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Management of a critically ill or injured child demands a systematic approach. This systematic approach must include a plan to identify and begin emergent treatment for stabilization of the patient even before a complete history and physical examination are obtainable. In addition, a timely, directed evaluation of each body area must be performed in order to minimize the chance of overlooking potentially serious additional/contributing illnesses or injuries.

The above is accomplished utilizing a PRIMARY and SECONDARY SURVEY system. The PRIMARY SURVEY is an initial assessment of the status of the patient's airway, oxygenation, ventilation, circulation and neurologic status. During this phase, life-threatening problems are identified and, because it is not uncommon to encounter serious physiologic alterations in the course of the primary survey, it is frequently necessary to interrupt the order of the survey to perform resuscitative measures. In contrast, the SECONDARY SURVEY includes a detailed, timely complete physical exam. It surveys each body area in a head-to-toe fashion. Included here are a directed history, a brief past medical history, indicated lab and/or radiographic studies which may lead to a specific diagnosis or a list of problems which may require further attention.

Mneumonics based on the ABCs can help guide one in the performance of both of these surveys.

Primary Survey

Airway

The goals of airway management are:

- Recognition and relief of obstruction
- Promotion of adequate gas exchange
- Prevention of aspiration of gastric contents
- Attention to protection of the cervical spine

Treatment/Therapeutic modalities:

- Triple Airway Maneuver: tilt head back, displace mandible forward open mouth (jaw thrust alone with suspected neck injuries - NOTE: the tongue is the most common obstruction to the pediatric airway)
- Use oral suction cautiously; may need oropharyngeal airway
- Endotracheal intubation; cricothyroidotomy

Breathing/Ventilation

Observe for adequate gas exchange - look, listen, feel. Deficient air exchange must be rapidly diagnosed and treated. The following mnemonic addresses treatable causes of inadequate breathing:

Cause	Intervention
A irway obstruction	jaw thrust
T ension pneumothorax	aspiration/chest tube
O pen pneumothorax	aspiration/chest tube
M assive pneumothorax	aspiration/chest tube
F lail chest	positive pressure ventilation
C ardiac tamponade	pericardiocentesis
G astric distension	NG tube

Methods to Augment Ventilation

- Mouth to mask (over patient's mouth/nose) breathing
- Bag-valve-mask ventilation
- Endotracheal intubation with mechanical ventilation
- Cricothyrotomy (needle/surgical)

Generous use of O₂ (100%) is warranted initially in almost all emergency settings. NOTE: Children will electively place themselves in a position of maximal airway comfort when allowed/able to do so. Do not change this position unnecessarily until more definitive airway/breathing measures are available.

Oxygen should be supplied by a means that meets the patient's needs, ie, percent of O₂ needed AND that is acceptable to the patient, eg: hood, nasal prongs, face mask, shield, cannula, etc.

Circulation

Assess overall circulatory status - note the quality, rate and regularity of the pulses - centrally and peripherally. Determine capillary refill time and blood pressure NOTE: blood pressure is an insensitive measure of adequate circulation in children until profound deficiencies exist - compromised circulation can and does exist despite a normal blood pressure.

APPROACH TO PEDIATRIC EMERGENCIES

Provide circulatory support; diagnose and control both external and internal hemorrhage:

- Control active hemorrhage - direct pressure
- IVF, crystalloid/colloid/blood
- MAST suit application (rarely truly appropriate in pediatrics)
- External cardiac massage (CPR)
- Defibrillation

Obtain reliable venous access: IV/IO access

Blood for lab studies, including Type and Crossmatch

Disability (De-Brain)

Rapid screening of neurological system is essential. Obtain "neuro vital signs": assessment of pupillary response; level of consciousness [Alert, Verbal response, Pain response, Unresponsive]; notation of localized signs.

Calculation of Glasgow Coma Scale can be used.

Exposure/Environment

Complete physical exam requires the removal of all clothing. Children cool rapidly because of their large surface-to-body ratio. Maintain temperature by radiant warmer or warming blanket at 36-37° C.

Address hypo-hyperthermia as needed.

Foley Catheter

Do not place if blood at urinary meatus or with suspected pelvic fracture

Gastric Decompression - Orogastric/Nasogastric Tubes

Do not place if suspected facial fractures present. **Always** confirm placement.

CHAPTER 17

History

Obtain an **A M P L E** history

A llergies

M edication

P ast medical illness

L ast medication

E vents surrounding illness/injury

Secondary Survey

Detailed Physical Exam

Head (HEENT)

- Maxillofacial trauma - palpate bony prominences; evidence for bloody or CSF discharge from nose, mouth, ears; nasal septal hematoma; check dentition; suspect basilar skull fracture with Battle's sign, raccoon eyes, hemotympanum
- Dehydration - sunken fontanelle and/or eyes
- Eyes - pupillary size and reaction, visual acuity, fundal exam
- Scalp - exam for lacerations/hematomas
- Fontanelle - sunken: dehydration
- bulging: may indicate increased ICP, meningitis/sepsis

Neck

Palpate for obvious signs of fracture/dislocation and midline position of trachea; examine for SQ emphysema, hematoma, localized pain; assess for JVD; **[NECK/C-SPINE FILMS]**

Chest

- Evaluate visually for adequacy of respiratory excursion, asymmetry of chest wall motion or presence of a flail segment
- Carefully palpate chest wall and auscultate lung fields and heart
- R/O pulmonary/myocardial contusion, aortic/tracheobronchial/esophageal disruptions; **[CHEST FILMS]**
- Examine/assess respiratory adequacy by: skin color, nasal flaring, use of accessory muscles, grunting, stridor, wheezing, positioning of child

APPROACH TO PEDIATRIC EMERGENCIES

Abdomen

- Initial exam: inspect for ease of abdominal wall movement with respiration, gentle palpation, auscultation of bowel sounds.
- Observe and palpate flanks
- Serial examinations are often needed to establish a definitive diagnosis
- Investigate pregnancy and its related problems with female patients

Pelvis

- Palpate bony prominences for tenderness, instability
- Exam perineum for laceration, hematoma, acute bleeding or discharge
- Check urethral meatus for blood
- Child/sexual abuse

Rectum

Evaluate integrity of wall, prostatic injury, muscle tone, occult GI hemorrhage; child abuse

Extremities

- Exam for signs of abrasion, contusion, hematoma, soft tissue injuries
- Exam for bony instability and neurovascular function
- Exam for fractures/dislocations

Back

Exam with neck/spinal immobilization as indicated **NOTE:** this is accomplished if no obvious spinal cord injury or paralysis is present.

Skin

- Exam for bruises/petechiae - color, size, "age" may be suggestive of trauma, coagulopathy, physical abuse
- Rash - hemorrhagic, stellate, or rapidly expanding may indicate life-threatening illnesses (eg: meningococemia, septic shock, anaphylaxis, etc)
- Burns
- Bites

Neurologic

- In-depth neuro exam: motor, sensory, cranial nerve and level of consciousness determinations
- Exam tympanic membranes, nose for basilar skull fracture
- Fundi exam
- Presence of spinal cord trauma

Detailed History

As appropriate and available

CHAPTER 17

Radiographic and Lab Studies

Based on physical finding in 1°/2° survey and history; may need serial exams and more sophisticated studies, eg: computed tomography

Monitoring

Continuous monitoring and frequent reevaluation are a must

List Findings

Documentation of initial assessments and resuscitation procedures; list additional areas needing consultation/investigate

Definitive Care

In-hospital care; determine need for operative intervention and/or intensive care admission

Diagnostic Modalities/Pathophysiologic Considerations

Dependent on the patient's presentation and history, some of the following may be useful.

Indications for Intubation of the Comatose Child

- Inability to maintain patent airway
- Glasgow Coma Scale < 8
- Absent cough reflex
- Absent gag reflex
- Hypoxemia with adequate supplemental oxygen
- Hypoventilation
- Impending brainstem herniation (hyperventilation Rx)

APPROACH TO PEDIATRIC EMERGENCIES

Basic CPR in Infants and Children

(for children > 8 years: AHA recommends CPR be performed as one would in an adult)

Infant
(< 1 year)

Older Child
(1-8 years)

Airway

Determine unresponsiveness
Call for help
Position patient supine
Support head and neck
Head-tilt/chin lift or jaw thrust
No blind finger sweeps

Breathing

2 initial breaths

Then: **20** breaths/min

Then: **15** breaths/min

Circulation

Check **brachial**/femoral pulse

Check **carotid**/femoral pulse

Activate EMS System

Compression rate: **100/min**

Compression rate: **80-100/min**

Compression:ventilation ratio = 5:1
Reassessment:palpate pulse every 10 cycles

Endotracheal Intubation (M-S-M-A-I-D)

All equipment at bedside and functioning

Mask	Appropriate size with bag and O ₂
Suction	Tonsillar tip and tracheal
Machine	Appropriate for patient's size and problem
Airway	Laryngoscope, blade & ET tubes Tube size = 16 + age in years/4 Tape, Benzoin < 8 years old, use uncuffed tube
IV	Patent and secure
Drugs	For intubation and resuscitation

Always check and re-check breath sounds following intubation.

Guidelines for Initiating Mechanical Ventilation

- Ventilator type: volume or pressure controlled
NOTE: generally the type of ventilator and kind of support depend upon patient characteristics, eg: age, weight, reason for need for support, pathophysiology of disease process, time/point in disease process
- Initial Ventilator Settings
 - * No Pulmonary Disease
 - ▷ Pressure Ventilator
 - ◇ Peak Pressure 16 - 24
 - ◇ PEEP 0 - 5
 - ◇ Rate Age Dependent
 - ◇ I:E Ratio 1:1-1:2 (Never > 1 sec)
 - ◇ FiO₂ ≤0.30
 - ▷ Volume Ventilator
 - ◇ Tidal Volume 8 - 15ml/kg
 - ◇ PEEP 0 - 5
 - ◇ Rate Age Dependent
 - ◇ Insp Time (%) 25 - 33
 - ◇ FiO₂ ≤0.30
 - * With Pulmonary Disease
 - ▷ Begin with ventilator set at above settings except FiO₂ = 1.0

APPROACH TO PEDIATRIC EMERGENCIES

- ▷ Adjust based upon
 - ◇ Physical examination
 - ◇ Non-invasive monitors: oximetry/capnography
 - ◇ Arterial blood gases (Capillary blood gases)

Classification of Severity of Shock in Children

	I	II	III	IV
Estimated blood volume deficit	10-15%	15-30%	30-40%	>40%
Pulse (bpm)	>100	>120	>150	>150
Resp	normal	increased	marked increase	tachypneic/ apneic
Capillary refill (sec)	<4	> 4	> 6 - 8	> 10
Blood pressure	normal	narrowed pulse pressure	hypotensive	severely hypotensive to absent
Mentation	normal	anxious	confused	unconscious
Orthostatic hypotension	+	++	+++	++++
Urine output (ml/kg)	1-3	0.5-1	<0.5	none

Common Causes of Coma in Infants and Children

Pneumonic: TIPS on the Vowels

- A -- Alcohol:** Not only the adolescent patient is at risk for depressed levels of consciousness from alcohol. Infants may absorb enough alcohol through the skin from alcohol baths or from alcohol-containing medications to cause coma.
- E -- Epilepsy (and other causes of seizures):** Both postictal states and continued subtle seizure activity without overt motor manifestations can cause the appearance of coma in the infant and child.
- I -- Insulin (hypo- or hyperglycemia):** Infants without adequate hepatic glycogen stores or depressed gluconeogenesis may succumb to hypoglycemia as the result of various disease processes. Hyperglycemia can also cause coma. A fingerstick glucose is indicated in all comatose children.
- I -- Intussusception:** A vacant blank stare is often seen in the child with intussusception.
- O -- Overdose:** Drug overdose may be intentional, accidental or the result of misguided attempts at recreational use. They can even be acquired transplacentally at birth. A toxic drug screen is indicated in all cases of coma without clear etiology.
- U -- Uremia (and other metabolic causes):** A serum ammonia and electrolytes are often helpful in providing clues to metabolic causes of coma.
- T -- Trauma:** In comatose infants, retinal hemorrhages should alert the examiner to the possibility of intracranial trauma due to a "shaken baby" or other form of abuse. Intracranial bleeds or cerebral edema resulting from trauma that caused hypoxia or shock may be assessed by a CT of the head.
- I -- Infection:** Infection is more common as a cause of altered sensorium in children than adults. A high index of suspicion should lead to a lumbar puncture as soon as the probability of increased intracranial pressure is excluded.
- P -- Psychiatric:** Factitious altered sensorium is exceedingly rare in children. It should be diagnosed by positive supporting evidence, not by lack of any other explanation for the an altered level of consciousness.
- S -- Stroke, shock, and other cardiovascular causes:** An altered level of consciousness can be caused by shock resulting in inadequate brain perfusion or by local cerebrovascular accidents. Hypertensive encephalopathy can cause a stroke like picture.

APPROACH TO PEDIATRIC EMERGENCIES

Glasgow Coma Scale

Response	Adults & Children	Infants	Points
Eye Opening	no response	no response	1
	to pain	to pain	2
	to voice	to voice	3
	spontaneous	spontaneous	4
Verbal	no response	no response	1
	incomprehensible	moans to pain	2
	inappropriate words	cries to pain	3
	disoriented conversation	irritable	4
	oriented and appropriate	coos, babbles	5
Motor	no response	no response	1
	decerebrate posturing	decerebrate posturing	2
	decorticate posturing	decorticate posturing	3
	withdraws to pain	withdraws to pain	4
	localizes pain	withdraws to touch	5
	obeys commands	normal spontaneous movements	6
Total Score			3-15

Evaluation and Management of Selected Pediatric Emergencies

Acute Respiratory Failure

Criteria

RR >90/min (<12 mos)

RR >70/min (≥12 mos)

P_aO₂ <40 torr (in absence of cyanotic heart disease)

PCO₂ >65 torr

Mechanical Ventilation

Tracheal Intubation

Definition

Clinical condition marked by inadequate O₂ elimination and/or inadequate oxygenation of blood

Etiologic Classification

- Lung Failure: diseases affecting airways, alveoli, capillary membranes, pulmonary circulation
 - * Upper airway obstruction
 - * Bronchiolitis
 - * Asthma
 - * Pneumonia
 - * Bronchopulmonary dysplasia
 - * Adult Respiratory Distress Syndrome
- Respiratory Pump Failure: disease along the pathway from brain stem to respiratory center to spinal cord, phrenic nerves to chest wall muscles
 - * Drug overdose
 - * CNS disease
 - * Neuromuscular disorders

Evaluation

- Physical exam is the most important tool
- Pulse oximetry (continuous/intermittent) gives information regarding oxygen saturation (O_2 sat $<90 = PO_2 <60$)
- Lab tests may include arterial blood gases, CXR

Signs & Symptoms

- Tachypnea/Dyspnea
- Intercostal Retractions
- Diminished Breath Sounds
- Cyanosis
- Altered sensorium

Blood Gas

- $PO_2 <60$ mm Hg ($FIO_2 0.6$)
- $PCO_2 >45$ mm Hg
- pH <7.3

Likely Underlying Causes

- Asthma (Hyperreactive Airways Disease)
- BPD (Bronchopulmonary Dysplasia)
- Bronchiolitis especially Respiratory Syncytial Virus
- ARDS (Adult Respiratory Distress Syndrome)
- Upper Airway Obstruction: CNS dysfunction; anatomic causes; infectious (croup, epiglottitis); trauma; foreign body aspiration; burns; anaphylaxis/laryngospasm

Management

Mechanical ventilation

Shock

Definition

Syndrome of acute homeostatic derangement of various etiologies involving multiple organ systems, which ultimately causes failure of cellular metabolism. **NOTE:** shock is **not necessarily** decreased intravascular volume.

Criteria

- MAP <40 mm Hg (<12 mos)
- MAP <50 mm Hg \geq 12 mos
- HR <50 BPM <12 mos
- HR <40 BPM \geq 12 mos
- Cardiac arrest
- Need for continued vasoactive drug infusion

Etiology - Classification

- Hypovolemia - usually secondary to fluid or blood loss
 - * Vomiting/diarrhea
 - * Hemorrhagic
- Cardiogenic - hypoperfusion caused by heart failure (either inadequate filling or ejection)
- Neurogenic - diminished or absent CNS activity and loss of vascular tone
- Septic - shock from overwhelming bacteremia &/or septicemia

Signs and Symptoms

- Vasoconstriction
- Acrocyanosis
- Poor peripheral pulses
- Altered consciousness
- Pallor
- Sweating
- Ileus
- Oliguria

Differential Diagnosis of the "Shocky" Infant

- Infections
 - * Meningitis
 - * Bacterial sepsis
 - * Viral infection
 - * Urinary tract infection
- Cardiac
 - * Dysrhythmias
 - * Supraventricular tachycardia
 - * Atrioventricular block
 - * Congenital heart disease

- * Pulmonary hypertension
- * Cardiomyopathies
- * Myocarditis
- * Infiltrative disease
- Metabolic
 - * Electrolyte disturbances
 - * Hypoglycemia/hyperglycemia
 - * Inborn errors of metabolism
- Gastrointestinal
 - * Intestinal obstruction or ischemia
 - * Gastroenteritis with dehydration
 - * Vomiting
- Miscellaneous
 - * Child abuse
 - * Anemia
 - * Hepatic failure
 - * Intracranial bleed

Treatment

- Hypovolemic - fluid resuscitation
- Cardiogenic - vasopressors
- Neurogenic - Trendelenberg position, fluids, vasopressors
- Septic - fluids, vasopressors, antibiotic/antiviral therapy

Congestive Heart Failure

Definition

Inability of heart to pump adequate blood volume for the circulatory and metabolic needs of the body

Etiology

- Commonly it results from:
 - * Volume overload - increased preload or excessive intravascular volume
 - * Pressure overload - increased afterload or increased vascular resistance
 - * Myocardial dysfunction - 2° congenital lesions or acquired cardiomyopathy or myocarditis
 - * Dysrhythmias

APPROACH TO PEDIATRIC EMERGENCIES

- Ninety percent of children who develop congestive heart failure do so in the 1st year of life as a result of congenital heart disease.
- Other etiologies include:
 - * Cor pulmonale from chronic lung disease (eg: bronchopulmonary dysplasia)
 - * Cardiomyopathy
 - * Electrolyte abnormalities
 - * Endocarditis or rheumatic carditis
 - * Renal failure
 - * Systemic hypertension
 - * Anemia
 - * Hyperthyroidism
 - * Overhydration

Signs and Symptoms

- Decreased exercise tolerance
- Altered behavior
- Weight loss
- Change in eating habits
- Tachycardia
- +/- gallop rhythm
- Cardiomegaly
- Venous congestion (hepatomegaly, JVD, edema)
- Tachypnea with crackles
- Rhonchi
- Wheezing
- Orthopnea
- Exercise intolerance

Diagnosis

- Chest X-ray
- Electrocardiography
- Arterial blood gas
- Echocardiography

Management - Improve contractility while reducing afterload.

- Inotropic Agents
 - * Digitalis
 - * Fluids
 - * Dopamine/Dobutamine
- Reduction of Preload (Volume Overload)
 - * Fluid restriction
 - * Diuretic therapy

CHAPTER 17

- Reduction of Afterload (Pressure Overload)
 - * Sodium nitroprusside

Altered Mental Status

Classification/Definitions

- Stupor: state of unresponsiveness - patient can be aroused by vigorous stimulation
- Coma: state of unresponsiveness - patient **cannot** be aroused (Unresponsive)
NOTE: Altered levels of consciousness, stupor and coma are signs of "brain failure" and should be treated emergently in an effort to minimize irreversible CNS injury.

Criteria for CNS Failure

- Glasgow Coma Scale < 5
- Fixed, Dilated pupils
- ICP > 20 torr (for > 20 min)

Management Goals

- Prevent secondary hypoxic-ischemic brain injury
- Prevent herniation
- Diagnosis and treatment (if possible) of underlying cause of coma

Spinal Cord Trauma

Pediatric spinal cord injuries are unusual. They are most commonly seen with MVA (motor vehicle accidents) in < 10 year old age group; in those > 10 years - MVAs as well as recreational and organized sporting accidents account for the majority of spinal cord injuries

Evaluation

- History - A spinal injury should be assumed until proved otherwise in any comatose child. Children who are awake and complaining of neck or back pain or radicular pain, dysesthesias or numbness also are possible candidates for a spinal injury.
- Examination - Palpate for tenderness of the neck or spine in awake older children. A careful evaluation of the movement of the extremities, sensation, and reflexes in awake children should be done.
- Any child who is awake and flaccid has a spinal cord injury until proven otherwise.
- Hypotension can result from loss of vasomotor tone due to a cervical cord injury.

Management

- Immobilization
- Airway protection
- Blood pressure support

NOTE: The early use of relatively high-dose steroids is advocated for some spinal cord injuries. Prompt neurosurgical intervention should be obtained when these patients are encountered.

Acute Renal Failure (AFR)

Criteria

BUN > 100 mg/dl
Serum Creatinine > 2 mg/dl
Dialysis

Diagnosis and Management

See Chapter 13 on Renal Disorders

Hypertensive Crisis

Hypertension in children is rare but should not be missed. It is defined as systolic, diastolic or mean arterial pressures that fall above the upper limit of normal (> 95%) for the patient's age. Careful attention must be given to the proper technique used to obtain blood pressure - especially in infants and small children.

Classification

- Hypertensive emergency
 - * This condition has life-threatening end organ (CNS, cardiac, renal) involvement and needs to be corrected within minutes to hours.
 - * Hypertensive encephalopathy
 - * Malignant hypertension
 - * Acute complications of accelerated hypertension
 - ▷ Pulmonary edema
 - ▷ Cerebrovascular accident with hemorrhage or infarction
 - * Eclampsia
 - * Pheochromocytoma
- Hypertensive urgency
 - * No evidence of life-threatening end organ involvement; needs to be corrected in hours to days.
 - ▷ Renal failure or impairment
 - ▷ Acute glomerulonephritis
 - ▷ Preeclampsia
 - ▷ Postoperative bleeding
 - ▷ Newly developed hypertension

Assessment

- Do not use too small a blood pressure cuff. The width of bladder on the blood pressure cuff should be at least 2/3 the length of the upper arm.
- Obtain a history to uncover possible underlying etiology of the hypertension (eg: renal disease, coarctation, pheochromocytoma, Cushing's disease, drug effect, neurofibromatosis).
- Physical exam should include four-extremity blood pressures, evaluation for end organ injury such as fundoscopic changes, decreased visual acuity, congestive heart failure, abdominal bruit, motor or sensor disturbances, and potential causes such as cafe au lait spots.
- Obtain urinalysis, electrolytes BUN, creatinine, chest X-ray, EKG and if CNS involvement, a CT of the head. If the patients condition permits consider obtaining renin level prior to beginning antihypertensive therapy.
- Patients with blood pressure >95th percentile require further evaluation and may require therapy. Patients with evidence of target organ injury (eg: headache, vomiting, epistaxis, decreased visual acuity, fundoscopic changes, congestive heart failure, proteinuria) or blood pressure significantly >95th percentile require immediate monitoring and treatment. NOTE: In patients being evaluated for **Hypertensive Cerebrovascular Syndromes**: when a patient presents with hypertension and an alteration in mental status - the hypertension work-up and emergent control should take precedent over the work-up for the change in mental status. Entities associated with HTCVS include: hypertensive encephalopathy, intracerebral hemorrhage, subarchnoid hemorrhage, head/neck trauma, side effects from recreational drugs and neoplasms.
- If possible, secure IV access before beginning therapy. (Nifedipine can be given sublingually to vomiting patients).

Etiology (Common Causes By Age)

- Neonate
 - * Coarctation of aorta
 - * Renovascular disease
 - * Intracranial hemorrhage
- Infants \leq 2 yrs
 - * Renovascular disease
 - * Intrinsic renal disease
 - * Coarctation of aorta
 - * Neuroblastoma
- 2-8 yrs
 - * Renovascular disease
 - * Intrinsic renal diagnosis

APPROACH TO PEDIATRIC EMERGENCIES

- > 8 yrs
 - * Renovascular disease
 - * Intrinsic renal disease
 - * Essential hypertension

Treatment

- Blood pressure should not be decreased by greater than one third of the total goal over the first 4-6 h.
- Patients with underlying chronic hypertension may have a shifted autoregulatory curve and require increased blood pressures to maintain normal cerebral perfusion. Therefore, elevated pressure should be lowered more slowly in these patients.
- Drugs

CHAPTER 17

Drug	Dose	Comments
Diazoxide arteriolar vasodilator	1-3 mg/kg rapid IVP (undiluted) q 15-20 min x 2-3 doses	First line drug. May be given in ER setting NOTE: give with furosemide to avoid rebound hypertension.
Labetalol alpha and beta blocker	1-3 mg/kg/hr IV	First line drug. May require ICU setting
Nitroprusside arteriolar and venous vasodilator	0.5-8.0 mcg/kg/min IV	Very short half-life Allows tight control of BP reduction. Requires ICU monitoring.
Hydralazine arteriolar vasodilator	0.1-0.2 mg/kg IV	Second line drug. Maintains cerebral, renal, coronary, and uterine perfusion.
Phentolamine alpha blocker	0.1-0.2 mg/kg IV Increase dose as needed Effective dose may vary among patients	Use in suspected excess catecholamine states.
Nifedipine Ca ⁺⁺ channel blocker	0.25-0.5 mg/kg SL	Can be given SL in vomiting patients.
Minoxidil arteriolar vasodilator	2.5-5.0 mg PO	Consider in refractory renovascular hypertension

Hyperkalemia

Etiology

- Cell breakdown
- Renal failure
- Leukocytosis
- Transfusion with aged blood
- Hypoaldosteronism
- Thrombocytosis >750K/mm³
- Aldosterone insensitivity
- Metabolic acidosis
- NaCl substitutes

APPROACH TO PEDIATRIC EMERGENCIES

- Cell lysis from blood drawing
- Decreased insulin
- K-sparing diuretics

Symptoms

- Apathy, weakness, paresthesias
- Tetany, carpal spasm
- ECG changes - T-wave elevation, loss of P-wave, widening of QRS, S-T depression, bradycardia, arrhythmia, cardiac arrest

Treatment

Drug	Dose and route	Onset (duration)	Mode of action	Comment
Calcium Gluconate 10% (100mg/ml)	20 mg/kg IV over 5 minutes may repeat x 2	Immediate (30-60 min)	Stabilizes Cell Membranes	CaCl can worsen acidosis Monitor for bradycardia Hold infusion if heart rate drops < 100.
Sodium Bicarbonate 7.5% (1mEq/cc)	1-2 mEq/kg IV	20 min (1-4 hours)	Enhances intracellular transport of K	Assure adequate ventilation Will precipitate if given with Calcium.
Glucose + Insulin	1-2 g/kg (5-10cc/kg 20% dextrose) 0.3 units/g glucose Administer by infusion together over 2 hours	15-30 min (3-6 hours)	Enhances intracellular transport of K	Monitor blood glucose
Sodium polystyrene sulfonate (Kayexalate)	1 g/kg P.O. in 70% sorbitol or P.R. in 30% sorbitol every 6 hours		Exchanges K for Na in the intestine	Monitor for sodium overload
Dialysis		Time required for vascular access	Removes K from serum	Can also correct metabolic acidosis and fluid overload problems

Gastrointestinal Hemorrhage

Blood loss in excess of 20cc/kg in 24 hours, or the equivalent need in blood/fluid replacement, constitutes GI failure and demands prompt diagnosis and treatment interactions.

Compartment Syndrome (CS)

This syndrome develops because of increased compartment contents in a limiting fascial envelope. Increased contents can be from hemorrhage and cellular swelling from ischemia or blunt trauma. When compartment pressure is greater than capillary perfusion pressure, ischemia further complicates/aggravates compartment swelling. Obvious sequelae included distal vascular and neuro problems.

Evaluation - Clinical signs of CS described as the "5 Ps":

- Pain is out of proportion to that expected. The most sensitive finding in the physical exam is exquisite pain with passive stretch of the involved muscles.
 - Paresthesia arises from sensory nerves contained in the compartment.
 - Pallor occurs in the distal part of the extremity due to poor capillary refill (> 3 seconds).
 - Pulselessness in the distal extremity is a very late sign.
 - Paralysis is also a late sign; early weakness should be sought instead.
- Note: CS is suspected even if only **one** of the above findings is present. Assessment relies on the accurate measurement of compartment pressure.

Treatment - Fasciotomy

Open Fractures

Management

- Cultures should be obtained from the wound as soon as possible on presentation in the emergency room.
- Antibiotic therapy: Include antistaphylococcal coverage (eg, a cephalosporin).
- For severely contaminated, massive crush - or farm injuries: Add gentamicin and penicillin for gram-negative rod and streptococcal coverage.
- Early operative debridement and irrigation is indicated in most cases, within 6 hours of injury.
- Tetanus prophylaxis