blood pressure even though they are still in shock or hypoperfusion
    - as blood loss continues to occur, pulses weaken, skin grows pale and cool, and hypotension develops (AKA “Deep Weeds”)

Anatomy and Physiology

- The nervous system
  - the brain and spinal cord in the pediatric patient are not as well protected by the developing skull and vertebrae as that of an adult
  - the neural tissue and vasculature are very fragile and prone to bleeding from injury
  - the subarachnoid space in a child is relatively smaller than that of an adult, providing less cushioning effect for the brain

Anatomy and Physiology

- Abdomen
  - begins at the child's nipple level
  - children are more prone to abdominal injuries
  - protrudes and has poor muscle tone
  - small, pliable ribcages offer less organ protection
  - solid organs are proportionally larger than an adult's
  - spleen is the most commonly injured solid organ, followed by the liver

Mechanism of Injury

- The manner in which the pediatric patient was injured
- Determining the mechanism of injury will provide many clues to finding hidden injuries and should be your first clue the child is potentially critically injured

Mechanism of Injury

- Evaluates three factors
  - the amount of force applied to the body
  - the length of time the force was applied
  - the areas of the body involved
- Knowledge of growth and development is crucial

Mechanism of Injury

- Significant mechanisms of injury include, but are not limited to:
  - multiple body systems injured
  - medium to high speed (>25 mph) vehicle collision
  - pedestrian vs vehicle collision
  - death of an occupant in the same vehicle
  - bicycle collision
  - falls >10 feet without loss of consciousness
  - falls <10 feet with loss of consciousness

Mechanism of Injury

- Non-significant mechanisms of injury include, but are not limited to:
  - minor isolated trauma to an extremity
  - minor falls without loss of consciousness

Blunt Trauma

- Occurs when a body area is struck by or strikes an object
- The transmission of energy, rather than the object, damages the tissues or organs beneath the skin as they collide with each other
- Muscle cells stretch, blood vessels tear, and bone may fracture
- Can also induce internal injury deep within the body cavity

Blunt Trauma

- Forces of compression cause hollow organs like the bladder or bowel to rupture, spilling their contents and hemorrhaging
- Alveoli or small airways may burst, permitting air to enter the pleural space
- Solid organs may contuse or lacerate, causing swelling and blood loss

Penetrating Trauma

- Incidence of penetrating trauma in the pediatric population is on the rise
- Caused by many mechanisms, the most common being knives, arrows, bullets, and blast injuries

Penetrating Trauma

- Low velocity injuries, such as injuries caused by knives, arrows, an object thrown by a lawn mower, or debris from a motor vehicle crash are usually limited by the relatively slow speed of the object when it enters the body – entrance wounds may not reflect the extent of injury
- High velocity injuries, usually caused by bullets, can cause extensive injury due to possible exit wounds and cavitation

Motor Vehicle Crashes

- The largest number of trauma deaths in children are due to motor vehicle crashes
- Three separate collisions occur
  - the vehicle striking another object or a sudden change in direction as in a rollover
  - the collision of the body with something in the car
  - organs striking other organs, muscle, bone, or other supporting structures
- Another collision can be loose objects that become projectile forces

Motor Vehicle Crashes

- Head trauma is a common injury for unrestrained children involved in a motor vehicle crash
- The unrestrained child's large head acts like a missile, leading the torso throughout the inside of the vehicle and through windshield
- Improper use of restraint systems can also lead to injury
- Patterns of injury may vary by the child's size, location in the vehicle, and restraint method used
- Infants have a greater risk of cervical fracture if car seat faces to the front

Collisions with Vehicles

- Children playing or riding a bicycle can dart out in front of motor vehicles without looking
- The area of greatest injury varies, depending on the size of the child and the height of the bumper at the time of impact
- Children who are injured in collisions with vehicles often sustain high energy injuries to the head, spine, abdomen, pelvis, or legs
- Children will often turn toward the oncoming vehicle prior to impact, whereas adults turn away

Airbag Injuries

- Although air bags have a good overall safety record and have saved thousands of lives, they pose several risks for children
- Children that are unbelted, improperly belted, or are too close to the dashboard when an airbag inflates are at risk for injury
- Children occupying the front seat have been killed or severely injured by front passenger air bags

Falls

- All children are at risk for falls
- Across the lifespan, children explore the world differently
- Falls account for greater than 1/3 of childhood injuries requiring medical attention
- In early childhood, children have a higher center of gravity
- Children can suffer facial trauma, upper extremity fracture, intraabdominal injury, abrasions, and chemical irritations

Falls

- The factors which contribute to the injuries sustained from a fall include the following:
  - the velocity of the fall
  - the child's body orientation at the time of impact
  - the type of impact surface
  - the amount of time force is applied to the body on impact

Falls

- Infants more commonly sustain falls from low objects, such as high chairs, baby walkers, shopping carts, beds, and tables
- Toddlers and preschoolers sustain falls from both low objects and high places, such as windows, balconies, and stairs
- School-age children are often involved in falls related to sports, or recreational activity, such as climbing, bicycling, playground equipment, and organized sports activities and can exhibit risky behavior

Recreational Injuries

- Although the health benefits of physical activity are clear, children who participate in sports and recreational activities are exposed to various injury risks
- The sports responsible for the highest number of EMS calls and emergency department visits are basketball, biking, football, baseball, skating, softball, and soccer
- Injuries from these sports include extremity injuries, head trauma, abdominal injury especially in football and soccer, and spinal cord injuries

Head Injuries

- Head injury is one of the most common types of pediatric trauma
- Occurs as a result of mechanisms associated with:
  - motor vehicle crashes
  - falls
  - sports and recreation
  - assault and child abuse

Head Injuries

- A child's brain may be damaged more than an adult's due to the thinner and more pliable cranium
- There are differences in cerebral blood volume and or cerebral tissue volume
- Young children can accumulate a significant percentage of their blood volume in their cranial vault
- Children can lose large amounts of blood from scalp lacerations

Head Injuries

- May present in hemorrhagic shock
- In infants less than 12 months of age, the white matter is not well myelinated and more susceptible to shearing injury and tears
- In children 13-23 months, there is a higher incidence of diffuse brain swelling and a lower incidence of subdural and epidural hematoma formation
- 5-15% also sustain associated neck injuries

Head Injuries

- Assessment and management
  - loss of consciousness, agitation, irritability, or listlessness
  - inability to recognize caregivers
  - persistent vomiting and retching (may indicate more severe injury)
  - prolonged seizure following injury (an infant may exhibit lip smacking or bicycling movements)
  - periorbital ecchymosis (raccoon eyes)

Head Injuries

- Assessment and management
  - postauricular ecchymosis (battle sign)
  - neurological deficits and signs of increased intracranial pressure
  - decreased or altered level of consciousness
  - bradycardia
  - vomiting
  - slurred speech

Head Injuries

- Assessment and management
  - posturing
  - seizures
  - inability to track objects
  - widened pulse pressure
  - pupil dilation with sluggish or absent reaction to light
  - ataxia while sitting, crawling, standing, or walking
  - bulging anterior fontanel, if fontanel has not closed

Head Injuries

- Assessment and management
  - care strategies are aimed at controlling secondary brain damage, such as cerebral swelling and ischemia
  - primary assessment A, B, C, D, E
  - provide adequate oxygenation
  - prepare for intubation if pediatric Glasgow Coma Score is eight or less
  - initiate an IV line and administer fluids as needed to maintain systolic blood pressure of 80-90 mmhg

Head Injuries

- Assessment and management
  - avoid fluid boluses in children who are hypertensive
  - spinal immobilization is necessary for all children who sustain possible head or spine injuries during a traumatic event
  - maintain normal body temperature to prevent an increase in intracranial pressure

Thoracic Injuries

- Majority occurring from blunt trauma
- Penetrating injuries are not as common in children, but may occur as a result of firearm accidents and high-velocity mechanisms
- Children have a soft, flexible ribcage that can be compressed a great deal without ribs breaking
- A significant force may cause injury to underlying structures without associated rib fractures or external signs of trauma

Thoracic Injuries

- Immediate life-threatening thoracic injuries include the following:
  - airway obstruction and injury
  - lung and chest wall injuries
  - open pneumothorax
  - tension pneumothorax
  - hemothorax
  - hemopneumothorax
  - flail chest

Thoracic Injuries

- Immediate life-threatening thoracic injuries include the following:
  - cardiac tamponade
  - hidden thoracic injuries
    - pulmonary contusion
    - myocardial contusion
- Airway injury: airway obstruction related to maxillofacial trauma or occasionally laryngeal injury

Thoracic Injuries

- Closed pneumothorax
  - when a force causes alveoli to rupture
  - air accumulates in the pleural space, leading to loss of the negative intrapleural pressure and partial or complete collapse of the lung
  - child may be asymptomatic if the pneumothorax is small or can present with respiratory distress and tachycardia
  - visible or palpable unequal chest wall movement
  - decreased or absent breath sounds to affected side
  - hyperresonant note to percussion over the affected side
  - if undiagnosed and untreated, may become a tension pneumothorax

Thoracic Injuries

- **Open pneumothorax**
  - occurs when a penetrating injury creates direct communication between the pleural space and the outside environment
  - the sudden equilibrium between the intrathoracic and atmospheric pressure causes collapse of the lung and a potential sucking chest wound
  - signs and symptoms are proportional to the size of wound
  - may present with respiratory distress and tachycardia
  - visible chest wound, reduced breath sounds, and a hyperresonant percussion note over the affected side
  - treatment involves placing an occlusive dressing over the wound and taping it down over only three sides to create a one-way valve

Thoracic Injuries

- **Tension pneumothorax**
  - the accumulation of air under pressure in the pleural space
  - occurs secondary to damage to the lung parenchyma or bronchus
  - air flows in during inspiration and is unable to escape during expiration, which progressively causes lung collapse
  - eventually leads to mediastinal shift to the opposite lung
  - reduces venous return
  - rapidly leads to hypotension and circulatory collapse
  - this may occur to a greater extent in young children who have a more mobile mediastinum than adults

Thoracic Injuries

- **Tension pneumothorax**
  - **children will present with severe respiratory and cardiovascular compromise, asymmetrical chest wall movement, decreased breath sounds to the affected side, distended neck veins, and in the late stage, tracheal deviation away from the affected side in older children**
  - **immediate intervention includes pleural needle decompression to the second intercostal space midclavicular line (insert large bore IV catheter over top of 3rd rib to avoid nerve and artery on bottom of rib)**

Thoracic Injuries

- **Hemothorax**
  - **occurs when blood accumulates in the pleural space, eventually leading to collapse of the affected lung**
  - **children have a smaller circulating blood volume, so the accumulation of smaller amounts of blood may be significant enough to produce signs of hypovolemic shock**
  - **usually presents with circulatory collapse, followed by respiratory distress**
  - **cyanosis**
  - **dyspnea**
  - **tachypnea and or ventilatory compromise**
  - **decreased chest wall movement**

Thoracic Injuries

- **Hemothorax**
  - diminished or absent breath sounds on the injured side
  - flat neck veins
  - dullness to percussion on the injured side
  - remember, hypotension tends to be a late sign in circulatory failure in children
  - compensatory mechanisms may initially mask serious hypovolemia
  - primary assessment with interventions as necessary
  - two large bore IV lines in place for volume replacement, if necessary, and prior to fluid removal

Thoracic Injuries

- **Flail chest and rib fractures**
  - flail chest is when two or more ribs are fractured in two or more places and a segment of the chest wall may be detached from the thoracic cage, resulting in paradoxical movement of the detached portion
  - rib fractures occur less commonly in children than adults – the elastic nature of their more cartilaginous bone requires greater force to fracture
  - the presence of rib fractures indicates significant transfer of energy to the tissues that lie underneath
  - the child will breathe as shallowly as possible to decrease movement of the thorax and therefore decrease pain
  - pulmonary contusion that results from a flail segment will impair gas exchange and lead to hypoxia and hypercapnia

Thoracic Injuries

- **Flail chest and rib fractures**
  - expose and examine the chest for deformities, contusions, abrasions, punctures/penetrations, burns, tenderness, lacerations, and swelling
  - examine for signs of respiratory distress, accessory muscle use, and any paradoxical motion
  - the child may find it easier and less painful to breathe if the flail segment is immobilized by taping a bulky dressing over the segment

Thoracic Injuries

- **Pericardial tamponade**
  - a collection of blood in the pericardial sac
  - most frequently occurs with penetrating injury, but can occur with blunt trauma as well
  - as blood accumulates in the noncompliant sac, it exerts pressure on the heart inhibiting ventricular filling – a small amount of blood can have a dramatic effect
  - the classic triad of narrowed pulse pressure, jugular venous distension, and muffled heart sounds may not present in children
  - children have short, fat necks, making the jugular veins difficult to see
  - children have thinner chest walls that allow more transmission of cardiac sounds

Thoracic Injuries

- **Pericardial tamponade**
  - **additional symptoms include hypotension, arrhythmias, and tachycardia**
  - **pericardial tamponade should be considered in any child with persistent hypotension, despite fluid resuscitation and adequate ventilation**
  - **initial treatment is pericardiocentesis**
  - **assess and manage airway, breathing, and circulation (ABCs), providing positive pressure ventilation when needed**
  - **obtain IV access and administer fluid to maintain cardiac output**

Abdominal Trauma

- **Abdominal trauma in children is related to a variety of causes, including sports, recreational activities, motor vehicle crashes, and bicycle crashes**

Abdominal Trauma

- Physiologic characteristics that increase the child's risk for developing abdominal injuries are:
  - the abdominals are thinner, weaker, and less developed
  - the chest wall is more pliable and does not provide as much protection to abdominal organs
  - the duodenum has an increased vascular blood supply
  - the liver, spleen, and kidneys are less protected by the ribs and overlying muscle and fat
  - solid organs in children are larger in proportion than adults

Abdominal Trauma

- Injuries to the spleen are the most common injuries in pediatric abdominal trauma
- Signs and symptoms of splenic injury
  - pain in the left upper quadrant of the abdomen which may radiate to the left shoulder
  - hypoactive or absent bowel sounds
  - dullness to percussion
  - signs of shock

Abdominal Trauma

- Liver laceration is a major cause of morbidity and mortality in children with abdominal trauma
- Signs and symptoms of liver laceration
  - abrasions or contusions to the right upper quadrant of the abdomen or right lower chest
  - abdominal distension
  - right-sided rib fractures
  - guarding, tenderness, or rigidity to palpation
  - signs of shock
  - dullness to percussion

Abdominal Trauma

- Assess for Cullen sign: bruises around the umbilicus which are predictive of significant internal abdominal bleeding
- Assess for Grey Turner sign: bruises in the right upper quadrant, left upper quadrant, or flank
- Open abdominal injuries: when an object enters the abdomen and opens the peritoneal cavity to the outside
- Evisceration: when the bowel protrudes from abdomen

Abdominal Trauma

- **Management**
  - goal during primary assessment is to evaluate the patient's ABCs and immediately care for any life-threatening injuries
  - expose the abdomen and determine the type of injury, extent of injury, and presence of shock
  - control any external hemorrhage
  - trauma to the kidneys, liver, and spleen can cause significant internal bleeding
  - cover an evisceration with saline-soaked gauze – occlusive dressings for organs
  - IV access for potential shock
  - monitor

Musculoskeletal Injuries

- **Occur more often as the child's environment expands to include bicycles, skateboards, snowboards, trampolines, and automobiles**
- **May sustain a fracture, sprain, subluxation, or dislocation of a joint**
- **Children often sustain musculoskeletal injuries without multisystem injuries**
- **These injuries are frequently related to sports and recreational activities**

Musculoskeletal Injuries

- Children's bones are more cartilaginous and therefore softer and more flexible than adult bones – this combined with the child's lower proportional muscle mass, means that the musculoskeletal system provides less protection for the internal organs
- The child's long bones tend to bend or crack rather than break
- A long bone fracture in a child suggests a high amount of absorbed energy

Musculoskeletal Injuries

- Greenstick fractures occur when bones fracture incompletely through the shaft – may not appear obviously bent
- If the child cannot bear weight on a long bone or has pain there, splint the limb and consider the bone fractured until proven otherwise
- Remember, immobilize the extremity one joint above, and one joint below, the suspected injury
- Injury to the epiphyseal plate of the bone during its development may affect normal growth

Musculoskeletal Injuries

- Subluxations occur in children as a result of a sudden, forceful, longitudinal pull on an extremity
- The most common subluxation is known as "nursemaid's elbow" or dislocation of the radial head
- History given is consistent with a sudden longitudinal pulling force on the extremity, such as a small child being pulled up or swung by an extended arm

Musculoskeletal Injuries

- Management
  - assess for deformities, shortness, or rotation of the affected extremity
  - edema or soft tissue injury
  - tenderness on palpation
  - reluctance or refusal to move or use an extremity

Musculoskeletal Injuries

- Management
  - assess for the “5 Ps”
    - pallor: Are the nail beds and skin pink? Does blanching occur with pressure? Is capillary refill <2 seconds?
    - pain: some children hesitate to complain of pain because injury might have occurred while disobeying caregivers
    - pulselessness: Are peripheral pulses distal to the injury present, strong, and equal?
    - paresthesia: What is the sensory status of the affected area and the area distal to the injury?
    - paralysis: Can the child spontaneously move the injured extremity?

Musculoskeletal Injuries

- Immobilize the injured extremity, including the joints above and below the site of injury
- Do not attempt to realign extremity
- If circulation is impaired, notify physician immediately
- Begin fluid resuscitation as necessary, and transport

This concludes part one of this presentation on the management of pediatric trauma patients. Part two covers drowning, burns, shock, fluid resuscitation, and advanced procedures.

Thank You

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