Diapositiva 1

Welcome to PALS

The Children's Hospital

Denver, Colorado

1

Diapositiva 2

Course Objectives

At the end of this lecture and appropriate course activities the participant should be able to

- **Perform and understand the standardized approach to pediatric assessment and categorization**
- **Recognize signs of respiratory distress, respiratory failure, and shock**

2

Slide 2: Lecture Objectives

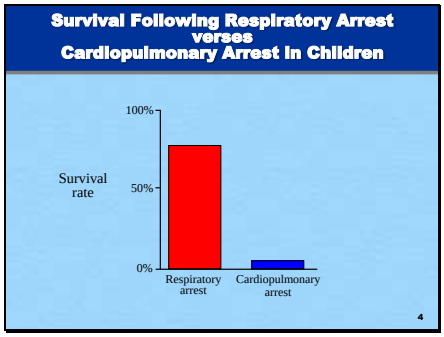
- The goals of this lecture are to help participants learn to
  - Perform a rapid cardiopulmonary assessment
  - Recognize signs of respiratory distress, respiratory failure, and shock
- Each participant should practice rapid cardiopulmonary assessment during the scenario practice stations and should be prepared to demonstrate it during the practical evaluation.

Diapositiva 3

Pathway to Cardiac Arrest

3

Diapositiva 4

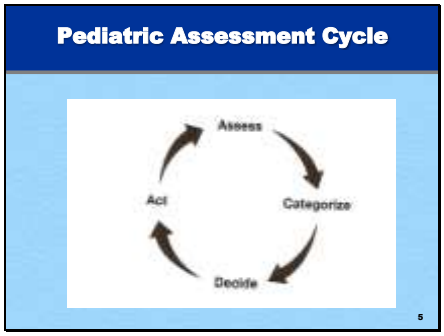


Optional

Slide 4: Survival Following Respiratory Arrest vs Cardiopulmonary Arrest in Children

- Respiratory and cardiac arrest are both life-threatening events requiring resuscitation.
- But good outcome of resuscitation (survival to hospital discharge) is more likely following respiratory arrest than cardiopulmonary/cardiac arrest.
- Respiratory arrest often precedes cardiac arrest in infants and children. If respiratory arrest is recognized early and treated appropriately, cardiac arrest can be prevented and the likelihood of recovery increased.

Diapositiva 5



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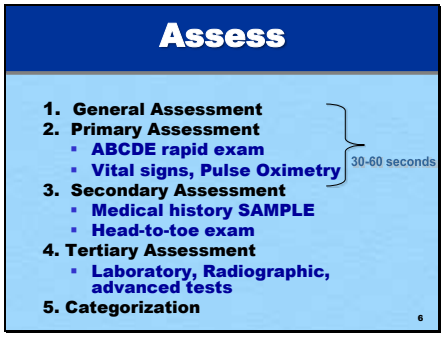

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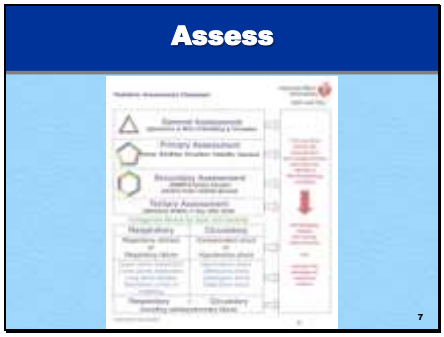

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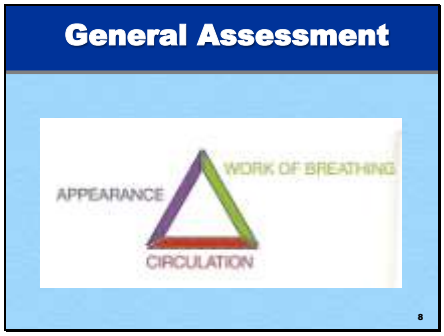
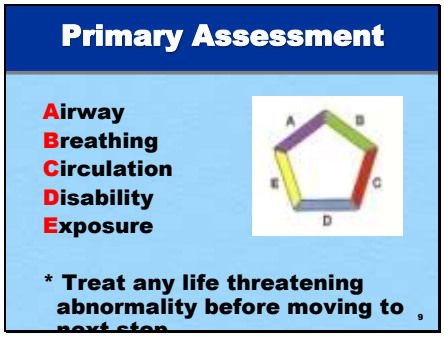


visual and auditory

- From the moment of the initial encounter with the infant or child the PALS provider should begin to form an opinion about the degree of distress the child demonstrates: is this an emergency or can the child wait for a more detailed assessment?
- Evaluation of general appearance can become instinctive and takes into account the child's
  - —General color
  - —Apparent mental status and responsiveness
  - —Activity, movement, and muscle tone
- Watch for age-appropriate behaviors (eg, resistance to separation from the primary caretaker and "stranger anxiety" in the toddler).

Diapositiva 9



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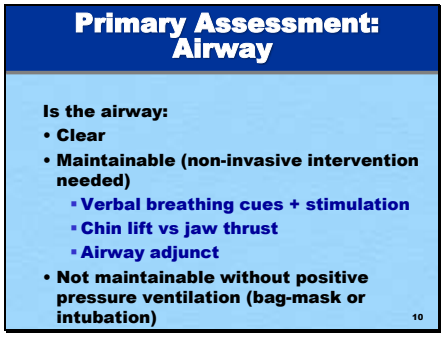
- Evaluation of general appearance can become instinctive and takes into account the child's
  - — General color
  - — Apparent mental status and responsiveness
  - — Activity, movement, and muscle tone
- Watch for age-appropriate behaviors (eg, resistance to separation from the primary caretaker and "stranger anxiety" in the toddler).
- Remember: a decreased response to painful stimulus is abnormal in a child of any age.

Diapositiva 10

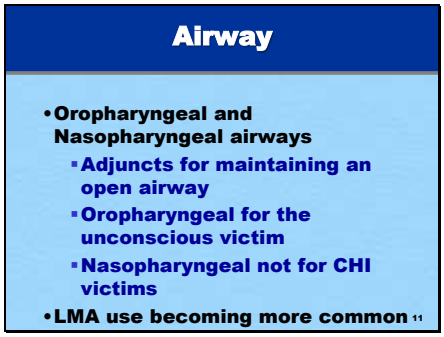


Slide 7: Physical Examination of the Airway

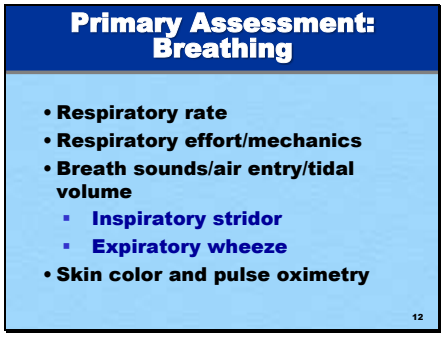
The participant should evaluate the child's airway and determine if intervention is required. The following terms can be helpful in determining the need for airway support:

- *Clear* means that no airway assistance or protection is necessary.
- *Maintainable* means that noninvasive assistance is necessary to ensure airway patency (head position, suctioning, bag-mask ventilation), but invasive intervention is not required.
- *Not maintainable* means that invasive intervention *is* necessary to maintain airway patency (eg, tracheal intubation, needle cricothy-rotomy, relief of foreign-body obstruction).

Diapositiva 11



Diapositiva 12

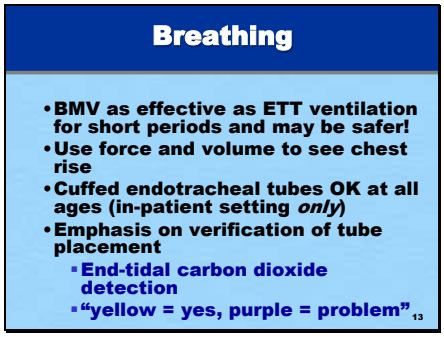


Slide 8: Physical Examination of Breathing

To assess the effectiveness of breathing you should evaluate the following:

- *Rate:* Should be *appropriate* for the child's clinical condition.
  - Tachypnea is a nonspecific sign of distress. A respiratory rate of more than 60 breaths per minute, however, is abnormal in all age groups.
  - A *slow* or irregular respiratory rate in an acutely ill or injured infant or child is ominous because it often indicates that respiratory arrest is imminent.
- *Effort:* Relates to the work of breathing and breathing mechanics.
- *Air entry/tidal volume:* Determined by observation of chest expansion and auscultation over central and peripheral lung fields.
  - Inspiratory stridor suggests croup or the presence of a foreign body.
  - Wheezing or a prolonged expiratory phase suggests asthma or bronchiolitis.
- *Skin color:* Pink skin and mucous membranes suggest good oxygenation; cyanosis suggests hypoxemia. Pulse oximetry can quantify oxygen saturation.

Diapositiva 13



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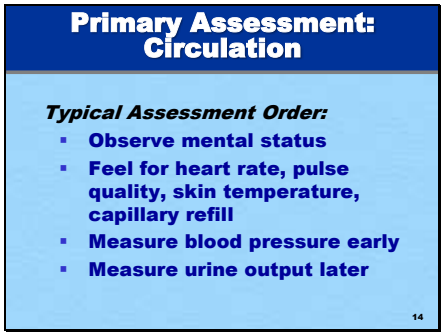
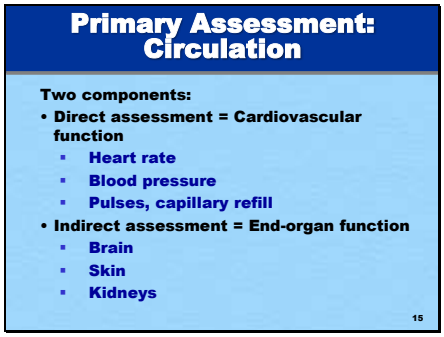


Slide 14: Physical Examination of the Circulation—Typical Assessment Order

- This slide describes the typical order of the rapid assessment of the circulation.
- Early measurement of blood pressure and later measurement of urine output indicate that blood pressure should be quantified quickly, although a precise quantitative measurement is not necessary to identify the presence of shock. Measurement of urine output requires an invasive procedure that should be completed after initial interventions.

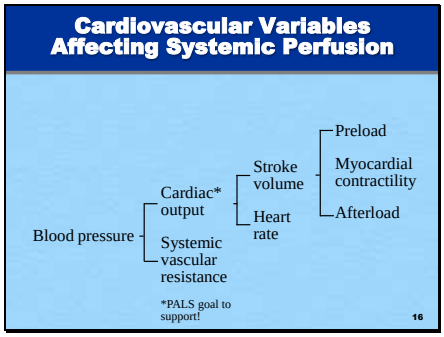
Diapositiva 15



Slide 13: Physical Examination of the Circulation

- *Cardiovascular assessment begins with an evaluation of the child's responsiveness*—if the child is unresponsive, urgent intervention is required. Then you begin *direct* assessment of the cardiovascular system, including evaluation of heart rate, quality of proximal and distal pulses, and blood pressure.
- Indirect assessment of the cardiovascular system is discussed later and includes evaluation of signs of end-organ *function* to evaluate end-organ *perfusion*.
  - End-organ function includes function of the brain, skin, and kidneys.
  - You will evaluate indirect signs of brain and skin perfusion during the cardiovascular assessment.
- A compromise in end-organ function may indicate that cardiac output and end-organ perfusion are inadequate.

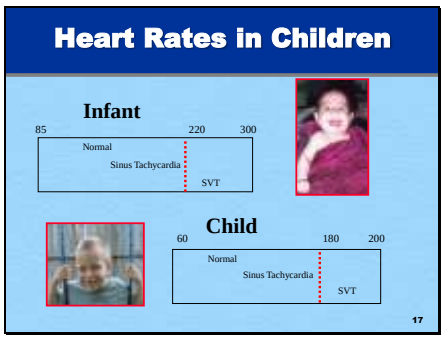
Diapositiva 16



Slide 10: Cardiovascular Variables Affecting Systemic Perfusion

- This graphic illustrates the relationship of cardiovascular variables that affect cardiac output and systemic perfusion. Note that one goal of PALS is to support cardiac output (the amount of blood delivered to the tissues each minute) that is adequate to meet tissue oxygen demand.
- Although many variables influence cardiac output and oxygen delivery, the only variables readily measured in the clinical setting are the child's heart rate and blood pressure. Note that blood pressure can be maintained despite a fall in cardiac output if systemic vascular resistance increases. This explains how children can have a normal blood pressure despite the presence of shock (*compensated* shock).
- If cardiac output is inadequate, we attempt to improve it through support of an optimal heart rate and stroke volume. Stroke volume is supported through manipulation of cardiac preload, contractility, and afterload.

Diapositiva 17

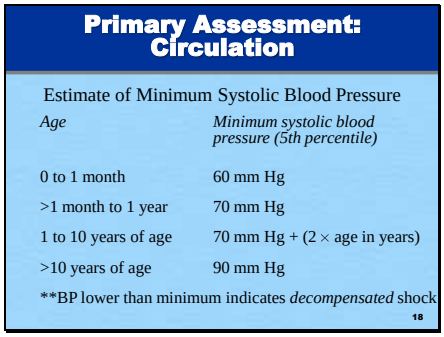


Slide 16: Typical Ranges of Heart Rates in Children

The heart rate in infants and children normally varies with age and activity.

- The "normal" range of heart rate decreases as the child ages.
- Heart rate must be evaluated in the context of the patient's clinical condition. Heart rate increases with fever, anxiety, pain, or shock.
  - A healthy, screaming 6-year-old child may have a heart rate of 130 bpm.
  - The same heart rate of 130 bpm in a quiet 6-year-old child may be evidence of shock.
- Increased heart rate (tachycardia) may be a nonspecific sign of cardiorespiratory distress.
- Heart rate ranges for normal sinus rhythm, sinus tachycardia, and supraventricular tachycardia (SVT) overlap, as depicted in the slide.
- The diagnosis of SVT should always be considered when the heart rate is more than 220 bpm in an infant and more than 180 bpm in a child.

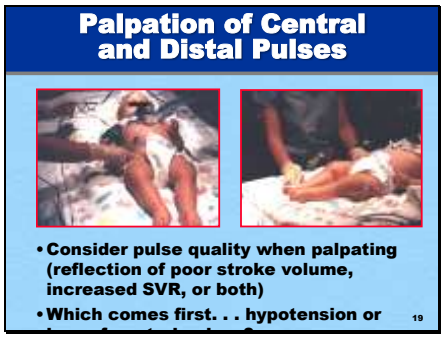
Diapositiva 18



Slide 20: Physical Examination of the Circulation—Estimate of Minimum Systolic Blood Pressure Ranges in Infants and Children

- *Lower-limit* (*5th percentile*) systolic pressures are estimated in children 1 to 10 years of age, using the following formula:
  70 mm Hg + (2 x age in years) = 5th percentile systolic BP
- Note that children older than 10 years should have a systolic blood pressure of at least 90 mm Hg.
- Blood pressures lower than the recommended ranges are usually inadequate.
- Remember: A child may demonstrate signs of shock despite a "normal" blood pressure (this is *compensated* shock). The presence of a blood pressure lower than the minimum systolic blood pressure range for the child's age indicates hypotension and the presence of *decompensated* shock.

Diapositiva 19

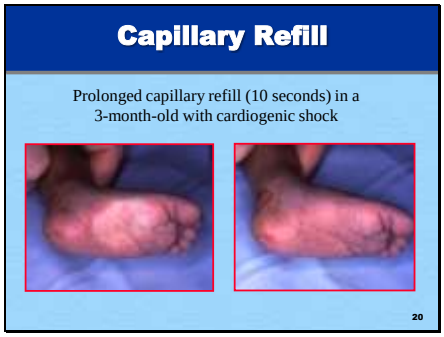


Slide 18: Palpation of Central and Distal Pulses

Evaluation of pulses and distal perfusion is part of the direct cardiovascular assessment.

- Palpation of central and peripheral pulses provides important information for the cardiovascular examination:
  - Palpation of pulses can be used to evaluate heart rate and some indirect evidence of stroke volume and systemic vascular resistance.
  - Pulse quality reflects the adequacy of peripheral perfusion.
  - Weak or absent pulses may indicate poor stroke volume, increased systemic vascular resistance, or both.
- Loss of perfusion in hands and feet often precedes hypotension and critical loss of vital organ perfusion in shock.
- Hypotension often develops before loss of central pulses.

Diapositiva 20

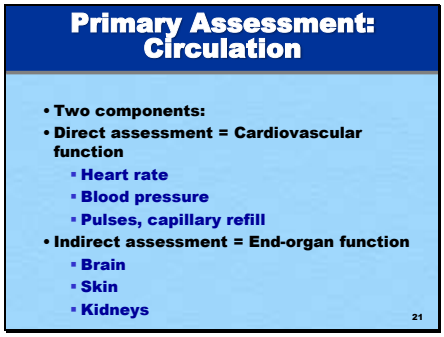


Slide 19: Evaluation of Capillary Refill

- These 2 photos of the foot demonstrate a capillary refill time of 10 seconds in a 3-month-old infant in cardiogenic shock with a systolic blood pressure of 90 mm Hg 1 hour before death.
- To evaluate capillary refill, elevate the extremity *above* the level of the heart to ensure that arterial (not venous) perfusion is being evaluated.

Note: Capillary refill can also be prolonged in cold ambient tempera-
tures or hypothermia.

Diapositiva 21



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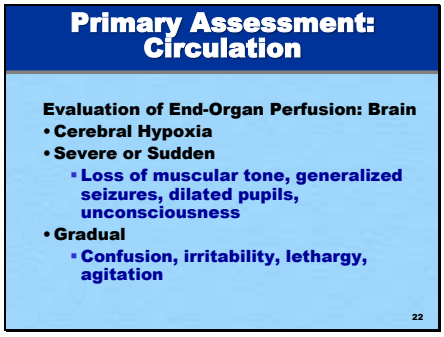
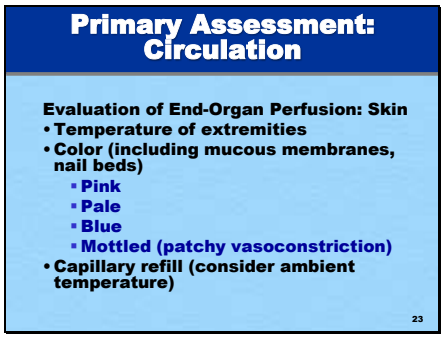
Diapositiva 22



Other causes of AMS exist:
Toxin, increased ICP, metabolic

Diapositiva 23



Slide 17: Physical Examination of the Circulation—Evaluation of Skin Perfusion

Indirect assessment: Evaluation of skin perfusion may provide important information about cardiac output.

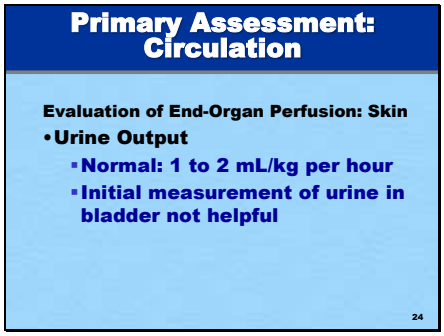
- Skin perfusion may be compromised early in some forms of shock (eg, hypovolemic and cardiogenic shock) that result in redistribution of blood flow away from the skin and toward vital organs (brain, heart).
- *Pulses:* Peripheral pulses may be diminished if stroke volume is decreased or peripheral vasoconstriction is present.
- *Temperature:* Cool extremities suggest inadequate cardiac output or cold ambient temperature.
- *Capillary refill:* Normal capillary refill time should be less than 2 seconds if the ambient temperature is warm.
- *Color* can change with changes in perfusion/oxygen delivery:
  - *Pink* color of mucous membranes indicates normal perfusion.
  - *Pale* color may indicate ischemia,

anemia, or cold environment.

- *Blue* color (cyanosis) indicates hypoxemia or inadequate perfusion with pooling of blood flow or increased oxygen extraction in the skin.
- *Mottled* color may be caused by a combination of the above.

- With distributive shock (eg, septic shock) skin perfusion may be normal or adequate.

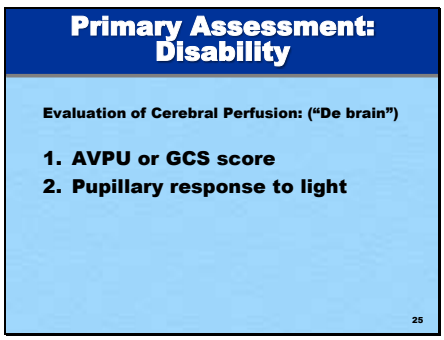
Diapositiva 24



Slide 22*: *Evaluation of End-Organ Perfusion—Kidneys

- Normal urine output is expected if the infant or child is well hydrated and well perfused with good renal function.
  - A decrease in "normal" urine output may indicate inadequate renal perfusion (caused by dehydration or low cardiac output) or a compromise in renal function.
  - Urine output decreases as renal perfusion decreases.
- When a bladder catheter is first inserted, the initial measurement of urine output is often not helpful because the volume of urine in the bladder accumulated over an unknown period of time. Once a urinary catheter is inserted, you can evaluate urine volume on an hourly basis.

Diapositiva 25



Slide 15: Physical Examination of the Circulation—Evaluation of Responsiveness

Indirect assessment: Evaluation of responsiveness may provide important information about cerebral perfusion.

- The AVPU assessment is used to describe the level of responsiveness as a simple, reproducible method of evaluating and tracking the child's level of consciousness (reflecting brain perfusion).
- The child's responsiveness and level of consciousness will deteriorate as cerebral perfusion deteriorates.

Note: If the level of consciousness/responsiveness has deteriorated, the healthcare provider should be prepared to rule out primary neurologic disease or injury but should also suspect a compromise in cardiorespiratory function.

Diapositiva 26

Primary Assessment: Disability

AVPU Scale:

- **A – Awake**
- **V – responsive to voice**
- **P – responsive to pain**
- **U – unresponsive**

26

Diapositiva 27

Primary Assessment: Disability

Glascow Coma Scale

- **Validated for trauma only**
- **What is the difference between localizing to pain and withdrawing from pain?**

27

Diapositiva 28

Primary Assessment: Exposure

- **Trauma**
  - **Bleeding, burns, abuse markings**
  - **Palpate bones**
- **Temperature**
- **Front and Back**

28

Diapositiva 29

Secondary Assessment

- **Focused History**
  - **Signs and symptoms**
  - **Allergies**
  - **Medications**
  - **PMH**
  - **Last Meal**
  - **Events**
- **Detailed Exam**

29

Diapositiva 30

Tertiary Assessment

- **Ancillary studies to help determine severity/categorize**
  - **ABG**
  - **VBG**
  - **Exhaled CO_2**
  - **Capnography**
  - **Chest X-ray**
  - **Lactate**
  - **Central Venous Oxygen Saturation**
  - **Echocardiography**

30

Diapositiva 31

Again. . .

31

Diapositiva 32

Classification of Cardiopulmonary Physiologic Status

- **Stable**
- **Respiratory distress**
- **Respiratory failure**
- **Shock**
  - **Compensated**
  - **Hypotensive**
- **Cardiopulmonary failure**

32

Slide 28: Classification of Cardiopulmonary Physiologic Status

The ABC-focused physical examination during rapid cardiopulmonary assessment enables rapid classification of cardiopulmonary physiologic status, which guides initial management.

Diapositiva 33

Categorize: Respiratory

- **Respiratory Distress vs. Failure**
- **Respiratory Problems**
  1. **Upper airway obstruction**
  2. **Lower airway obstruction**
  3. **Lung tissue disease**
  4. **Disordered control of breathing**

33

Diapositiva 34

Rapid Cardiopulmonary Assessment: Classification of Physiologic Status

Respiratory distress: **Increased work of breathing**

Respiratory failure: **Inadequate oxygenation or ventilation +/- distress**

34

Slide 9: Rapid Cardiopulmonary Assessment: Classification of Physiologic Status

- Rapid cardiopulmonary assessment allows classification of the patient's respiratory status.
  - *Respiratory distress* is characterized by increased effort/increased work of breathing.
  - *Respiratory failure* indicates the presence of inadequate pulmonary gas exchange, resulting in inadequate oxygenation or ventilation. Note that respiratory failure may be present *with or without* respiratory distress.
- A video shown later in this course includes images of infants and children in respiratory distress and respiratory failure.

Diapositiva 35

Upper Airway Obstruction

Location:
- Nose, pharynx, larynx

Example:
- Foreign Body Aspiration
- Swelling of the tissues
  - Anaphylaxis or croup
- Mass

Symptoms:
- Tachypnea
- Change in voice
- Stridor (usually inspiratory)
- Poor chest rise
- drooling

35

Diapositiva 36

Lower Airway Obstruction

Location:
- Trachea, bronchi, bronchioles

Example:
- Asthma
- Bronchiolitis

Symptoms:
- Tachypnea
- Wheezing
- Increased respiratory effort
- Prolonged expiratory phase

36

Diapositiva 37

Lung Tissue Disease

Location:
- Lung tissue

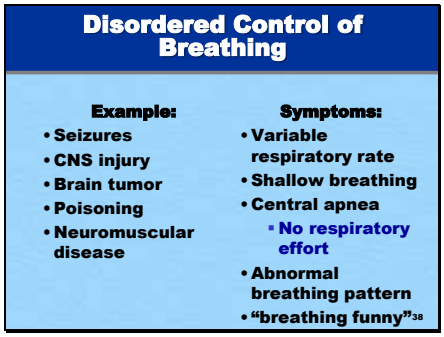
Example:
- Pneumonia
- Pulmonary edema
  - CHF or leak (sepsis)
- ARDS

Symptoms:
- Marked tachypnea
- Grunting
- Hypoxemia
- Crackles
- Diminished breath sounds

37

- Grunting closes glottis, incerased PEEP, prevent collapse
- Hypercarbia late

Diapositiva 38



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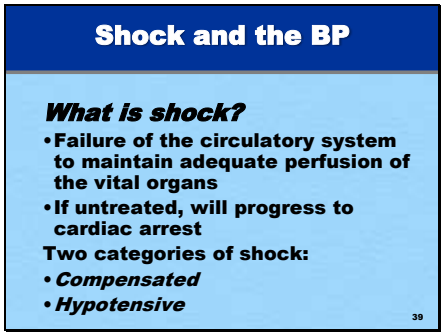

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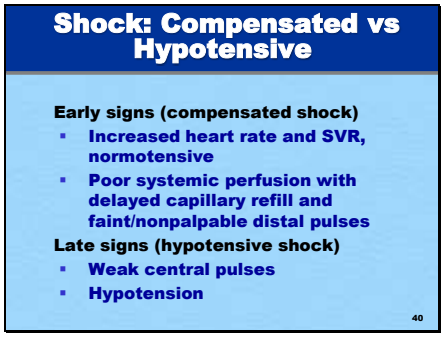


Slide 23: Classification of Physiologic Status—Shock

- Once you have examined the child's circulatory function, you should be able to determine if the child is in shock and to further classify the shock as compensated or decompensated.
- A major goal of the PALS Provider Course is to ensure that participants are able to recognize and manage compensated shock to prevent the development of decompensated shock and cardiac arrest.
- Early signs of compensated shock include tachycardia (a nonspecific sign) and evidence of poor systemic perfusion (reviewed in slide 21)
- Hypotension is a critical sign of decompensation that is typically accompanied by weak central pulses and altered mental status.

Diapositiva 41

Time Matters

Compensated Shock

Possibly hours

Hypotensive Shock

Potentially minutes

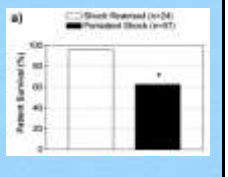
Cardiac Arrest

41

Diapositiva 42

Early Shock Reversal Saves Lives

- **Reversing shock leads to 9X increase in survival**
- **Delay of treatment by even one hour doubles chances of death**



42

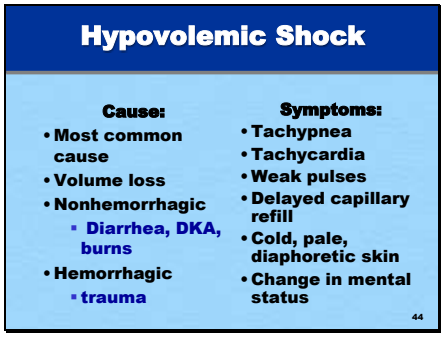
Diapositiva 43

Types of Shock

- **Hypovolemic**
- **Distributive**
- **Cardiogenic**
- **Obstructive**

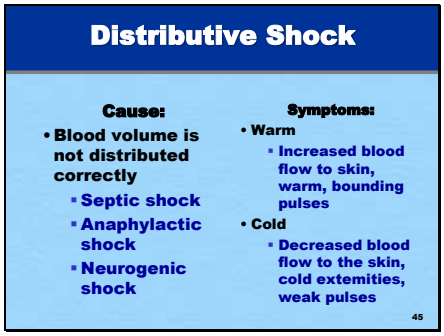
43

Diapositiva 44

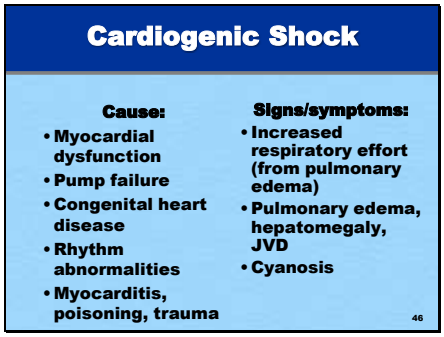


- Ask group- why tachypnea -

Diapositiva 45



Diapositiva 46



Diapositiva 47

Obstructive Shock

Cause:

- Impaired cardiac output caused by physical obstruction to blood flow

Symptoms:

- Tamponade
  - Muffled heart sounds, distended neck veins
- Tension Pneumothorax
  - Dimished breath sounds, distended neck veins, tracheal deviation
- Heart outflow lesions
  - First two weeks of life, differential BP and saturation

47

Diapositiva 48

Medications for Shock

- Warm Shock
  - Norepinepherine
  - Vasopressin
- Cold Shock
  - Epinepherine
- Cardiogenic Shock
  - Milrinone

48

Diapositiva 49

Example Case:

14 year old male with a h/o asthma presents with increased work of breathing. RR 70, no breathsounds heard on right side, poor capillary refill.

Categorization?

Obstructive Shock – tension pneumothorax

Treatment?

Needle decompression over 3rd rib at midclavicular line

49

Diapositiva 50

Cardiopulmonary Failure

Cardiopulmonary failure produces signs of respiratory failure and shock:

- **Agonal respirations**
- **Bradycardia**
- **Cyanosis and poor perfusion**

50

Slide 27: Classification of Physiologic Status—Cardiopulmonary Failure

- The preceding discussion separated the physical examination and physiologic assessment of respiratory failure and shock as if they were unrelated.
- But late respiratory failure and decompensated (late) shock can ultimately result in cardiopulmonary failure.
- The clinical characteristics of cardiopulmonary failure may not allow identification of the primary problem (cardiovascular vs respiratory).

Diapositiva 51

Organize your thinking

- **Triangle (ABC)**
- **Primary ABCDE/Pox VS**
- **Secondary SAMPLE, head-to-toe**
- **Tertiary as needed**
- **Categorize**

51

Diapositiva 52

Categorize

- **Respiratory distress/failure**
  - **Upper airway obstruction**
  - **Lower airway obstruction**
  - **Lung tissue disease**
  - **Disordered control of breathing**
- **Shock compensated/hypotensive**
  - **Hypovolemic**
  - **Distributive**
  - **Cardiogenic**
  - **Obstructive**
- **Cardiopulmonary failure**

52

Diapositiva 53

Pathway

53

Diapositiva 54

Review of PALS Updates

Multiple changes made in 2005 regarding pediatric care. . .

54

Diapositiva 55

Cardiopulmonary Failure & Circulation

- **High quality CPR =**
  - **"Push hard, push fast"**
  - **Minimize interruptions of chest compressions**
  - **Allow full chest recoil**
  - **Do not provide excessive ventilation**

55

Diapositiva 56

Why?

- Improve circulation to vital organs
- Chest compressions interrupted - blood flow stops
- First few compressions are not effective
- The more interruptions in chest compressions, the worse the victim's chance of survival from cardiac arrest
- Full recoil refills the heart

56

Diapositiva 57

Compression to ventilation ratio

- Lone Rescuer
  - 30:2 for infant thru adult
  - 3:1 for neonates
  - Goal rate of at least 100 compressions per minute

57

Diapositiva 58

Compression to ventilation ratio

- Two-person, healthcare provider
  - 30:2 for adult
  - 15:2 for infant and child
  - 3:1 for neonates
  - Goal rate of at least 100 compressions per minute

58

Diapositiva 59

Compression to ventilation ratio

Once an advanced airway has been established:

2-person healthcare rescue:

- **Rescuer 1 provides continuous CPR at 100/minute without pauses for ventilation**
- **Rescuer 2 delivers 8-10 breaths per minute**

59

Diapositiva 60

Defibrillation

IMMEDIATELY

1 shock → CPR (2 Minutes) →

Drugs, interventions, evaluate

60

- "What has been shown in adults is that the earlier they receive a shock, the greater the chances of survival. For every minute that defibrillation is delayed, survival decreases by 7 percent to 10 percent

Diapositiva 61

Pulseless Arrest Algorithm

***Why the change*:**

- **Machine delay = CPR delay**
  - **~40 seconds between shock and rhythm analysis**
- **High success rate after 1 shock**
  - **VF elimated 85% of time after 1 shock**

61

- 37 second delay between shock delivery and rhythm analysis
- VF eliminated 85% of the time after first shock
- Takes several minutes for a normal heart rhythm to return, will help to create blood flow to heart and increases liklihood of return of effective heart pumping

Diapositiva 62

Defibrillators and AEDs

- Automatic Electronic Defibrillator:
  - Biphasic shocks with AED beginning at 1 year of age
- Biphasic vs monophasic
  - Same success rate, lower energy

62

Diapositiva 63

Additional Changes

- Only use low dose epinephrine
  - NO longer recommended high dose
- IV and IO routes of drug administration
  - Preferred over endotracheal (ET) route
- Cuffed endotracheal tubes
  - OK for infants and children (not neonates)
  - Must use correct tube size and cuff inflation pressure (in-hospital use

63

Diapositiva 64

Additional Changes

- End-tidal CO2 detection
  - Recommended to confirm ETT placement
- Induced hypothermia
  - Consider use in comatose patients for 12 to 24 hours post resuscitation

64

Diapositiva 65

Take home point

Effective CPR is important . . . do not interrupt it!

65

Diapositiva 66