

# Pediatric Trauma: Are You Prepared to Care for This Child in Your PACU?

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- ▶ **Definition of Trauma:** 1 a : an injury (such as a wound) to living tissue caused by an extrinsic agent b : a disordered psychic or behavioral state resulting from severe mental or emotional stress or physical injury

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## ▶ **Epidemiology:**

- Injury is the leading cause of death in children > 1 year of age
- Death from unintentional injury accounts for 65% of all injury deaths in children younger than 19 years
- Each year approximately 20,000 children and teenagers die as a result of injury
- For every child that dies from an injury, 40 others are hospitalized and 1120 are treated in the ED.

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- ▶ Approximately 1 in 4 children receive medical care yearly due to unintentional injury
- ▶ The cost of injury for these patients in the US is around \$50 billion per year
- ▶ Increase in survival rate due to Pediatric Trauma Centers
- ▶ 17 million children live more than an hour's transport to a pediatric trauma center and may be treated in an adult trauma center

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▶ **Intentional Injuries:** Intentional injuries are injuries that occur with purposeful intent and include homicide, suicide, domestic violence, sexual assault and rape, bias related violence and firearms

▶ **Nonaccidental Trauma:** Non-accidental trauma (NAT) is an injury that is purposefully inflicted upon a child and is also called child abuse. Often the injury is to the skin and soft tissue, but approximately a third of NAT's are fractures.

▶ **Unintentional Injuries:** Unintentional injuries are injuries that occur without purposeful intent, and are a leading cause of death and disability

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## ▶ **Mechanism of actions/injury:**

- ▶ Falls (sports, trampolines, monkey bars)
- ▶ MVC's
- ▶ Struck by/against (blunt trauma)
- ▶ Bicycle related
- ▶ Penetrating injury (gun shot wounds, stabbing, dog bites, snake bites, eye globe injuries)
- ▶ Burns
- ▶ Drowning
- ▶ Machinery (lawn mowers)

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- ▶ Most Pediatric trauma is a result of blunt trauma with penetrating injury accounting for 10-20% of all pediatric trauma admissions. Blunt and penetrating traumas are interrelated in that blunt force can result in penetrating injury such as metal from cars, door handles.
- ▶ Trauma is the leading cause of death in children 1-17 years of age
- ▶ More prevalent in males
- ▶ Burns most common in children aged 1-4 years
- ▶ Upper limb fractures common in 5-9 years
- ▶ Lower limb fractures and traumatic brain injury (TBI) common in adolescents

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- ### ▶ Neuro Assessments
- ▶ Who needs one?
  - ▶ Everyone post operatively especially those injured by falls, MVC's and any type of head injury. Why? Establish baseline.
  - ▶ What is included in a neuro exam?

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- ### Guidelines for Basic Neurological Observation and Assessment:
- Level of Consciousness: Age appropriate Glasgow Coma Scale
  - Signs of Increased intracranial pressure
  - Pupillary response
  - Extremity movement and strength
  - Vital Signs

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- ### ▶ Assessing Level of Consciousness
- The Glasgow coma Scale is used to assess a patients level of Consciousness. The scale can be used on infants, children and adults and is modified depending on age. It assesses 3 activities:
- Eye opening
  - Motor response
  - Verbal response

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### Modified Glasgow Coma Scale for Infants and Children

	Child	Infant	Score
Eye Opening	Spontaneous	Spontaneous	4
	To Speech	To speech	3
	To pain only	To pain only	2
	No response	No response	1
Best Verbal Response	Oriented	Coos and babbles	5
	Confused	Irritable cry	4
	Inappropriate words	Cries to pain	3
	Incomprehensible sounds	Moans to pain	2
	No response	No response	1
Best Motor Response	Obeys commands	Moves spontaneously and purposefully	6
	Localizes painful stimuli	Withdraws to touch	5
	Withdraws in response to pain	Withdraws to response to pain	4
	Flexion in response to pain	Abnormal flexion posture to pain	3
	Extension in response to pain	Abnormal extension posture to pain	2
	No response	No response	1

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- ### Abnormal Flexion also known as Decorticate Posturing:
- Arms "to the core"
  - Internal rotation
  - Arms held in flexion
  - Legs held in extension

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### Abnormal Extension also known as Decerebrate Posturing:

- Arms held in flexion
- External rotation
- Legs held in extension
- Head and neck arched and stiff
- Toes pointed downward

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### Ways to Elicit a Painful Response:

- Peripheral Pain Response: Apply pressure to the lateral aspect of finger or toe with a pen/pencil. Apply the pressure for 10-15 seconds and document response.
- Central Pain Response: Use the knuckles of your fist to lightly apply pressure to your patient's chest and maintain for 15 seconds. Document response
- Supra-orbital pressure: Place the flat of your thumb on the supra-orbital ridge (it's the small notch below the inner part of eyebrow). Your hand should rest on patient's head. Apply gradually increasing pressure for 10 -20 seconds and document response.

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▶ Trapezius Twist: Using your thumb and 2 fingers grab about 2 inches of the trapezius muscle located at the angle where the neck and shoulder meet applying gradually increasing pressure for 10-20 seconds and document response. Note: high level spinal cord injury may interfere with response. Do not do if cervical spine not cleared.

If painful stimuli is required to arouse patient this is a RED FLAG and should be reported immediately!

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### Considerations when completing Glasgow Coma Scale:

- If unable to assess any of the parameters the score does not count
- Eye opening may not be able to be assessed due to swelling from trauma (Chart 1C under Eye Opening)
- If you can only open 1 eye document the response from that eye
- If ETT or trach present chart 1T under best verbal response
- Make sure that you receive report of patient's neuro status before the OR
- Talk to parents to get a developmental baseline (developmental delays)
- Is patient hearing impaired?

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### Signs of Increased Intracranial Pressure (ICP)

#### Infants:

- Sunsetting eyes ( eyes that look downward and do not cross midline when assessing vertical gaze)
- Bulging of anterior fontanel
- Distended head veins
- Increased sleepiness
- Vomiting
- Irritability

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### Signs of Increased ICP in:

#### Children:

- Headache
- Drowsiness
- Irritability
- Nausea/vomiting
- Ataxia
- A change in thinking or concentration

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### Assessment of Pupils:

- Check pupils for size, equality and reaction to light
- Check pupil size in ambient lighting. The size of the pupil adjusted to ambient light is the size charted.
- Check to see if pupils are midline or if there is a deviation
- Use a concentrated light source.

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- ▶ Turn off ambient light to assess reaction to light. Use a concentrated light source and check each pupil for direct constriction ( eye that light shines in reacts) and for consensual constriction ( eye that light is not shined in should also constrict). Move light from outer aspect of eye inward when performing checks, and document response
- ▶ Keep in mind that 20% of the population has anisocoria or unequal pupil size (a normal variation) Another RED FLAG is if pupils do not react or the response changes. Need to report changes. Anesthesia and meds on board?

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### Assessment of Limb Movement and Muscle Strength

- Can the patient follow commands?
- Can they move extremity against gravity and resistance?
- Are movements and strength the same on each side?
- Assess and document each extremity separately
  - a) Arms: straight arm lift, elbow flexion and extension
  - b) Legs: leg extension, plantar flexion and dorsiflexion

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### Assessment of Vital Signs (VS)

- ▶ Assess vital signs according to your hospital guidelines. Per ASPAN Standards, nurses interviewed state that VS are done Q 5-15 minutes for the first 15-30 minutes until stable then Q 15 minutes while in Phase 1 then Q 30-60 minutes while in Phase 2 including admission and discharge VS.
- ▶ Know your parameters for VS for the age of the child you are caring for.
- ▶ Note that changes in VS, especially BP can be late signs of decompensation.

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- ▶ Bradycardia can be a late sign of progressive increased ICP
- ▶ Bradycardia, Hypertension and Bradypnea are called the Cushing triad and indicate pressure on the medullary center of the brain
- ▶ The medulla is part of the brain stem regulates the autonomic and involuntary functions such as breathing, heart rate and blood pressure
- ▶ Be aware of medications given in the OR and effects on respiratory system

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### Neurovascular Checks:

Who needs them? Any patient with:

- Musculoskeletal trauma to an extremity
  - Fracture
  - Crush injury
- Post-operative
  - Orthopedic surgery (fractures, external fixators, casts)
  - Spinal surgery
  - Plastic surgery on extremities
  - Cardiac catheterization
  - Tourniquet applied for long time

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- Application of any restrictive dressing
- Application of traction
- Circumferential burns
- Signs of infection of the limb

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### 5 P's of Neurovascular Assessments:

- Pallor: an indication of perfusion of extremity
  - Color (pink, pale, blue white,)
  - Capillary Refill (brisk, delayed)
  - Temperature (warm, cool, cold, dry, moist)
  - Edema dependent? Mild or severe
- Pain: The most important indicator of possible compartment syndrome
  - Constant?
  - Worse with passive flexion of extremity?
  - No relief with pain meds? Disproportionate to injury?

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- Pulse: Always check distal to injury, dressing cast
  - Radial, brachial, Pedal, Posterior tibial
  - Is the pulse palpable?
  - Strong, weak, bounding or absent?
  - Can it be found with a doppler?
  - Mark spot where pulse can be found if weak or found with Doppler
- Paralysis: Can patient move extremity?
  - Spontaneous movement? Full or limited?
  - Increased pain with movement?
  - Follow commands? Watch infants and young children for extremity movement

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- Paresthesia: Does the patient have sensation in affected extremity?
- Pins and needles sensation?
- Numbness or tingling?
- Use varying pressures; light touch vs pricking
- Does patient state it feels like "it fell asleep"

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- Nerves and Sensation:
  - Radial Nerve: webbing space between thumb and index finger and back of hand
  - Median Nerve: webbing space between thumb and index finger and palmar surface of hand
  - Ulna Nerve: palpate between little finger and distal ring finger, on palmar and dorsal surface of hand
  - Peroneal Nerve: dorsal surface of foot
  - Tibial Nerve: Plantar surface of foot

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### Neurovascular Complications:

- Nerve injury (median nerve in supracondylar fractures most common injured nerve):
  - Median nerve injury (unable to make OK sign)
  - Brachial nerve injury (finger extension)
  - Ulnar nerve injury (numb pinky, claw hand)
  - Radial nerve injury (wrist drop)
  - Circumflex axillary nerve injury (numb deltoid)
  - Sciatic nerve injury (foot drop)
  - Peroneal nerve injury (foot drop)

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□ Compartment syndrome: Compartment Syndrome is a condition that occurs when the compartment pressure builds and is higher than the perfusion pressure and can result in muscle necrosis and nerve ischemia.

- Assess the 5 P's.

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- Pain and paresthesia are the early symptoms of compartment syndrome
- Diagnosis can be difficult in young children. It is suggested to use the 3 A's instead. Increasing anxiety, agitation and analgesia requirements.
- Acute compartment syndrome is a medical emergency!
- Compartment syndrome can affect any compartment in the body: hands, arms, feet, legs, abdomen.
- Compartment can occur from crush injuries, circumferential burns, snake bites or restrictive dressings (casts)

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### Hemodynamic Monitoring:

What do these vital signs tell me?

Temperature  
Heart Rate  
Respiratory Status  
Blood Pressure

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**Temperature:** Normal body temperature is usually 98.6 F but can range from 97-99 degrees F. A low temperature can signify poor perfusion, hypothermia, sepsis, or an infection. Complications of inadvertent hypothermia include:

- Surgical wound infection
- Coagulopathy
- Negative nitrogen balance
- Delayed wound healing
- Delayed post-anesthetic recovery

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- Delayed post-anesthetic recovery
- Prolonged hospitalization
- Shivering
- Patient Discomfort
- Morbid myocardial outcomes (d/t sympathetic nervous system activation)

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A high temperature can be indicative of infection, or Malignant Hyperthermia (although it is not the first sign). Intraoperative hyperthermia can have other etiologies such as:

- Infectious fever
- Blood in the fourth cerebral ventricle
- Mismatched blood transfusions
- Excessive warming

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### Heart Rate and Blood Pressure:

- Heart rate and blood pressure are used to evaluate hemodynamic status and to help rule out hemorrhage.
- Normal heart rates for infants and children vary by age. Know where to find normal values: PALS card, Broselow tape
- Normal blood pressure for children age 1-10 years old is greater than 90 plus 2x age.
- Hypotension is less than 70 plus 2x age in years.
- Infants 1 month to 12 months old <70
- Children over 10 years of age < 90
- Term neonates 0-28 days old <60

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- Tachycardia is usually the first sign of hypovolemia which is the most common type of shock seen in pediatric trauma patients.
- Cool and tachycardic → consider patient to be in shock unless proven otherwise
- Children are able to compensate due to physiologic reserve and so blood pressure is a late sign and sign of decompensation.
- Bradycardia in a hypotensive child along with poor perfusion is an ominous sign and needs immediate treatment to prevent cardiac arrest
- Patients with tachycardia, fevers, or in pain, with an injury may exhibit tachycardia

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### Respiratory Rate:

Assess patient's respiratory rate. Know normal range for age

Too fast or too slow?

Effort of breathing?

Oxygen saturation?

Breath sounds

Fast respirations with tachycardia with injury can be pain.  
Need to complete full assessment to rule out shock

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### Sepsis:

- The infectious organism or endotoxins activate the immune system including macrophages, neutrophils and monocytes
- The interaction of these cells with the infecting organism stimulates release of inflammatory mediators (cytokines) that continue the inflammatory response
- Cytokines produce vasodilation and damage to the lining of the blood vessels causing increased capillary permeability
- Cytokines activate the coagulation cascade and may result in microvascular thrombosis and disseminated intravascular coagulation (DIC)
- Specific inflammatory mediators can impair cardiac contractility and cause myocardial dysfunction

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- The combination of inadequate perfusion with microvascular thrombosis leads to ischemia. Diffuse and patchy, and due to the variability of perfusion throughout the body, there are varying levels of hypoxia and ischemia

- In septic shock, peripheral perfusion may appear adequate, may have fever or be hypothermic, and WBC may be increased, normal or decreased

- If Lactate greater than 2mmol/l and sepsis suspected begin treatment. Elevated lactate is a late sign in pediatrics

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### Treatment for Sepsis:

Administer IV antibiotics within first hour of onset, administer IVF bolus and repeat bolus as necessary. Start vasoactive drug therapy if shock persists after fluid boluses. Reassess after each bolus. Further management includes monitoring and support of organ function, treatment of the source of the infection, and evaluation of therapy. Transfer to higher level of care as needed.

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### PACU Initial Assessment:

#### Physical Assessment:

- Airway, Breathing, Circulation and Disability
- Baseline observations (Vital Signs)
- Oxygen requirements
- IV Fluids
- Analgesia
- Urine Output
- Reportable Blood Loss
- Assessments of wounds, incisions including dressings
- Presence and Patency of Drains including NGT

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Observations should be made at least every 15 minutes or more frequently if needed. Follow your Institutions policy for VS (Q15 mn x4, Q30 mn x2 Q 1hr x2 etc.) until your patient meets Discharge Criteria.

#### Discharge Criteria:

- VS, Observations within age appropriate limits
- Core temp > 36 degrees
- Sedation score 2 or less
- No active vomiting
- Pain managed

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### PACU Nursing Interventions:

#### Primary survey:

- Airway
- Breathing
- Circulation
- Disability
- Exposure

Evaluate-identify- intervene sequence is continuous  
Secondary Survey (more comprehensive assessment)  
Transition to definitive care

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### Airway: (and cervical spine stabilization)

- Is the airway open?
- Signs of obstructed airway:
  - increased respiratory effort with retractions
  - abnormal inspiratory sounds (stridor, snoring)
  - No airway or breath sounds though there is respiratory effort
- Chest/abdomen movement
- Head tilt, chin lift to open airway
- If cervical spine injury suspected jaw thrust without head extension
- Advanced interventions if airway cannot be maintained (intubation)
- Oral airways
- Nasal airway

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### Cervical spine immobilization:

- Motor Vehicle collision
- Peds Struck collision (bike, motorcycle)
- Falls
- Injuries to clavicle, abdomen, flank, back, spine, pelvic fracture
- Altered mental status, intoxication
- Guarding of the neck
- Anatomic disposition to neck injury Down syndrome, previous neck injury

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- Patient may arrive in PACU with C collar on. Needs to stay on until cleared.
- May have distracting injury such as femur fracture and be focused on that pain versus pain in neck
- CT to clear

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### Breathing:

- Respiratory rate and pattern
- Respiratory effort
- Chest expansion and air movement (lung and airway sounds)
- O2 saturations

Respiratory rates vary by age but a respiratory rate < 10 or > 60 consistently is not normal and requires further assessment

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### Breathing pattern:

- Regular
- Irregular
- Fast (high fever, pain, sepsis)
- Slow (CNS injury, hypoxia, shock, hypothermia, drugs that depress respiratory drive, respiratory muscle fatigue)
- Apnea

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### Breathing Effort:

- Conditions that cause increased resistance to airflow (asthma, bronchiolitis)
- Or conditions that cause the lungs to be difficult to inflate (pneumonia, pulmonary edema, pleural effusion)
- Nasal flaring
- Retractions
- Head bobbing, seesaw retractions
- Gasping, grunting or use of accessory muscles

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### Chest expansion, lung and airway sounds:

- ▶ Tension pneumothorax: breath sounds on one side, tracheal shift
- ▶ Flail chest: asymmetric chest rise
- ▶ Hemothorax: unilateral decreased breath sounds, dullness to percussion
- ▶ Abnormal breath sounds: stridor, wheezing, gurgling, grunting, gasping, crackles
  - Stridor: upper airway obstruction, high pitched
  - Grunting: exhaling against a partially closed glottis, keeps small airways and alveolar sacs open. Can be from pain or fever. May indicate progression from respiratory distress to failure. Pulmonary contusion, acute respiratory distress syndrome, cardiac conditions.

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- Snoring: normal, soft tissue swelling
- Wheezing: lower airway obstruction, asthma or bronchiolitis
- Crackles: or rales sharp cracking inspiratory sounds lung tissue disease
- Gurgling: bubbling sound heard during inspiration or expiration Upper airway obstruction from airway secretions, blood, vomit

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### Pulse oximetry:

- Used to assess hemoglobin saturated with oxygen.
- Sensors applied opposite each other on a pulsatile tissue bed, waveform appropriate, pulse rate matches EKG rate.
- Can indicate low hypoxemia before bradycardia or cyanosis
- Bright light in room can affect reading
- Weak pulses or poor perfusion can cause errors in reading

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- ❑ Can report false high readings in carbon monoxide poisoning as it doesn't differentiate between carboxyhemoglobin and hemoglobin saturated with oxygen
- ❑ Need to assess patient- as patient can have normal O2 saturation and be in respiratory distress
- ❑ Only indicates oxygen saturation and not oxygen delivery (ex: if patient anemic, O2 sat may be 100% but O2 content in the blood and O2 delivery may be low)

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### Interventions for Respiratory Distress or Failure:

- ❑ Support an open airway
- ❑ Administer O2 (cannula, mask, high concentration delivery system)
- ❑ Assist ventilation with bag mask device
- ❑ Prepare for advanced airway (if needed)

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### Circulation/ Fluid Resuscitation:

Circulation is assessed by:

- Heart rate and rhythm
- Pulses
- Capillary refill time
- Skin color and temperature
- Blood pressure

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- ❑ Know normal values for your patients age
- ❑ Check central and peripheral pulses (weak, strong)
- ❑ Normal capillary refill time is 2 seconds or less
- ❑ Skin color (pale, pink, dusky, cool, hot, mottled)
- ❑ Blood Pressure: hypotension is  $<70$  plus 2x years of age in children age 1-10 years

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### Fluid Resuscitation :

- ❑ Hypovolemic and Distributive Shock:
  - 20 ml/kg bolus of isotonic crystalloid over 5-10 minutes (repeat as needed)
- ❑ Cardiogenic Shock:
  - 5-10 ml/kg over 10-20 minutes (repeat as needed)
- ❑ Burns: varies as there are different formulas
  - Most common  $4\text{ml/kg}/\%TBSA$  burn +  $1500\text{ ml}/\text{m}^2$  total BSA of LR
  - Need to also give some D5W as peds patients have limited glycogen stores and risk hypoglycemia

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### Rapid IVF Delivery:

Make sure IV is patent and use as large IV as possible  
 Use a stop-cock and 60 ml syringe to implement the push-pull method to deliver fluid  
 Most IV pumps can not deliver fluids at a sufficient rate  
 Reassess patient after each bolus (HR, BP, breath sounds, mental status, urine output)

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### Disability:

An evaluation of neurologic function.

□ Level of consciousness

□ TICLS:

- Muscle Tone
- Interactiveness
- Consolability
- Look/gaze/ stare
- Speech/cry

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### AVPU Scale: a tool to rapidly assess cerebral cortex function

**Alert:** awake, active and appropriately responsive to caregivers. (appropriateness based on child's age/ developmental level)

**Voice:** Child responds only to voice

**Painful:** Responds to painful stimuli

**Unresponsive:** Does not respond to any stimulus

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### Correlation of AVPU to GCS:

Response	GCS
A	15
V	13
P	8
U	6

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### Pupil Response:

□ Normal pupil response to light

**PERRL**= Pupils Equal Round Reactive to Light

Document: Size, Equality of pupils, Constriction of pupils

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□ Abnormal pupil response:

- Pinpoint pupils: narcotic on board (opioids)
- Dilated pupils:
  - Predominant sympathetic autonomic activity
  - Sympathomimetic ingestion (cocaine)
  - Anticholinergic ingestion (local or systemic atropine)
  - Increased Intracranial Pressure

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□ Unilaterally Dilated Pupils:

- Inadvertent topical absorption of a breathing treatment (Ipratropium)
- Dilating eye drops

□ Unilaterally dilated Pupils with altered mental status:

- Ipsilateral (same side) lateral herniation of the temporal lobe, caused by increased ICP

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### Exposure:

- Perform a focused physical exam
- Remove clothing and observe front and back of trunk, extremities, face and head
- Use heat lamps if needed to maintain temperature
- Look for evidence of trauma:
  - Bleeding
  - Burns
  - Bruising
  - Extremity deformity

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### Secondary Assessment:

- ▶ A focused history and detailed physical exam
    - Signs and Symptoms
    - Allergies
    - Medications
    - Past medical history
    - Last meal
    - Events
- Always Evaluate-Identify-Intervene It's a continual process

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### Case Study #1

- ▶ Patient FD is a 14 year old African American male. No previous medical or surgical history. No allergies.
- ▶ Was out for a walk to get something to eat, got into an altercation with an unknown assailant and was stabbed multiple times. No loss of consciousness.
- ▶ EMS noted stab injuries to the left flank, left scapula, left forearm. A dressing was placed over each site. On arrival to ED patient complaining of generalized severe abdominal pain made worse by palpation

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### ▶ VS:

BP: 132/64 (left arm), Pulse=77, Temp: 37.4 C (axillary)  
Resp.=18

Wt. 59 kg SpO2 100% room air

CT obtained showed free air near stomach, left eighth rib fracture, concern for hollow viscus injury

Labs: HGB 9.9 WBC 3.57 Hct. 32.5

Level 1 to OR with verbal consent from grandmother

### ▶ OR findings:

- ▶ 3 cm left diaphragm injury, fractured rib, moderate liver laceration in left lateral segment, through and through gastric perforation (2 holes in stomach)

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- ▶ Arrived to PACU with NG (placed on LIS). Left chest tube placed to 20 cm suction, Skin vac in place
- ▶ VS: T: 37.7 P: 100 BP: 118/64 R: 20 SpO2: 100% face mask
- ▶ Concerns? What to watch for? Bleeding, Respiratory Distress, Pain
- ▶ Patient did well but was readmitted 2 days after discharge for abdominal pain. Constipation from opioids.
- ▶ Received enemas and had large bowel movements with relief of pain.

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### Case Study #2

- ▶ Patient is a healthy 6 year old that fell off the monkey bars and has a left supracondylar fracture.
- ▶ Patient able to move fingers, but unable to make the OK sign. States fingers feel funny. Fingers pink, warm with brisk refill
- ▶ VS: T: 37 P: 110 R: 24 BP: 105/62 SPO2: 99% on room air Weight: 20 kg
- ▶ Patient to the OR for CRPP and casting

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- Received patient from OR with long cast on left arm. Arm elevated on 1 pillow. Fingers cool, dry with capillary refill at 2-3 seconds
- As patient awoke, he was crying with pain. Patient received Toradol in the OR along with Fentanyl 20 mcg IV
- Patient given Tylenol and Oxycodone 2mg po
- Patient continues to complain of pain in left arm, fingers cool, dusky with cap refill 4-5 seconds

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- Orthopedics notified and came to bedside. Concern for compartment syndrome.
- Patient crying and not consolable, pain medications not working.
- Patient back to the OR for fasciotomy.

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