Course requirements

- BLS competency testing
- Skills stations
- EKG rhythm identification
- PALS core case discussion and simulations
- PALS core case testing stations
- Written exam

Course outline

- Systemic approach to seriously ill or injured child
- Recognition of respiratory distress and failure
- Management of respiratory distress and failure
- Recognition of shock
- Management of shock
- Rhythm identification
- Pharmacology
- Vascular access
- Recognition and management of bradycardia
- Recognition and management of tachycardia
- Recognition and management of cardiac arrest
- Post resuscitation management

Skills stations

- BLS competency testing (child / infant / AED)
- Airway competency (ET / LMA / WFC)
- Vascular access (IO)
- Rhythm recognition review
• Kids are not small adults

• Don’t panic
  – Disorganization is counter productive
  – It is better to do something right than to undo the mistake and correct it

• Preventing an arrest is primary since the outcome if an arrest occurs is usually poor.

• A systematic approach is essential

• Remember Kids like
  – Air ———— Respiratory
  – Water ——— Shock
  – Sugar ——— Glycemic unbalance
• Problem areas
  – Respiratory
    • Asthma, pneumonia, respiratory failure
  – Circulatory
    • Dehydration, shock
  – Glucose
    • Hyperglycemia, hypoglycemia
  – Trauma
  – Cardiac arrest

• Phases of the systemic approach
  – Initial impression
    • Conscious, breathing, color, activity
  – Evaluate- life threatening / non life threatening
    • Primary ABCDE
    • Secondary – med history, physical exam
    • Diagnostic tests
  – Identify
    • Respiratory, circulatory, cardiac arrest
  – Intervene
PALS Handbook

- **Assessment**
  - Initial pediatric assessment
    - General appearance
    - Work of breathing
    - Skin perfusion
  - Primary assessment
    - Airway - patent noiseless
    - Breathing – present, rate, sounds
    - Circulation
    - Disability
    - Exposure
  - Secondary assessment
    - Physical exam – head to toe
    - Sample history
      - Symptoms, allergies, meds, past history, last meal, events causing
    - Bedside
      - BGL, Vital signs, EKG monitor
  - Tertiary survey
    - Focused history and examination
    - Diagnostic tests
      - ABG and VBG
      - Hemoglobin concentrations
      - Central venous oxygen saturation
      - Arterial lactate
      - CVP monitoring
      - Chest X-ray
      - Peak expiratory flow

Categorize
  - respiratory, circulatory, cardiac
• Airway assessment
  – Clear – unobstructed
  – Maintainable – by position or simple airway maneuvers
  – Not maintainable
    • FBAO – Heimlich, blows, CPR
    • Requires an advanced airway
• Breathing
  – Respiratory rate
  – Respiratory effort
  – Chest expansion and airway movement
  – Lung and airway sounds
  – SPO2
• Normal respiratory rates by age
  – Age | Breaths / min
  – Infant < 1 year | 30-60
  – Toddler (1-3 years) | 24-30
  – Preschooler (4-5 years) | 22-34
  – School age (6-12 years) | 18-30
  – Adolescent | 12-16
• Assessment of respiratory rates
• Method
  – Count respirations for 30 seconds and multiply by 2 for minute rate
• Note
  – Anxiety can raise the respiratory rate
  – Assess rates frequently if child has respiratory difficulty
• Abnormal respiratory rates
  – Apnea
    • Central apnea – suppression of the brain or spinal cord
  – Tachypnea – causes
    • Fever, pain, acidosis, anemia, sepsis
    • CHF, congenital heart defects
  – Bradypnea – causes
    • Respiratory failure
    • CNS injury or infection
    • Hypothermia
    • Medications
    • Note: may signal arrest in an acutely ill child

• Respiratory effort
  – Dyspneic children and infants
    • Work hard to maintain adequate oxygenation
    • Fatigue easily and go into respiratory failure
    • It is important to recognize and treat respiratory difficulty
  – Early signs or respiratory distress
    • Nasal flaring
      – Dilation of the nostrils to increase air intake
    • Retractions
      – Inward movement of the chest wall, neck, and sternum
    • Head bobbing
      – Caused by neck muscles used to assist ventilation
    • Seesaw respirations
      – Chest retracts and abdomen expands during inspiration
      – Most common in children with neuromuscular disease
• Respiratory effort
• Chest expansion
  – Normal
    • Symmetrical chest rise (full expansion)
    • In infants the abdomen may move more than the chest
  – Abnormal
    • Decreased or asymmetrical chest rise
      – Inadequate effort
      – Airway obstruction
      – Pneumothorax / hemothorax
      – FBAO
      – Mucous plug
      – Pleural effusion

• Lung and airway sounds
  – Stridor
    • Coarse high pitched sound heard during inspiration
    • Indicates an upper airway obstruction
  – Grunting
    • Short low pitched sound heard during expiration
    • Sign of lung disease (alveolar collapse)
    – Early
  – Gurgling
    • Upper airway obstruction
    • Due to secretions or vomit in the upper airway
  – Wheezing
    • High pitched whistling sound heard on expansion and inspiration
  – Crackles – accumulation of alveolar fluid (hairs rubbing together)
### Respiratory effort

- **Chest neck and sternum retractions**
  - **Mild to moderate breathing difficulty**
    - **Location**
    - **Subcostal**
    - **Substernal**
    - **Intercostal**
    - **Description**
      - Abdomen below rib cage
      - Abdomen below sternum
      - Between the ribs
  - **Severe breathing difficulty**
    - **Location**
    - **Supraclavicular**
    - **Suprasternal**
    - **Description**
      - Neck above the clavicle
      - Chest above the breastbone

### RESPIRATORY DISTRESS / FAILURE

![Image of respiratory distress]
• How to assess circulation and perfusion
  – Heart rate and rhythm
  – Pulses
  – Capillary refill
  – Skin color and temperature
  – Blood pressure

• Normal heart rate table
  – Age  
    – Infant-3mo. 85-205 80-160
    – 3 mo.- 2yrs 100-190 75-160
    – 2 yrs. -10 yrs. 60- 140 60-90
    – >10 yrs. 60-100 50-90

• Abnormal heart rates
  – Bradycardia
    • Slight bradycardia in athletic children
    • Usually results from hypoxia (poor perfusion) in ill children
    • Can result from heart blocks and drug overdoses
  – Tachycardia
    • Mostly related to a cause (i.e. fever, anxiety)
    • May result from cardiac problems (SVT)
  – Cardiac arrest
    • Poor prognosis

• Pulses
  – Central
    • Femoral, brachial (infants), carotid (older children), axillary
  – Peripheral
    • Radial, dorsal pedis, posterior tibial
• **Pulse assessment**
  – Normal pulses are strong and equal
  – Weak or unequal pulses indicate circulatory problems
  – Pulsus paradoxus
    • Fluctuation in volume with the respiratory cycle
    • Usually associated with asthma and tamponade
  – Intubated patients
    • Reduction in pulse volume indicates hypovolemia

• **Capillary refill**
  – The time it takes blood to return to tissue blanched by pressure
  – Best performed at room temperature
  – Select an extremity slightly above the level of the heart
  – Measure the time to return to normal color (< 2 seconds)

• **Skin color and temperature**
  – Normal – uniform color over the entire body
  – Inadequate tissue perfusion
    • Pallor
      – Decreased blood supply to the skin
      – Decreased number of red cells
    • Mottling
      – Hypoxia, hypovolemia, chock
    • Cyanosis
      – Low oxygen tension
      – Alveolar hypoventilation (TBI / drug O.D.)
      – Diffusion effect (pneumonia, PE)
      – Ventilation/perfusion unbalance (asthma)
      – Intracardiac shunt
• Blood pressure
• Cuff selection
  – Inaccurate readings result from improper cuff selection
  – The proper cuff should cover 50-75% of the distance from axilla to A.C. fossa

• Normal Pediatric Blood Pressures
  – Age  Systolic  Diastolic
  – Neonate  60-80  30-53
  – Infant (1-6 MO.)  73-102  40-68
  – Infant (6-12 MO.)  80-104  44-68
  – Infant (1 year)  68-103  20-58
  – Child (2 years)  70-106  25-65
  – Child (7 years)  79-115  38-79
  – Adolescent  93-131  45-85

• Hypotension by age
  – Age  Systolic
  – 0-28 DAYS  <60
  – Infant (1-12 MO.)  <70
  – Children (1-10YR.)  <70 + age /2
  – Children (>10 years)  <90
• Primary concerns
  – Inadequate circulatory function
    • Decreased level of consciousness
    • Loss of muscle tone
    • Centralized seizures
    • Pupil dilation
  – Evaluation of the neurological function
• Assessment of disability
  – AVPU
    • A- Alert
    • V- Voice (response)
    • P- Pain (response to)
    • U- Unresponsive
  – Glasgow coma scale
    • Eye opening
      – Spontaneous, speech, pain, none
    • Verbal response
      – Oriented, confused, Inappropriate, Incomprehensible, none
    • Motor response
      – Obeys, Localizes, Withdraws, Flexion, Extension, None
    • 1 point for each (maximum score 15 minimum score 3)
  – Pupillary response
    • Size
    • Equality
    • Constriction in response to light
• Full body exposure
  – Clothing may cover indications of injuries and physical abnormalities
  – Clothing also makes it difficult to visualize chest movement
  – Skin abnormalities such as a rash may be missed by clothing
  – To correctly assess your patient remove as much clothing as necessary

• Full body assessment (head to toe)
  – Head
    • Skull – fractures, bleeding
    • Eyes – pupillary response, vision, movement
    • Ears – hearing, bleeding
    • Nose and mouth – bleeding, fractures, speech
  – Neck and spine
    • Deformity / fractures / movement
    • Supple or rigid
    • Spine – deformity, movement, pain
  – Chest
    • Equal expansion
    • Bruising deformity or evidence of trauma
    • Lung sounds
    • Heart sounds
  – Abdomen
    • Soft, rigid, tender, guarding, pain (check all 4 quadrants)
    • Bruising, lacerations, swelling, pain, bleeding
    • Vomiting, bowel movements
  – Pelvis
    • Crepitus, pain, genitalia, bleeding, swelling, hip fracture / dislocation
  – Upper extremities and Lower extremities
    • Range of motion, fractures / dislocation, pain, swelling, bruising, bleeding, distal pulses, feeling
  – Skin - Rashes, bites, abnormalities
• General
  – Definitions
    • Respiratory distress
      – The body’s increased respiratory efforts to meet the body’s oxygen demands
    • Respiratory failure
      – Inadequate oxygen and ventilation
  – Hypoxemia
    • Low oxygen tension
      – Not enough oxygen to meet tissue oxygen requirements
      – Does not always create tissue hypoxia
      – Mechanisms of hypoxemia
        » Low atmospheric oxygen
          • High altitude
        » Alveolar hypoventilation
          • TBI, drug O.D., CNS infection, apnea, neurological problems
        » Diffusion effect
          • Pulmonary edema, interstitial pneumonia
        » V/Q unbalance
          • Asthma, ARDS, bronchiolitis, FBAO, embolus, atelectasis
        » Right to left shunt
          • Congenital heart disease, extra-cardiac shunt
• General continued
  – Tissue hypoxia
    • Results from inadequate tissue perfusion without compensation
    • Signs of tissue hypoxia
      – Tachycardia
      – Tachypnea
      – Nasal flaring
      – Agitation, anxiety, irritability
      – Cyanosis (late)
      – Decreased level of consciousness (late)
      – Bradycardia (late)

  – Hypercarbia
    • CO2 is the by product of respiration
    • Retained CO2 creates respiratory acidosis
    • Causes
      – Decreased respiratory rate
      – CNS dysfunction
      – Drugs
• Respiratory distress
  – The body’s increased efforts to meet the oxygen demands

• Physiological factors
  – Increased airway resistance (upper and lower)
  – Decreased lung compliance
  – Use of accessory muscles
  – CNS disorders that control breathing

• Signs of respiratory distress
  – Tachypnea
  – Increased respiratory effort
  – Nasal flaring
  – Inadequate respiratory effort (bradypnea)
  – Abnormal airway sounds (stridor, wheezing, rales)
  – Tachycardia
  – Pale cool skin
  – Changes in level of consciousness
• Respiratory failure
  – Inadequate oxygen and ventilation
• Signs of respiratory failure
  – Marked tachypnea (early)
  – Bradypnea (late)
  – Increased, decreased, or no respiratory effort
  – Poor to absent air movement
  – Tachycardia (early)
  – Cyanosis (late)
  – Stupor / coma (late)
• Examples of respiratory failure
RESPIRATORY PROBLEMS

• Types or respiratory problems
  – Upper airway obstruction
  – Lower airway obstruction
  – Lung tissue disease
  – Disordered control of breathing

• Upper airway obstruction
  – Causes
    • Croup / epiglottitis
    • Anaphylaxis
    • Abscesses / tumors
    • Foreign body airway obstruction
    • Secretions
    • Subglottic stenosis
  – Signs
    • Tachypnea
    • Increased respiratory effort
    • Change in voice
    • Stridor (high pitched sound)
• Lower airway obstruction
  – Causes
    • Asthma
    • Bronchiolitis
  – Signs
    • Tachypnea
    • Wheezing
    • Increased respiratory effort
    • Prolonged expiratory phase
    • Cough

• Lung tissue disease
  – Causes
    • Pneumonia
    • Pulmonary edema
    • Pulmonary contusion (trauma)
  – Signs
    • Tachycardia and Tachypnea
    • Increased respiratory effort
    • Grunting
    • Crackles / rales
    • Diminished breath sounds
    • hypoxemia

• Disordered control of breathing
  – Causes
    • Neurological disorders
    • Brain injury, tumors, hydrocephalus
    • Neuromuscular disease
  – Signs
    • Variable irregular respiratory rate and effort
    • Shallow breathing
    • Central apnea
MANAGING RESPIRATORY DISTRESS AND FAILURE

• General
  • Respiratory failure is the major cause of pediatric cardiac arrest
    – Procedure
      • Detect and treat early
      • Identify the type and severity
      • Stabilize oxygenation and ventilation
      • Find the cause after stabilization
    – Target management based on 4 types
      • Upper airway obstruction
      • Lower airway obstruction
      • Lung tissue disease
      • Disordered control of breathing
    – For patients with potential for decline
      • Apply oxygen preferably humidified
      • Start an IV
      • Draw labs
      • Try to identify
        – The problem
        – Type and severity

Life threatening problems
Primary assessment (ABCDE)
Treat life they occur
If there are no life threatening problems proceed to the secondary survey
• Upper airway obstruction

  – Most common causes
    • Croup
    • Anaphylaxis
    • Foreign body airway obstruction

  – Croup
    • Most common 1 month to 5 years
    • Signs
    • Dyspnea, swelling of the vocal cords, barking cough
    • Causes
    • Viral, bacterial, allergic, inhaled irritants

  – Treatments
    • Maintain the airway, administer humidified oxygen if SPO2 < 94%
    • nebulized racemic epinephrine or albuterol
    • Administer dexamethasone or a steroid
    • Consider heliox treatment
    • Severs dyspnea consider advanced or a surgical airway
• Upper airway obstruction continued

  – Anaphylaxis
    • High flow oxygen / monitor / IV
    • Nebulized racemic epinephrine or albuterol every 15 minutes
    • Administer Benadryl and an H2 blocker
    • Prepare for intubation
    • Treat hypotension
      – Trendelenburg position
      – IV fluid boluses 20 ml /kg as needed
      – Epinephrine infusion if fluids are unsuccessful
    • Consider a surgical airway if intubation is not possible

  – Foreign body airway obstruction
    • Object in the trachea / non life threatening
      – High flow oxygen / monitor / IV
      – Prepare for bronchoscopy
    • Life threatening obstruction
      – Heimlich / CPR (back blows and thrusts / CPR infant)
      – Laryngoscope / Magill forceps
      – Prepare for a surgical airway

• Managing respiratory distress and failure
• **Lung tissue disease**

• **Causes**
  – Infectious pneumonia
  – Chemical and aspiration pneumonitis
  – Cardiogenic and non cardiogenic pulmonary edema

• **Infectious pneumonia**
  – High flow humidified O2 /I.V. / EKG / APO2
  – Diagnostic tests (ABG, X-ray, labs, cultures)
  – Antibiotic therapy
  – Treat wheezing with albuterol
  – Initiate I.V. fluids
  – Normalize temperature
  – CPAP / BIPAP / intubation for severe respiratory distress

• **Chemical pneumonitis**
  – Aspiration of a toxic gas or powder
  – Initiate humidified high flow oxygen initially
  – Treat wheezing with a nebulized bronchodilator
  – CPAP / BIPAP / Intubation with a ventilator for severe cases (failure)

• **Aspiration pneumonitis**
  – Aspiration of stomach contents
  – Initiate high floe humidified oxygen initially
  – Consider CPAP or BIPAP
  – For severe distress intubation with a ventilator
• Lung tissue disease continued
• Cardiogenic pulmonary edema
  – Causes
    • Ventricular myocardial dysfunction
    • Excess pulmonary hydrostatic pressure
    • Plasma red cell diffusion into the alveolar sacks
  – Treatment
    • High flow oxygen, I.V., EKG
    • Ventilation support
      – CPAP / BIPAP, Ambu bag, intubation (PEEP 6-10)
    • Consider diuretics
    • Reduce metabolic demand (temperature and work of breathing)

• Non cardiogenic pulmonary edema (ARDS)
  – Definition
    • Injury to interface between alveoli and pulmonary vessels
    • Triggers the release of inflammatory mediators
  – Causes
    • Pneumonia, sepsis, pancreatitis, trauma
  – Characteristics
    • acute onset
    • PaO2 /FiO2 < 200
    • Bilateral infiltrates (chest x-ray)
    • No evidence of cardiogenic causes
LUNG TISSUE DISEASE CONTINUED

ARDS treatment
- Cardiac monitor, vital signs, SPO2
- Labs (ABG, blood gas, CBC)
- Provide ventilation support
  - Ambu bag
  - CPAP/BIPAP
  - Intubation
  - Ventilator
- Indications for ventilation support
  - Worsening clinical and radiographic lung disease
  - Hypoxia refractory to high FiO2
- Combat hypoxemia
  - Peep until oxygen saturation is adequate
  - Low tidal volumes (5-7 ml/kg)
  - Peak inspiratory pressures < 30-50 cm H2O
Disordered control of breathing

Causes
- Increased ICP
- TBI
- Subdural / epidural hematoma
- Brain tumor, hydrocephalies
- Neuromuscular disease
- CNS depression
  - Drugs, Infection, Seizures, Metabolic disorders

Interventions for ICP
- Manage ABC’S
- Assess breathing problems
  - Assist ventilations (Ambu, ET tube hyper-oxygenate)
- Poor perfusion or end organ function
  - Administer 20 ml/kg boluses of a crystalloid solution
- Administer osmotic agents
  - Mannitol, dexamethasone
- Treat agitation and pain aggressively
- Avoid hyperthermia

Interventions for poisoning and drug overdose
- Manage ABC’S
- Contact poison control (1-800-222-1222)
- Prepare suctioning in case of vomiting
- Administer antidote
- Perform diagnostic tests

Interventions with neuromuscular disease
- Ventilation support
- Manage secretions
• Definition
  – Delivery of oxygen and nutrients do not meet the system’s needs.
  – This creates inadequate peripheral and end organ perfusion.
  – The areas of primary concern are the brain, kidneys, heart and liver

• Pathophysiology
  – Cells need constant oxygen delivery
  – The primary system is the circulatory system
  – The secondary system is anaerobic metabolism
    • Oxygen is created by acid conversion
    • This method has a limited ability to sustain oxygen demands
    • It also creates an undesirable acidic condition in the body

• Oxygen delivery and perfusion requirements
  – Sufficient oxygen in the blood
  – Adequate cardiac output
  – Adequate distribution
• Cardiac output
  – Cardiac output represents the pumping adequacy of the heart.
  – Cardiac output (CO) = Stroke volume x Heart rate
  – The cardiac output is determined by;
    • Preload – the volume of blood in the ventricles before contraction
    • Contractility – the strength of contraction
    • Afterload – the systemic resistance

• Compensatory mechanisms
  – The body compensates for shock by the following mechanisms
    • Tachycardia
    • Vasoconstriction
    • Increased contractility
    • Increase in smooth venous tone

• Organ response to compensated shock
  – Heart – tachycardia
  – Skin – cool, pale, mottled, diaphoretic
  – Peripheral circulation – delayed capillary refill
  – Pulses – weak peripheral, narrow pulse pressure
  – Kidneys – reduced urine output
  – Intestines – vomiting, ileus
• Shock states
  – Compensated – good perfusion
    • Early signs of compensated shock
    • Normal skin color and temperature
  – Compensated poor perfusion
    • Later signs of compensated shock
    • Pale, mottled skin, normal blood pressure lower urine output
  – Decompensated – blood pressure drops
    • All signs of late compensated shock
    • Blood pressure drops

• Response to shock in adults and children
  – Adults
    • Compensate for a shorter time
    • Decompensate more quickly
    • Can sustain de-compensation better
  – Children
    • Compensate for a longer period of time
    • Once they decompensate they crash quickly

• Hypotensive shock
  • Hypotensive shock is decompensated shock
  • Hypotension in children
Hypovolemic shock (Fluid loss)

- **Causes**
  - Diarrhea
  - Vomiting
  - Hemorrhage
  - Osmotic diuresis (DKA)
  - Inadequate fluid intake
  - Third space loss (anaphylaxis)
  - Large burns

- **Signs**
  - Tachypnea
  - Tachycardia
  - Systolic hypotension / narrow pulse pressure
  - Weak or absent peripheral pulses
  - Delayed capillary refill
  - Cool, pale, mottled, diaphoretic skin
  - Changes in level of consciousness
  - Oliguria
  - Extremities cooler than the trunk
• Hypovolemic shock management

  – Non-hemorrhagic shock
    • Rapid 20 ml/kg boluses of crystalloid fluids
    • If no improvement after 3 boluses (60 ml/kg)
      – fluid boluses under estimated
      – Consider colloids
      – Possible occult bleed
      – Combined
    • Determine the cause and correct the lab values
    • Manage the airway and oxygenate (Ambu bag, intubation)

  – Hemorrhagic shock
    • High flow oxygen
    • Begin 20ml/kg crystalloid boluses
    • Consider blood transfusion of whole blood or red blood cells
    • Reasons for transfusion
      – Known signs of significant blood loss
      – Crystalloid refractory hypotension
    • Do not use vasopressors to raise the blood pressure
    • Correct acid base unbalances
DISTRIBUTIVE SHOCK

• Causes
  – Sepsis
  – Anaphylaxis
  – Neurogenic problems
    • CNS disorders
    • Drugs
    • Spinal cord injuries

• Physiology
  – High to normal cardiac output – low SVR
  – Variable blood flow and perfusion (variable SVR)
  – Increased capillary permeability
  – Pulmonary hypertension (increased PVR)
  – Release if inflammatory mediators
  – Vasodilation causes blood pooling and clotting
  – Increased lactic acid buildup / acidosis
  – May lead to hypovolemic shock and cardiac dysfunction
  – Warm shock – blood shunted to the periphery

• Signs
  – Tachypnea / tachycardia
  – Warm shock
  – Cold shock
  – Changes in level of consciousness
  – Oliguria
  – Fever or hypothermia
  – Petechial or purpuric rash (septic shock)
• Septic shock (sepsis)

• Signs
  – Fever
  – Presence of infection
  – Hypotension
  – Tachycardia
  – Tachypnea
  – Acidosis
  – Metabolic unbalance

• Pathophysiology
  – Infection / endotoxin stimulates the immune system
    • Releases inflammatory mediators
    • Cytokines create micro clots
  – Variable SVR creates mal distribution of flow
    • Creates blood pooling and localized hypoxia
  – Relative hypovolemia
    • Vasodilation / increased permeability
  – Adrenal insufficiency
    • Cytokines create micro clots causing renal insufficiency
    • May create myocardial dysfunction
• Septic shock management

• Goal
  – Restore hemodynamic stability
  – Identify and control the infection

• Management
  – High flow oxygen
  – Rapid aggressive fluid bolus administration
  – Rapid administration of antibiotics (after culture)
  – Hemodynamic support
    • Vasopressors, hydrocortisone
  – Identify and correct metabolic problems
  – Diagnostic tests
    • Lactic acid concentration, base deficiency, CV oxygen saturation
  – Monitor severity of shock and response to fluids

  – Refractory septic shock management
  – Establish arterial and CV access
  – Administer vasoactive therapy
  – Administer additional crystalloid boluses (consider colloids)
  – If the hemoglobin concentration is < 10 g/dl consider a transfusion
  – Consider assisted ventilation Ambu bag or ET with a ventilator

• Therapeutic end points
  – Good distal pulses and perfusion
  – SCVO2 > 70%
  – Correct metabolic acidosis
  – Correct lactic acid concentration
• **Anaphylaxis**

• **Pathophysiology**
  – Multisystem allergic response to an allergen
  – Vasodilation with increased capillary permeability
  – Pulmonary vasoconstriction
    • Increased right side afterload
    • Reduced pulmonary blood flow
  – Sever inflammatory response
  – Death may occur in minutes

• **Signs**
  – Anxiety or agitation
  – Nausea and vomiting
  – Urticaria (hives)
  – Angioedema
  – Respiratory distress
  – Hypotension
  – Tachycardia

• **Management**
  – Epinephrine 1/1000 IM injection (second dose 10-15 min. if severe)
  – 20 ml/kg fluid bolus as required to support circulation
  – Albuterol by nebulizer (mild – intermittent/ severe – continuous)
  – Antihistamines H1 diphenhydramine / H2 ranitidine or famotidine
  – Corticosteroids – Solu-Medrol (methyl prednisone)
• **Causes**
  – Injuries to the cervical and thoracic spine above T6

• **Pathophysiology**
  – Loss of sympathetic nerves that control innervation to the heart

• **Signs**
  – Hypotension
  – Normal heart rate or bradycardia
  – Increased respiratory rate
  – Diaphragmatic breathing
  – Inability to compensate for hypovolemia

• **Management**
  – Position the child flat or head down
    • Improves venous return
  – Administer 20 ml/kg crystalloid bolus
  – Vasopressors if refractory to fluids
    • Norepinephrine
    • epinephrine
  – Provide warming or cooling as required
• **Definition**
  Cardiogenic shock is poor perfusion resulting from cardiac dysfunction

• **Causes**
  – Congenital heart disease
  – Myocarditis
  – Cardiomyopathy
  – Arrhythmias
  – Sepsis
  – Poisoning or drug overdose
  – Myocardial injury (trauma)

• **Pathophysiology**
  – Increased heart rate and ventricular afterload
    • Increased ventricular workload and myocardial oxygen consumption
  – Compensatory increase in SVR
    • Diverts blood from periphery to brain and organs
  – Decrease in stroke volume
    • Decreased contractility and increased afterload
  – Increased venous tone
    • Increases CV and pulmonary capillary wedge pressure
  – Diminished renal blood flow (fluid retention)
  – Pulmonary edema
• Signs
  – Tachypnea
  – Tachycardia
  – Low blood pressure / narrow pulse pressure
  – Weak or absent pulses
  – Delayed capillary refill, cool extremities
  – Signs of congestive heart failure
    • Pulmonary edema, JVD distension
  – Changes in level of consciousness
  – Cold pale diaphoretic skin / cyanosis
  – oliguria

• Management
  – Goals
    • Improve cardiac function and output
    • Increase ejection fraction
  – Management
    • Cautious fluid administration / reduce afterload (5-10 ml/kg
    • Lab and diagnostic studies
      – ABG, X-ray, cardiac enzymes, hemoglobin
    • EKG
    • Medications
      – Diuretics – pulmonary edema
      – Vasodilators – lower afterload
      – Inotropes – increase contractility and cardiac output
      – Analgesics – for pain
• **Definition**
  - Cardiac output impaired by a physical obstruction to blood flow

• **Causes**
  - Cardiac tamponade
  - Tension pneumothorax
  - Ductal dependent congenital heart lesions
  - Massive pulmonary embolism

• **Signs**
  - Respiratory failure / pulmonary edema
  - Rapid deterioration in peripheral perfusion
  - Congestive heart failure (left, right side or both sides)
  - Absence of femoral pulses
  - Metabolic acidosis
  - Rapid changes in LOC
  - Tachycardia
  - Hypotension
  - Chest pain
  - Cool extremities and trunk / possible cyanosis
• **Cause**
  – Accumulation of blood in the pericardial sac
  – Reduces ventricular filling and stroke volume

• **Findings**
  – Respiratory distress and increased respiratory effort
  – Tachycardia
  – Cool extremities / delayed capillary refill
  – Muffled heart sounds
  – Narrow pulse pressure
  – Distended neck veins
  – Changes in LOC.

• **Treatment**
  – Initially
    • Rapid identification
    • Oxygen and fluid administration
  – Pericardial centesis
    • Perform if impending arrest
    • Requires a skilled person
    • Best done with fluoroscopy or electrocardiography
TENSION PNEUMOTHORAX

• **Cause**
  – Entry of air into the pleural space that accumulates under pressure
    • Trauma or spontaneous
    • May occur in ventilated patients

• **Findings**
  – Respiratory distress with increased respiratory effort
  – Distended neck veins
  – Tracheal deviation
  – Rapid deterioration in perfusion
  – Rapid evolution tachycardia to bradycardia
  – Hypotension
  – Changes in LOC

• **Treatment**
  – Immediate needle decompression
  – Insert an 18-20 gage. Needle
    • Over the top of the 3rd rib (second intercostal space)
    • At the mid clavicular line
  – A gush of air will be heard after decompression
  – More than 1 decompression may be necessary
  – A chest tube will ultimately be required
• **Causes**
  - Cyanotic congenital heart lesions
    • Patent ductus arteriosus
  - Left ventricular outflow obstructive lesions
    • Coarctation of the aorta
    • Aortic valve stenosis
    • Hypoplastic left heart syndrome

• **Findings**
  - Respiratory failure
  - Cardiomegaly (rapid deterioration in perfusion)
  - Higher pre ductal versus post ductal pressures
  - Absence of femoral pulses
  - Cyanosis
  - Hypotension with tachycardia

• **Treatment**
  - Continuous infusion of prostaglandin E to close ductus arteriosus
  - Ventilation support with oxygen administration
  - Electrocardiography
  - Inotropic agents to improve contractility
  - Fluids to improve cardiac output (caution)
  - Correct metabolic derangements
PULMONARY EMBOLIS

• **Cause**
  – Partial or total obstruction of the pulmonary artery and its branches by a blood clot

• **Findings**
  – Respiratory distress with increased respiratory effort
  – Tachycardia
  – Cyanosis
  – Hypotension
  – Changes in the level of consciousness
  – Increased ventilation has no effect on SPO2

• **Treatment**
  – Initial – ventilation support and fluid therapy
  – CT angiography / echocardiography (diagnostic)
  – Anticoagulant therapy (heparin)
  – Consider thrombolytic agents (TPA)
SHOCK MANAGEMENT

• Fundamentals
  – Optimize the oxygen content of the blood
  – Improve volume distribution and cardiac output
  – Reduce the oxygen demand
  – Correct metabolic derangements

• Successful treatment of shock
  – Therapeutic end points
    • Normal heart rate and blood pressure
    • Normal pulses
    • Capillary refill < 2 seconds
    • Warm extremities
    • Normal mental status
    • Urine output > 1 ml/kg/hr
    • Decreased serum lactate
    • Reduced base deficit
    • ScvO2 > 70%
SHOCK ALGORITHMS

• Trauma shock

20 ML/KG RAPID BOLUS LR OR NS

20 ML/KG RAPID BOLUS LR OR NS

20 ML/KG RAPID BOLUS LR OR NS

10 ML/KG PACKED RBC

SURGERY / WHOLE BLOOD

• Cardiac shock

20 ML/KG BOLUS NS OR LR

20 ML/KG BOLUS NS OR LR

DOPAMINE 2-20mcg/kg/min
EPINEPHRINE 0.1-1 mcg/kg/min
Dehydration shock

- **20ml/kg BOLUS NS OR LR**
- **DO NOT USE VASOPRESSORS**
- **REPEAT 20ml/kg BOLUSES AS LONG AS LUNGS ARE CLEAR**
- **CONSIDER A MAINTENANCE INFUSION**
• Septic shock

First 5 minutes
- Recognize altered mental status and perfusion.
- Maintain airway and establish access according to PALS guidelines.

5 to 15 minutes
- Push 20 cc/kg isotonic crystalloid or colloid boluses up to and over 60 cc/kg
- Correct hypoglycemia and hypocalcemia

Fluid responsive?
- Yes
  - Observe in PICU
  - Give hydrocortisone

- No
  - Fluid refractory shock
    - Establish central venous access, begin dopamine therapy and establish arterial monitoring
  - Fluid refractory-dopamine resistant shock
    - Titrate epinephrine for cold shock. Norepinephrine for warm shock

Catecholamine-resistant shock
- Is patient at risk for adrenal insufficiency?
  - Yes
  - Catecholamine-resistant shock
  - Add vasodilator or Type III phosphodiesterase inhibitor with volume loading
  - Persistent catecholamine-resistant shock
    - Place pulmonary artery catheter and direct fluid, vasoopressor, vasodilator, and hormonal therapies to attain normal MAP-CVP and CI >3.3 L/min/m²
  - Refractory shock
    - Consider ECMO

- No
  - Do not give hydrocortisone

Normal blood pressure, cold shock, SVC O₂ sat <70%
- Add vasodilator or Type III phosphodiesterase inhibitor with volume loading

Low blood pressure, cold shock, SVC O₂ sat <70%
- Titrated volume and epinephrine

Low blood pressure, warm shock
- Titrated volume and norepinephrine
- Low dose vasopressin or angiotensin?
• I.V. Access
  – Most common I.V. sites
    • Antecubital
    • Hand
    • Scalp on infants
  – Most common I.V. needles
    • 24 gage
    • 22 gage
    • 20 gage

• I.O. access
  – Any drug or fluid that can be given I.V. can be given I.O
  – Easier to attain than I.V. access especially in arrest situations
  – Contraindications
    • Fractures in an extremity
    • Previous attempt in the same place
    • Infection overlying the bone
• I.O. INSERTION SITES
• INFANT / PEDI INSERTION SITE

Location Site for
Pediatric Bone Injection Gun

A. Tibial Tuberosity
B. 0.5 in Medially, towards inner leg
C. 0.5 in Down, towards foot

Penetration Site
• OLDER PEDIATRIC / YOUNG ADULT

Location Site for
Adult Bone Injection Gun

Penetration Site

A
Tibial Tuberosity

B
1in Medially, towards inner leg

C
0.5in Up, towards knee
Insertion procedure using a Jamshidi needle

- Identify the tibial tuberosity
- Disinfect the area
- Leave the stylette in the needle
- Stabilize the leg
  - Do not put your hand behind the leg
  - Be sure the leg is fully on a hard flat surface
- Insert the needle perpendicular to the leg
- Use a twisting motion with firm pressure
- Insert until you feel a sudden decrease in resistance
  - A slight popping sound may be heard
- Remove the stylette aspirate and flush with a syringe
- Confirm placement
  - Pressurized fluids flow freely
  - There is no infiltration to surrounding tissues
- Stabilize the needle and tape over the flange
- Attach a 3 way stopcock
• **Drugs to control SVT**
  
  • **Adenosine**
    - **Classification** - antiarrhythmic
    - **Indications** – treatment of SVT
    - **Actions**
      - Stimulates adenosine receptors
      - Transiently blocks AV node conduction
      - Transiently interrupts reentry pathways
      - Depresses sinus node activity
    - **Dose**
      - First dose – 0.1 mg/kg rapid push (6 mg max dose)
      - Second dose – 0.2mg/kg rapid push (12 mg max dose)

• **Drugs to control bradycardia**
  
  • **Epinephrine**
    - **Classification** – catecholamine, vasopressor, inotrope
    - **Indication** – symptomatic bradycardia
    - **Action**
      - Stimulates beta 1 and 2 adrenergic receptors
      - Increases contractility, heart rate, blood pressure
      - Dilates bronchi and arterioles
    - **Dose**
      - IV / IO 0.1 mg/kg of 1/10000 every 3-5 minutes
• DRUGS TO CONTROL ASTHMA AND CROUP

• Albuterol
  – Classification: bronchiole dilator, beta adrenergic agent
  – Indications: asthma, anaphylaxis,
  – Action
    • Bronchiole and vasodilator,
  – Dose
    • Severe asthma: 0.5 mg/kg/hr continuous nebulizer treatment

• Atrovent (Ipratropium bromide)
  – Classification: anticholergic
  – Indication: asthma
  – Action
    • Blocks parasympathetic choline receptors
    • Inhibits serious mucus secretions
  – Dose
    • Nebulizer: 250-500 mcg every 20 minutes x 2

• Terbutaline
  – Classification: beta agonist, bronchiole dilator
  – Indications: asthma
  – Action
    • Dilates bronchioles and arterioles
  – Dose
    • IV/IO: 0.1 – 10 mcg/kg/min. Consider 10 mcg/kg over 5 minutes
• Asthma and croup continued

• Epinephrine
  – Classification – catecholamine, vasopressor
  – Indications – asthma and croup
  – Action
    • Stimulates beta 1 and 2 receptors
    • Increases contractility, heart rate, and systolic blood pressure
  – Dose
    • Asthma - 0.1 mg/kg of 1/1000 SQ (max dose 0.3 mg)
    • Croup – 0.25 mg racemic by nebulizer (2.25% in 3 ml)
    • Croup – 0.5 ml/kg of 1/1000 in 3 ml N.S, by nebulizer

• Dexamethasone
  – Classification - corticosteroid
  – Indication – croup and asthma
  – Action – anti-inflammatory agent
  – Dose
    • Croup – PO /IM /IV -0.6 mg/kg 1 dose (16 mg max)
    • Asthma – PO/IM/IV -0.6 mg/kg every 24 hours (16 mg max)

• Magnesium sulfate
  – Classification – electrolyte, bronchiole dilator
  – Indications - asthma
  – Action – smooth muscle relaxant, anti-arrhythmic
  – Dose asthma – 25 –50 mg/kg slow infusion (maximum 2 g)
**DRUGS FOR ANAPHYLAXIS**

- **Diphenhydramine**
  - Classification: antihistamine
  - Indication: anaphylaxis
  - Action:
    - Competes with histamines for H1 receptor sites
    - Decreases allergic response by blocking histamines
  - Dose:
    - 1-2 mg/kg every 4-6 hours (maximum dose 50 mg)

- **Epinephrine**
  - Classification: catecholamine, vasopressor
  - Indications: asthma and croup
  - Action:
    - Stimulates beta 1 and 2 receptors
    - Increases contractility, heart rate, and systolic blood pressure
  - Dose:
    - Asthma: 0.1 mg/kg of 1/1000 SQ (max dose 0.3 mg)

- **Dexamethasone**
  - Classification: corticosteroid
  - Indication: croup and asthma
  - Action: anti-inflammatory agent
  - Dose:
    - Asthma: PO/IM/IV -0.6 mg/kg every 24 hours (16 mg max)
• SHOCK FROM TRAUMA AND BURNS

• Albumen
  – Classification - plasma and volume expander
  – Indications - shock, trauma, burns
  – Action
    • Expands intravascular volume through colloid oncotic effect
    • Augments preload and thus cardiac output
  – Dose
    • IV / IO - 0.5-1 g/kg

• Norepinephrine
  – Classification - inotrope, vasopressor
  – Indication - hypotensive shock refractory to fluid boluses
  – Action
    • Activates alpha receptors causing vasoconstriction
    • Activates beta receptors increasing myocardial contractility and heart rate
  – Dose
    • IV / IO - 0.1—2 mcg / kg/min infusion

  I
• **SHOCK TRAUMA BURNS**

• **Vasopressin**
  – **Classification** – antidiuretic hormone
  – **Indication** – septic shock
  – **Action**
    • Mediated by vasopressin receptors
  – **Dose**
    • IV/IO -0.0002 – 0.002 units/kg/min continuous infusion
  – **Monitor**
    • Blood pressure and distal pulses
    • Water intoxication (headache, drowsiness)

• **Dopamine**
  – **Classification** – catecholamine, vasopressor, inotrope
  – **Indication**
    • Cardiogenic shock
    • Distributive shock
  – **Action**
    • 5 – 15 mcg/kg/min – increases, contractility, decreases SVR
    • 15 – 20mcg/kg/min – increases SVR and constriction of the arteries
  – **Dose**
    • IV/IO -2 – 20 mcg/kg/min
• **Alprostadil**
  – **Classification** – vasodilator, prostaglandin
  – **Indication**
    • Maintain patency with ductus arteriosus
    • Tetralogy of Fallot
    • Aortic stenosis or obstructive lesions
  – **Action**
    • Acts on FPE receptors to dilate arteries and arterioles
    • Stimulates uterine and smooth muscles
  – **Dose**
    • IV / IO – initial - 0.05 – 0.1 mg/kg/min infusion
    • IV / IO – maintenance – 0.01 - 0.05 mg/kg/min infusion

• **Inamrinone (Amrinone) and Milrinone**
  – **Classification** – phosphodiesterase inhibitor
  – **Indication**
    • Myocardial dysfunction and increased SVR
    • Cardiogenic shock with increased SVR
    • Post cardiac surgery
  – **Action**
    • Increases myocardial contractility
    • Reduces preload and afterload (relaxes smooth muscle)
  – **Dose** IV / IO
    • loading – 0.75 - 1 mg/kg slow bolus – amrinone
    • Infusion – 5 – 10 mcg/kg/min – amrinone
    • Loading – 50 mcg /kg (10-60 minutes) - milrinone
    • Infusion – 0.25 – 0.75mcg/kg/min - milrinone
• **Nitroglycerine**
  - Classification – vasodilator, antihypertensive
  - Indication – CHF, cardiogenic shock
  - Action - stimulates nitric oxide
  - Dose
    - Child / infant – 0.25 – 0.5 mcg/kg/min (titrate 1 mcg/kg/min)
    - Adolescents – 5-10 mcg/min (titrate to max of 200 mcg/min)

• **Nitroprusside** (monitor thiocyanate and cyanide)
  - Classification – vasodilator, antihypertensive
  - Indication – severe hypertension
  - Action
    - Relaxes arterial and venous beds by nitric oxide release
    - Reduces ventricular filling pressures and afterload
  - Dose
    - Initial – 0.3 – 1 mcg/kg/min (titrate as required to 8 mcg/kg/min)

• **Lasix (furosemide)**
  - Classification – loop diuretic
  - Indication - pulmonary edema / fluid overload
  - Action
    - Inhibits reabsorption of sodium in ascending loop of Henle
    - Increases excretion of potassium
  - Dose - 1 mg/kg (max dose 20 mg)
• **Dobutamine**
  – Classification – selective beta adrenergic agent
  – Indication - ventricular dysfunction
  – Action
    • Stimulates beta 1 receptors
    • Increases contractility, automaticity, and conduction velocity
    • Increases heart rate and vasodilation
    • Alpha blocking effects (risk of hypotension)
  – Dose - IV / IO – 2 – 20 mcg/kg/min

• **Lidocaine**
  – Classification - antiarrhythmic
  – Indication – wide complex tachycardia with a pulse
  – Action
    • Stabilizes cardiac membrane and decreases automaticity
    • Abolishes reentry
  – Dose
    • 1 mg/kg bolus followed by infusion 1-2 mg/min
**Calcium chloride**
- Classification - electrolyte
- Indication
  - Hypocalcemia
  - Hyperkalemia
  - Calcium channel overdose
  - Consider for hypomagnesemia
- Action
  - Maintains nervous, muscular and skeletal functions
  - Maintains cardiac contractility, coagulation and enzyme functions
  - Affects secretory function of endocrine and exocrine glands
- Dose
  - Arrest – 20 mg/kg bolus  
  - Non arrest – 20 mg.kg infuse over 30-60 minutes

**Sodium bicarbonate**
- Classification - electrolyte
- Indication
  - Severe metabolic acidosis
  - Hyperkalemia
  - Sodium channel blocker overdose (tricyclic antidepressants)
- Action – increases plasma bicarbonate
- Dose - IV/IO
  - Metabolic acidosis / hyperkalemia – 1 mEq slow bolus (50 mEq max)
  - Sodium channel blocker overdose – 1 – 2 mEq bolus until pH >7.45

**Magnesium sulfate**
- Classification – electrolyte, bronchodilator
- Indication – asthma, torsades, and hypomagnesemia
- Action – smooth muscle relaxant, antiarrhythmic
- Dose
  - asthma – 25 – 50 mg/kg infusion (20 min) to a max of 2g
  - Torsades (pulseless) – 25-50 mg/kg bolus to a max of 2g
  - Torsades (pulse) – 25-50 mg/kg over 20 minutes
**Epinephrine**
- **Classification** – Catecholamine, vasopressor, inotrope
- **Indication** – cardiac arrest
- **Action**
  - Stimulates beta 1 and 2 receptors
  - Increases contractility, heart rate, and systolic blood pressure
  - Dilates bronchi and arterioles
- **Dose**
  - IV/IO – 0.1 mg/kg of 1/10000 every 3-5 minutes
  - ET tube – 0.1 mg/kg of 1/1000 every 3-5 minutes

**Vasopressin**
- **Classification** – antidiuretic hormone
- **Indication** – cardiac arrest
- **Action**
  - Mediated by vasopressin receptors
  - Vasoconstrictor increases catecholamine response
  - Increases water permeability in the distal tubes
- **Dose** – IV/IO 0.4-1 unit/kg (maximum dose = 40 units)
• Amiodarone
  – Classification - antiarrhythmic
  – Indication – cardiac arrest
  – Action
    • Works in both the atria and ventricles
    • Prolongs action potential duration
    • Slows sinus rate
    • Inhibits alpha and beta adrenergic receptors
  – Dose
    • IV/IO – 5 mg/kg rapid bolus (maximum dose = 300 mg)
    • Follow up with a drip infusion

• Lidocaine
  – Classification – antiarrhythmic, anesthetic
  – Indication – cardiac arrest
  – Action
    • Works primarily in the ventricles
    • Increases electrical stimulation stabilizing cardiac membranes
    • Reduces ICP by inhibiting sodium channels
  – Dose
    • IV/IO -1 mg/kg loading bolus – repeat dose (max 3 mg/kg)
    • Follow up with a drip
    • ET – 2-3 mg/kg
• **Etomidate**
  - **Classification** - sedative, hypnotic
  - **Indication**
    - Sedation for RSI (especially for head injuries)
    - Sedative for hypotension, trauma, cardiac disease
  - **Action**
    - Short acting sedative hypnotic agent
    - Non barbiturate or benzodiazepine
    - Decreases ICP, cerebral blood flow and cerebral metabolic rate
  - **Dose** - 0.2 – 0.4 mg/kg IV/IO infused over 20 – 30 seconds (max dose 20 mg)

• **Atropine**
  - **Classification** - anticholinergic
  - **Indication** – RSI
    - 1 – 5 years receiving succinylcholine
    - > 5 years receiving a second dose of succinylcholine
  - **Action**
    - Increases heart rate and cardiac output by blocking vagal stimulation
    - Causes mydriasis (paralysis)
  - **Dose**
    - IV/IO – 0.01 - 0.02 mg/kg (min dose -0.1 mg / max dose 0.5 mg)
    - IM - 0.2 mg/kg

• **Lidocaine**
  - **Classification** - antiarrhythmic
  - **Indication**- RSI to reduce ICP
  - **Action**
    - Reduces ICP by inhibiting sodium channels in neurons
    - Reduces metabolic activity
  - **Dose** – 1 – 2 mg/kg
• Narcotic overdose
  – Naloxone (Narcan)
    • Classification – opioid antagonist
    • Indication – reverse opiate overdose
    • Action – competes with opioids for receptor site
    • Dose – 4 mg (repeat until total reversal)

• Anaphylaxis
  – Epinephrine
    • Classification – catecholamine, vasopressor, inotrope
    • Indication - anaphylaxis
    • Action
      – Beta adrenergic stimulator (particularly beta 2)
      – Increases heart rate, contractility and automaticity
    • Dose
      – IM -0.01 mg/kg of 1/1000 every 15 min. (0.3 mg max)
      – IV/IO – 0.01 - 0.1 mg/kg of 1/10000 (max dose 1 mg)
      – Hypotension refractory to fluids – 0.1 – 1 mcg/kg/min

• Hypoglycemia
  – Dextrose (glucose)
    • Classification -carbohydrate
    • Indication - hypoglycemia
    • Action – increases blood glucose
    • Dose - 0.5 – 1 g/kg
    • Concentrations
      – D50W – 1- 2 ml/kg
      – D25W – 2-4 ml/kg – dilute D50 1:1 with N.S.
      – D12.5W – 5-10 ml/kg dilute D25 1:1 with N.S. (newborns)
<table>
<thead>
<tr>
<th>Equipment</th>
<th>GRAY* 3-5 kg</th>
<th>PINK Small Infant 6-7 kg</th>
<th>RED Infant 8-9 kg</th>
<th>PURPLE Toddler 10-11 kg</th>
<th>YELLOW Small Child 12-14 kg</th>
<th>WHITE Child 15-18 kg</th>
<th>BLUE Child 19-23 kg</th>
<th>ORANGE Large Child 24-29 kg</th>
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<tr>
<td>Resuscitation bag</td>
<td>Infant/child</td>
<td>Infant/child</td>
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<tr>
<td>Oxygen mask (NRB)</td>
<td>Pediatric</td>
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<td>Oral airway (mm)</td>
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<td>Laryngoscope blade (size)</td>
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<td>1 Straight</td>
<td>1 Straight</td>
<td>2 Straight</td>
<td>2 Straight or curved</td>
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<tr>
<td>ET tube (mm)†</td>
<td>3.5 Uncuffed</td>
<td>3.5 Uncuffed</td>
<td>4.0 Uncuffed</td>
<td>4.5 Uncuffed</td>
<td>5.0 Uncuffed</td>
<td>5.5 Uncuffed</td>
<td>6.0 Cuffed</td>
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<td>ET tube insertion length (cm)</td>
<td>3 kg 9-9.5</td>
<td>4 kg 9.5-10</td>
<td>5 kg 10-10.5</td>
<td>10.5-11</td>
<td>11-12</td>
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<td>16.5</td>
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<td>Suction catheter (F)</td>
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<td>BP cuff (Neonatal /5/Infant)</td>
<td>Infant/child</td>
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<td>IO (ga)</td>
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<td>Urinary catheter (F)</td>
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<td>Chest tube (F)</td>
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<td>28-32</td>
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</tbody>
</table>
BRADYCARDIAS

• **General**
  – Starlings law
    • CO = STROKE VOLUME X HEART RATE
  – Primary bradycardia (cardiac causes)
    • Congenital abnormality in the pacemaker system
    • Surgical injury to the conduction system
    • Cardiomyopathy
    • Myocarditis
  – Secondary bradycardia (non cardiac causes)
    • Hypoxia
    • Acidosis
    • Hypotension
    • Hypothermia
    • Drug effects

• **Signs and symptoms**
  – Hypotension
  – Decreased level of consciousness
  – Shock
  – Poor organ perfusion
  – Respiratory distress or failure
  – Sudden collapse

• **Types of bradycardia**
  – Sinus bradycardia
  – First degree heart block
  – Mobitz 1 (Wenckebach)
  – Mobitz 2 (second degree type 2)
  – Third degree (complete heart block)
• First degree Heart Block

**CAUSES**
- May be normal
- AV node disease
- Enhanced vagal tone
- Myocarditis
- Hyperkalemia
- Hypoxemia
- MI
- Cardiac surgery
- Drugs
- Rheumatic fever

**SYMPTOMS**
- Asymptomatic

• Wenckebach Mobitz 1

**CAUSES**
- May be normal
- Drugs
- Vagal tone stimulation
- MI

**SYMPTOMS**
- Light headed
- Fainting
BRADYCARDIAS

• Second degree Mobitz 2

CAUSES
Abnormal conduction
Parasympathetic control
Drugs (rare)
MI
Cardiac surgery

SYMPTOMS
Irregular heart beat
Light headedness
Syncope

• Third degree (complete HB)

CAUSES
Conduction deficiencies
Myocarditis
Cardiac surgery
MI
Parasympathetic tone
Drug toxicity
Severe hypoxia
Severe acidosis

SYMPTOMS
Fatigue
Light headedness
Syncope
• Treating underlying causes
  – Hypoxia – high concentration oxygen / assist ventilations
  – Acidosis – ventilation respiratory / bicarbonate metabolic
  – Hyperkalemia – restore normal potassium levels
  – Hypothermia – warm
  – Heart blocks – atropine, pacing, inotropic drugs
  – Toxins, poisons and drugs
    • Cholinesterase inhibitors
    • Calcium channel blockers
    • Beta blockers
    • Alpha adrenergic agents

BRADYCARDIA ALGORITHM

CAB Ventilate, oxygenate, Intubate, IV/IO, vital signs
HR < 60 bpm poor perfusion, agonal breathing

NO

Observe CBA Pedes unit

Poor perfusion Hypotension Respiratory distress

Reversible causes Hypoxia Hypoglycemia Hypothermia

YES

HR <60 CPR

Epi 1/10000 0.01 mg/kg

Atropine - 0.02 mg/kg 0.5 mg child 1.0 mg adolescent

Pacemaker
• **General**
  – Tachycardias are fast rhythms originating in either the atria or ventricles
  – Sinus tachycardias usually do not create hemodynamic compromise but actually increase cardiac output (stress and fever)
  – Rapid tachyarrhythmias reduce cardiac output by not allowing ventricular filling during diastole.
  – Severe hemodynamic compromise can occur if these rhythms are allowed to continue

• **Types of tachycardias**
  – Sinus tachycardia
  – Supraventricular tachycardia (SVT) – stable / unstable
  – Wide complex tachycardia – stable / unstable

• **Signs of hemodynamic instability**
  – Poor feeding and irritability
  – Respiratory distress and failure
  – Signs of shock (poor perfusion and hypotension)
  – Altered mental status
  – Sudden collapse (weak rapid pulses)
• Common causes
  – Pain
  – Anxiety
  – Hypoxia
  – Hypovolemia
  – Shock
  – Fever
  – Metabolic stress
  – Injury (pneumothorax, tamponade, embolism)
  – Toxins
  – Anemia

• SINUS TACHYCARDIA ALGORITHM

  TREAT THE CAUSE
  TREAT THE ARRHYTHMIA

  CAB, OXYGEN, VITAL SIGNS, EKG, HX, LABS, 12 LEAD

  TREAT THE CAUSE
  ANXIETY, FEVER, HYPOXIA, HYPOVOLENIA
  EXERTION, PAIN, INJURY, TOXINS
• **General**
  – May be episodic (PSVT)
  – Tolerated better in infants
  – Prolonged SVT can lead to CHF resulting in severe hemodynamic compromise

• **Signs and symptoms**
  – Tachypnea
  – Wheezes, crackles, grunting associated with CHF
  – Delayed capillary refill time (cool extremities)
  – Diaphoresis hypotension
  – Altered mental status
  – Irritability
  – Lethargy

• **STABLE SVT ALGORITHM**

```
CAB OXYGEN EKG SPO2
VITAL SIGNS  IV  LABS

12 LEAD EKG

VAGAL MANEUVERS

ADENOSINE 6 – 12mg

PEDIATRIC CARDIOLOGIST
```
SUPRAVENTRICULAR TACHYCARDIA

- SUPRAVENTRICULAR ALGORITHM (UNSTABLE)

  CAB OXYGEN VITALS IV /IO
  SPO2 EKG PREPARE CODE EQ

  12 LEAD CONSULT

  VAGAL MANEUVERS

  ADENOSINE 0.1 mg/kg RAPID WITH FLUSH

  SYNC CARDIOVERSION 0.5-1.0 J/kg

  SYNC CARDIOVERSION UP TO 2 J/kg

  SYNC CARDIOVERSION UP TO 2 J/kg
• STABLE WIDE COMPLEX TACHYCARDIA ALGORITHM

CAB OXYGEN    EKG    SPO2
VITAL SIGNS    IV/IO    LABS
HISTORY    12 LEAD

AMIODARONE 5 mg/kg (20-60 min)
OR
Lidocaine 1.0 mg/kg

SYNC CARDIOVERSION
0.5 – 1 J/kg  MAY INCREASE TO 2 J/kg

SUCCESSFUL

PEDIATRIC CARDIOLOGIST
• UNSTABLE WIDE COMPLEX TACHYCARDIA ALGORITHM

CAB OXYGEN EKG SPO2
VITALS IV/IO LABS
BRIEF HISTORY

IMMEDIATE SYNCHRONIZED
CARDIOVERSION 0.5-1 J/kg

SUCCESSFUL

PEDiatric CARDIOLOGIST

SECOND SYNCHRONIZED
CARDIOVERSION UP TO 2 J/kg

UNSUCCESSFUL

AMIODARONE 5mg/kg
OVER 20-60 MIN

PROCAINAMIDE 15 mg/kg
OVER 30-60 MIN

3rd SYNC CARDIOVERSION
UP TO 2 J/kg
• PATHWAYS

RESPIRATORY FAILURE

HYPOTENSIVE SHOCK

CARDIO / PULMONARY FAILURE

SUDDEN ARRHYTHMIA

HYPOXIC / ASPHICAL ARREST

SUDDEN CARDIAC ARREST

• CAUSES OF CARDIAC ARREST

5H

HYPOVOLEMIA
HYPOXIA
HYDROGEN ION
HYPOGLYCEMIA
HYPO – HYPER KALEMIA
HYPOTHERMIA

5T

TENSION PNEUMOTHORAX
TAMPONADE CARDIAC
TOXINS
THROMBUS PULMONARY
THROMBOSIS CORONARY
CAUSES OF CARDIAC ARREST

OUT OF HOSPITAL
- RESPIRATORY
  - UPPER AIRWAY
  - LOWER AIRWAY
  - DISORDERED CONTROL BREATHING
  - LUNG TISSUE DISEASE
- HYPOTENSION
  - HYPOVOLEMIC SHOCK
  - CARDIOGENIC SHOCK
  - DISTRIBUTIVE SHOCK
- SIDS  ARRHYTHMIAS
  - TRAUMA  DROWNING

IN HOSPITAL
- RESPIRATORY
  - UPPER AIRWAY
  - LOWER AIRWAY
  - DISORDERED CONTROL BREATHING
  - LUNG TISSUE DISEASE
- HYPOTENSION
  - HYPOVOLEMIC SHOCK
  - CARDIOGENIC SHOCK
  - TOXICOLOGIC SHOCK
  - DISTRIBUTIVE SHOCK
- HYPOTENSION
  - METABOLIC/ELECTROLYTE
  - HYPOVOLEMIC SHOCK
  - CARDIOGENIC SHOCK
  - TOXICOLOGIC SHOCK
  - DISTRIBUTIVE SHOCK
- ARRHYTHMIAS
CARDIAC ARREST RHYTHMS

- Non shockable rhythms
  - PEA Asystole Torsades

- Shockable rhythms
  - Pulseless Ventricular tachycardia
  - Ventricular tachycardia

- Ventricular tachycardia and Torsades
• Intravenous
  – Give the drug by bolus injection
  – Give while continuing CPR
  – Follow with a 5-10 ml bolus of normal saline
  – Raise the extremity

• Intraosseous
  – IO access can be established for all age groups
  – IO access can be achieved in 30 – 60 seconds
  – IO is preferred over the endotracheal route
  – Any drug given IV can also be given IO

• Endotracheal
  – Drug absorption is unpredictable
  – Optimal dose of most drugs is unknown
  – Recommended dose is higher
  – A limited number of drugs can be given
• Stimulant / vasopressors
  – Epinephrine – 0.1-0.2 mg/kg IV/IO 1/10000
  – Epinephrine – 0.1 mg/kg ET 1/1000
  – Vasopressin – use if no response to epinephrine

• Antiarrhythmics
  – Amiodarone – 5 mg/kg may repeat x2
    • Refractory VF or VTACH
  – Lidocaine – 1 mg/kg
  – Magnesium sulfate – 25- 50 mg/kg
    • Torsades or hypomagnesemia
CARDIAC ARREST ALGORITHM
PEA AND ASYSTOLE

CONTINUOUS CPR
2 MIN. CYCLES
PERIODIC PULSE CHECK

CPR MONITOR / DEFIB OXYGENATE

INTUBATE / CO2 IV / IO ACCESS

EPINEPHERINE 0.01 mg/kg 1/10000 REPEAT EVERY 3-5 MINUTES

IDENTIFY AND TREAT CAUSES
5 H’S AND T ‘S
PALS Handbook

CARDIAC ARREST ALGORITHM
PULSELESS VTACH AND VF

CPR MONITOR/DEFIB OXYGENATE
DEFIBRILLATE AT 2 J/Kg

INTUBATE / CO2 IV / IOI ACCESS

DEFIBRILLATE AT 4 J/Kg

EPINEPHRINE IV/IO 0.01 mg/kg (1/10000)
EVERY 3-5 MINUTES

DEFIBRILLATE AT 4 J/Kg

AMIODARONE 5mg/kg REPEAT TO 15mg/kg

DEFIBRILLATE AT 4 J/Kg

TREAT REVERSIBLE CAUSES
• **Shock**
• **Factors**
  – Intravascular volume
  – Blood pressure
  – Tissue oxygenation
  – Metabolic demand
  – Arrhythmias
  – Post myocardial dysfunction

**POST RESUSCITATION MANAGEMENT**

- **Optimize Ventilation and Oxygenation**
- **Persistent Shock**
  - Identify Causes
  - 20cc/kg Fluid Bolus
  - Inotropic Support

**Hypotensive**
- Epinephrine
- Dopamine
- Norepinephrine

**Normotensive**
- Dobutamine
- Epinephrine
- Milrinone
- Dopamine

- If patient remains unconscious:
  - Mild hypothermia

**Monitor & Treat**
- Hypoglycemia
- Electrolytes
- ABG’s
- Agitation
- Seizures
- Consult
- Transport
POST RESUSCITATION MANAGEMENT

• Respiratory
  – Factors
    • Oxygenation
    • Intubation
    • Ventilation
    • Analgesia and Sedation
    • Neuromuscular blockade

• Cardiovascular
  – Factors
    • Intravascular volume
    • Blood pressure
    • Tissue oxygenation
    • Metabolic demand
    • Arrhythmias
    • Post arrest myocardial dysfunction
• **Neurologic**
  – Factors
    • Brain perfusion
    • Blood pressure
    • Temperature control
    • Increased ICP
    • Seizures

• **Gastrointestinal**
  – Factors
    • Gastric distension
      – Naso or orogastric tube
    • Ileus
    • Hepatic failure

• **Hematologic system**
  – Factors
    • Blood component therapy
    • Coagulopathy
    • Platelets
    • RBC and WBC
• History and assessment

HISTORY
MULTIPLE BIRTHS
PREMATURE
MERCONIUM
NARCOTIC USE

ASSESSMENT
GESTATION
AMNIOTIC FLUID
BREATHING
CRYING
MUSCLE TONE

• Typical newborn vital signs
  – Heart rate – 100 – 180
  – Respiratory rate 30 – 60 bpm
  – Systolic blood pressure – 55 – 90 mmHg
  – Diastolic blood pressure – 25 – 55 mmHg

<table>
<thead>
<tr>
<th>Sign</th>
<th>0</th>
<th>1</th>
<th>2</th>
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<tbody>
<tr>
<td>Heart rate</td>
<td>Absent</td>
<td>&lt; 100</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>Muscle tone</td>
<td>Limp</td>
<td>Some flexion</td>
<td>Active motion</td>
</tr>
<tr>
<td>Respiratory effort</td>
<td>Absent</td>
<td>Slow/irregular</td>
<td>Good exchange</td>
</tr>
<tr>
<td>Response to stimulation</td>
<td>No response</td>
<td>Grimace</td>
<td>Cough, sneeze or cry</td>
</tr>
<tr>
<td>Color</td>
<td>Blue/pale</td>
<td>Peripheral cyanosis</td>
<td>Pink</td>
</tr>
</tbody>
</table>
- **Meconium**
  - Suction mouth and nose if obstructed
  - Intubate
  - Suction using a meconium aspirator
  - Repeat with new tubes until clear