FLUID & ELECTROLYTES

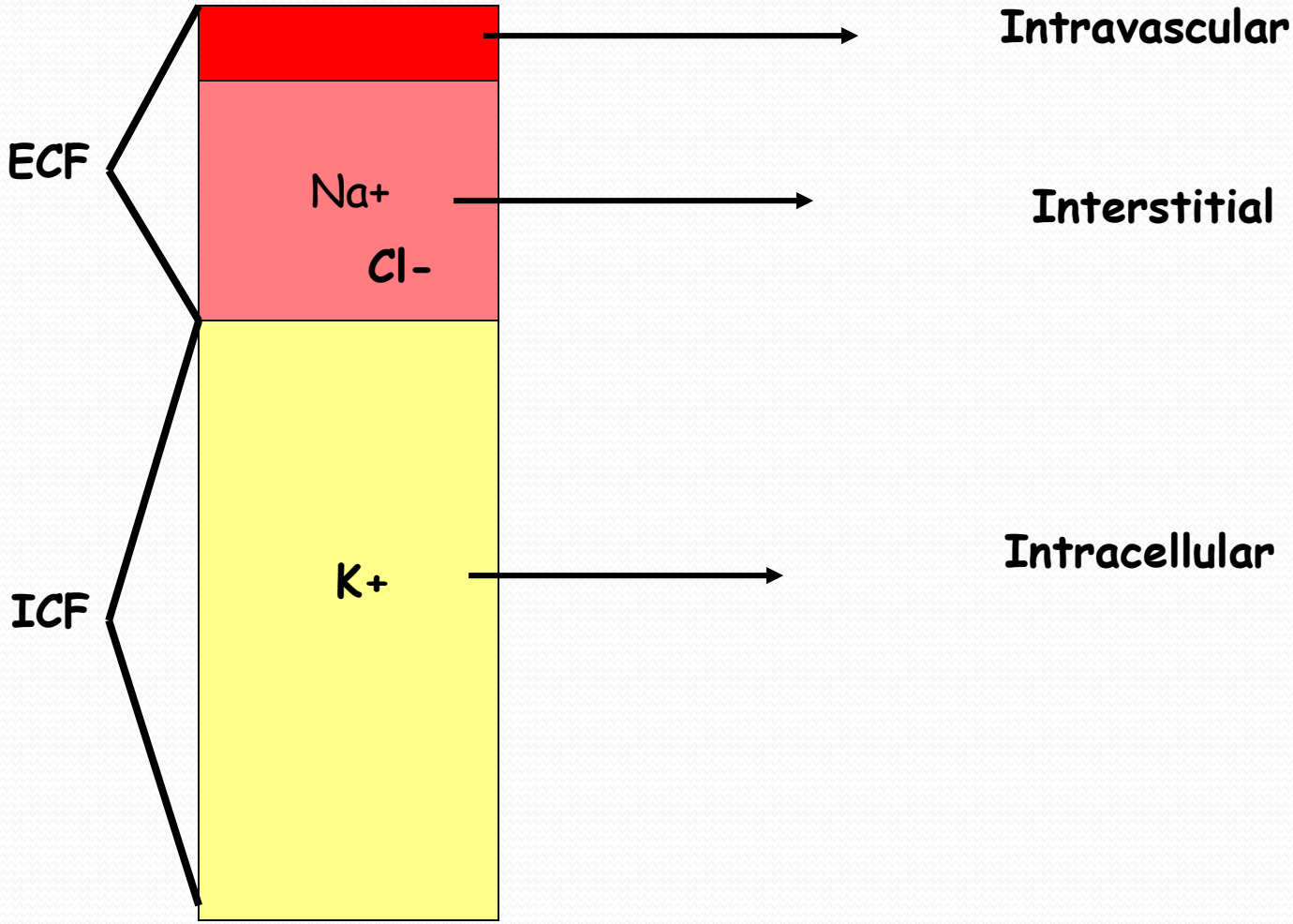
Dr Ahmed Abdulkader

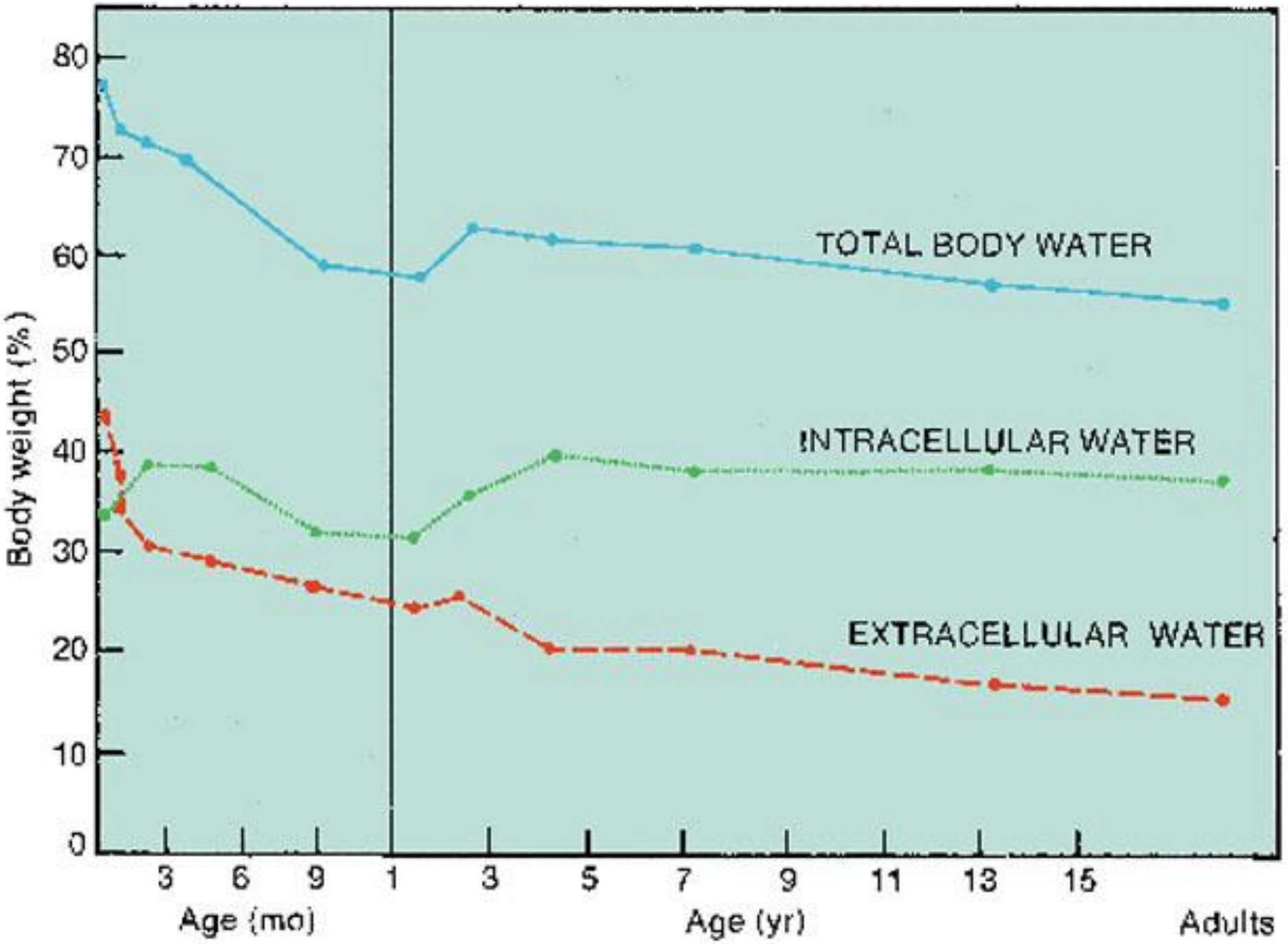
April , 9 2020

Electrolyte Concentrations

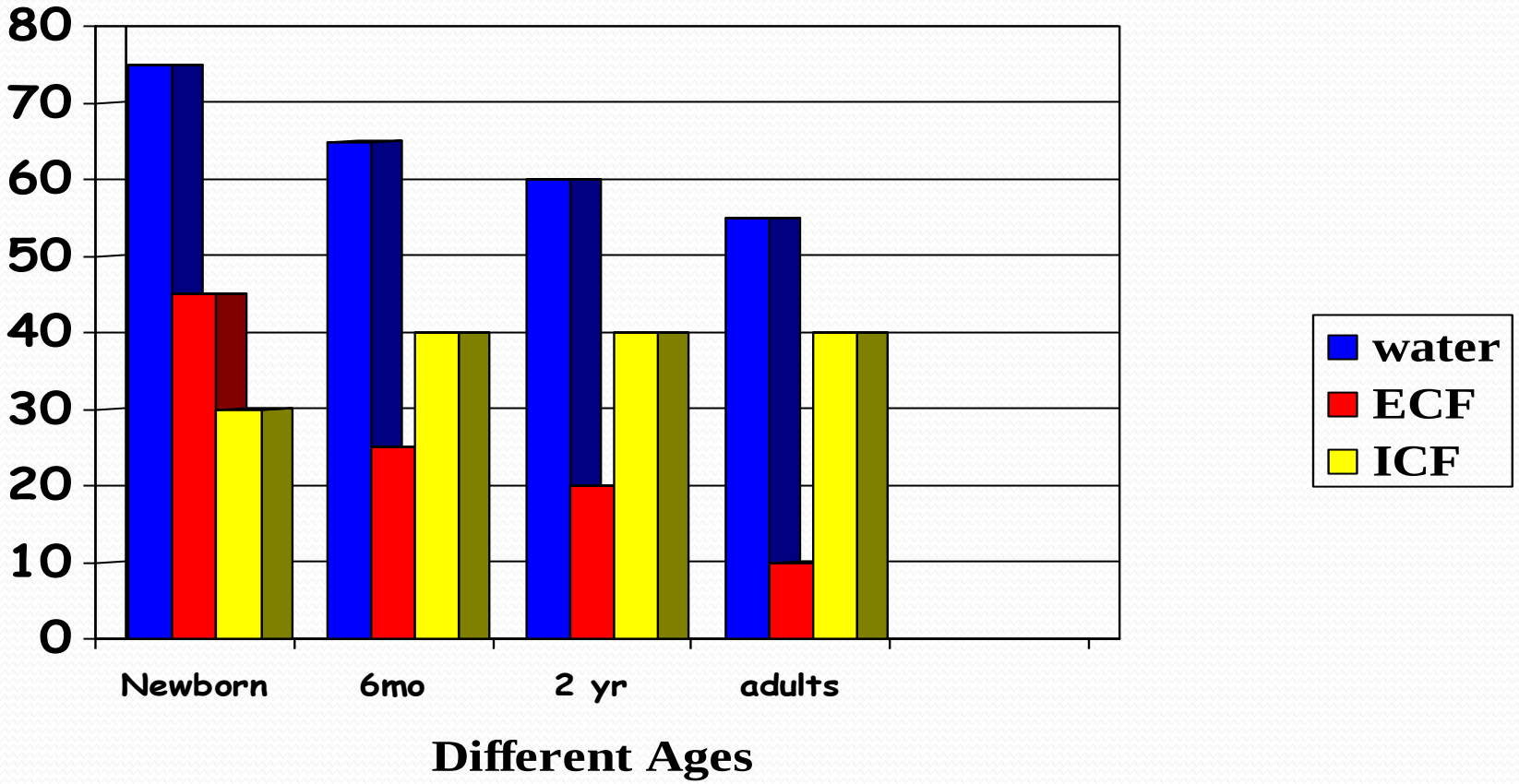
Component	ECF	ICF
Na+	High	Low
K+	Low	High
Ca++	Low	Low (higher than ECF)
Proteins	High	High

Distribution of Body Water

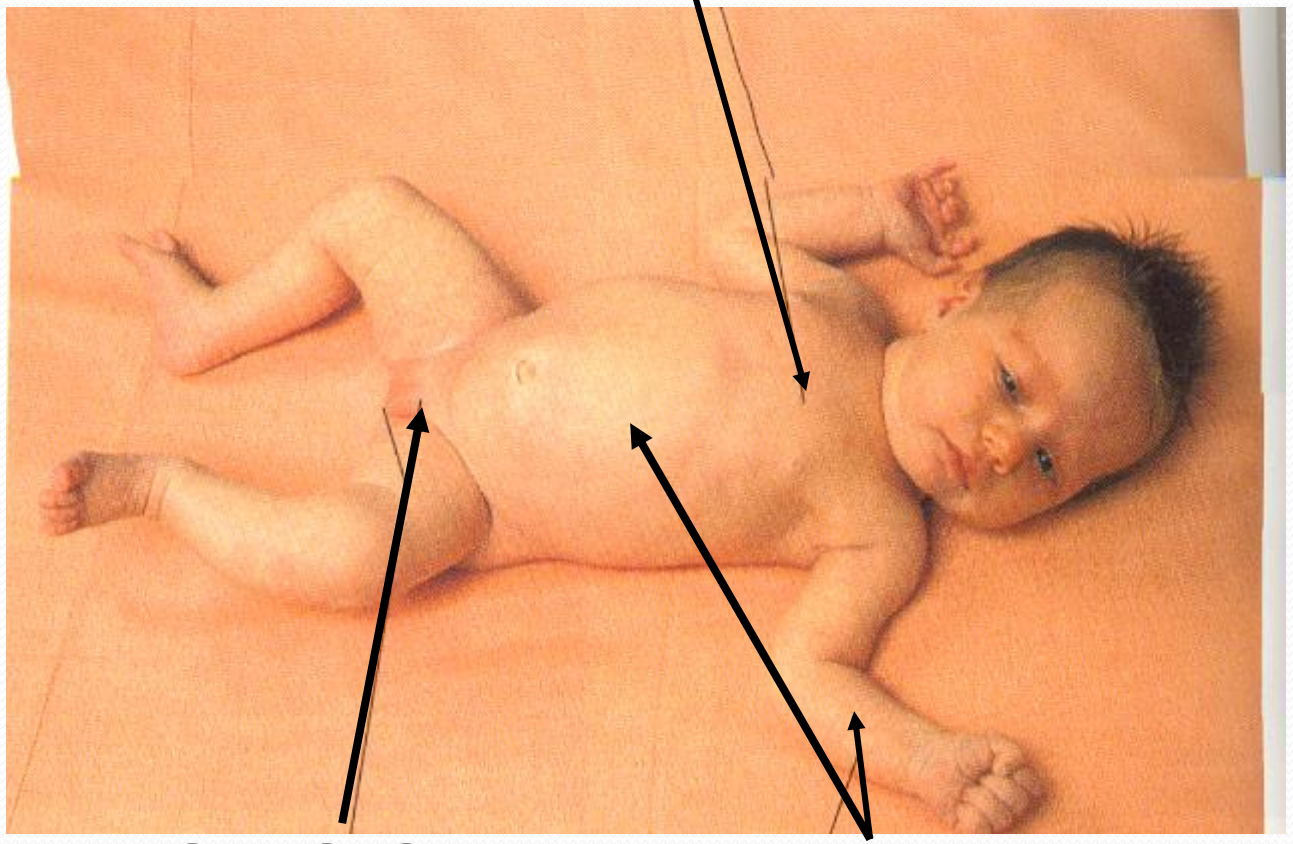



Body weight (%)
80
70
60
50
40
30
20
10
0
TOTAL BODY WATER
INTRACELLULAR WATER
EXTRACELLULAR WATER
3
6
9
1
3
5
7
9
11
13
15
Age (mo)
Age (yr)
Adults

% of Water in the Body

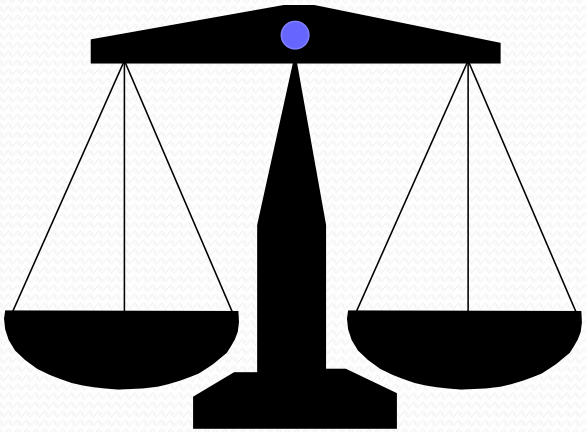


Fluid Losses in Infants



Factors in Water Balance differences between children & adults

- Surface Area (BSA)
- Metabolic Rate
- Kidney Function
- Fluid Requirements



Maintenance Requirements

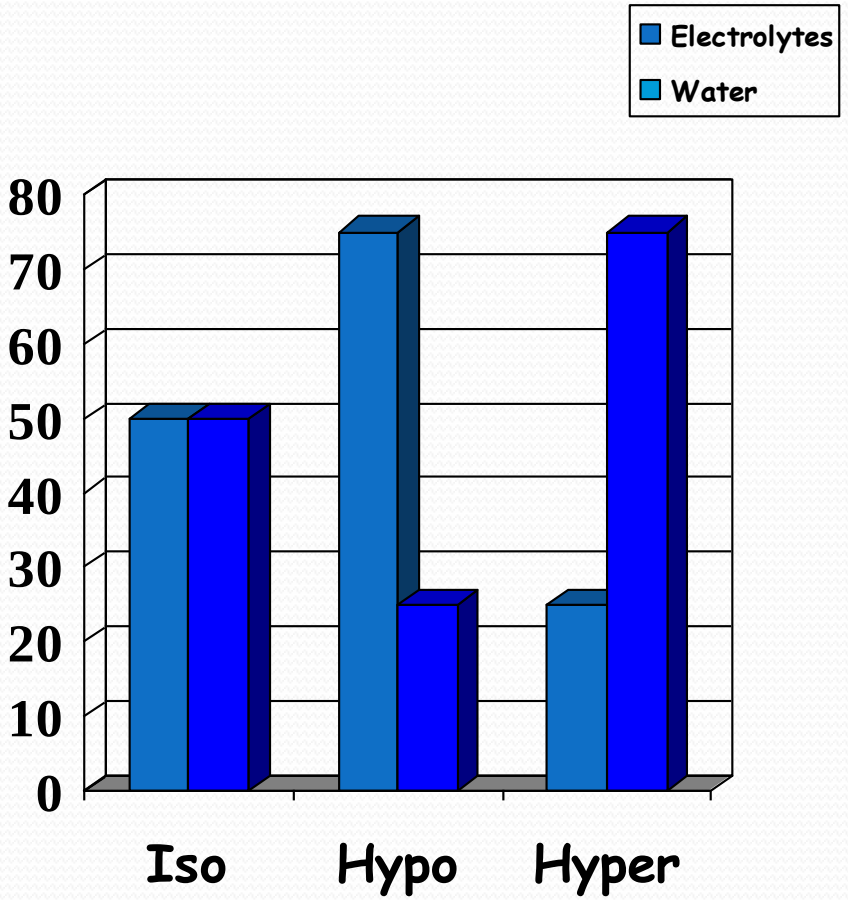
Weight	Requirement
0-10 kg	100cc/kg/24hr
11-20 kg	1000 + 50cc/kg/24hr
>20 kg	1500 + 20cc/kg/hr

Maintenance Requirements

Example	Requirement
8 kg child	800cc/24hr 33 cc/hr
15 kg	1250cc/24hr
28 kg	1660cc/24hr

Dehydration = Total Out > Total In

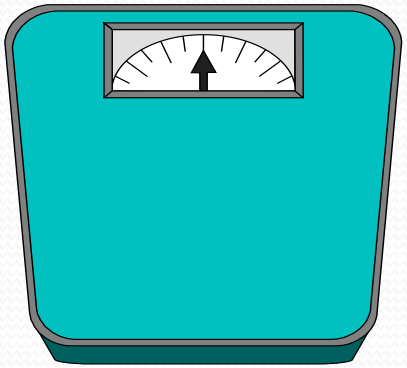
- Types:
- Isotonic
  - Electrolyte = Water
- Hypotonic
  - Electrolyte > Water
- Hypertonic
  - Water > Electrolyte



Degrees of Dehydration

	Mild	Moderate	Severe
Fluid Vol loss	<50ml/kg	50-90ml/kg	>100 ml/kg
Skin Color	Pale	Gray	Mottled
Skin Elasticity	Decreased	Poor	Very Poor
M.M.	Dry	Very Dry	Parched
U.O.	Decreased	Oliguria	Marked Oliguria
BP	Normal	Normal or lowered	Lowered
Pulse	Normal or Increased	Increased	Rapid, thready
Cap R. T.	<2 sec	2-3 sec	>3 sec

Assessment



- VS
- Weight
- U.O.
- Behavior—changed—Response to stimuli
- Skin changes
- General Body assessment—sunken eyes, no tears, sunken fontanel

Earliest Detectable Signs

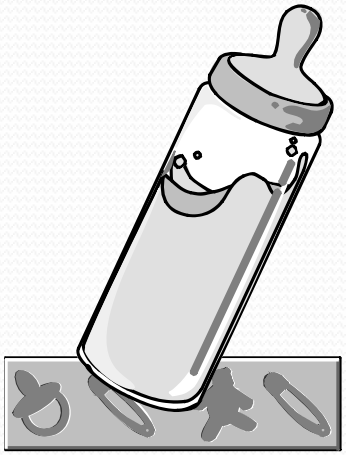
- Tachycardia
- Dry skin and mucous membranes
- Sunken fontanels
- Circulatory Failure (coolness, mottling of extremities)
- Loss of skin elasticity
- Delayed cap refill

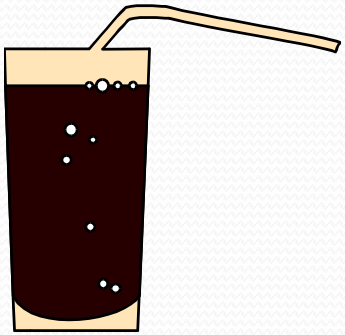
Loss of Skin Elasticity due to dehydration

Manifestations of ECF Deficit (Dehydration)

- S & S
  - Weight loss
  - Blood pressure drop
  - Delayed capillary refill
  - Oliguria
  - Sunken fontanel
  - Decreased skin turgor
- Physiologic Basis
  - Decreased fluid vol.
  - Inadequate circ. Blood
  - Decreased vascular volume
  - Inadequate kidney circ.
  - Decreased fluid volume
  - Decreased interstitial fluid

Management of Mild to Moderate Dehydration





- Oral Rehydration
  - Pedialyte
  - Infalyte
  - Rehydralate
- Rules regarding rehydration
  - 50-100ml/kg within 4 hours

Oral Rehydration

- ORS (Oral Rehydrating Solution)
  - First 4-6 hours
    - Na + glucose (Pedialyte, RS)
  - Then, if tolerated, give 30-60 cc/kg X 24 hours
    - Glucose + Na (Pedialyte, Lytren,Resol,Infalyte)

Oral Rehydration

- Oral fluids commonly given to children when sick:
  - Apple juice (low Na, High K)
  - Coke (Low Na, Low K, High sugar)
  - Pepsi (Na—little better than Coke, no K)
  - 7-Up (sugar, small Na, no K)
  - Gatorade (high Na, sugar)
  - Grape juice (low Na, high K)
  - Orange juice (low Na, High K)
  - Milk (has Na, K, Cl, $HCO_{3)}$

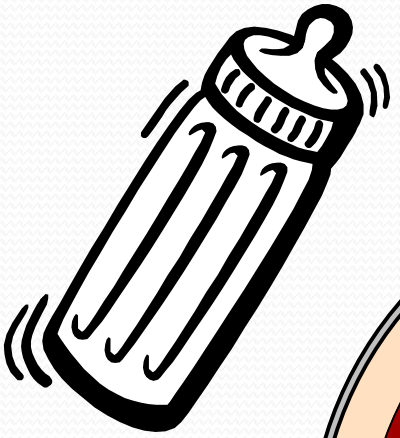
Moderate to Severe Dehydration

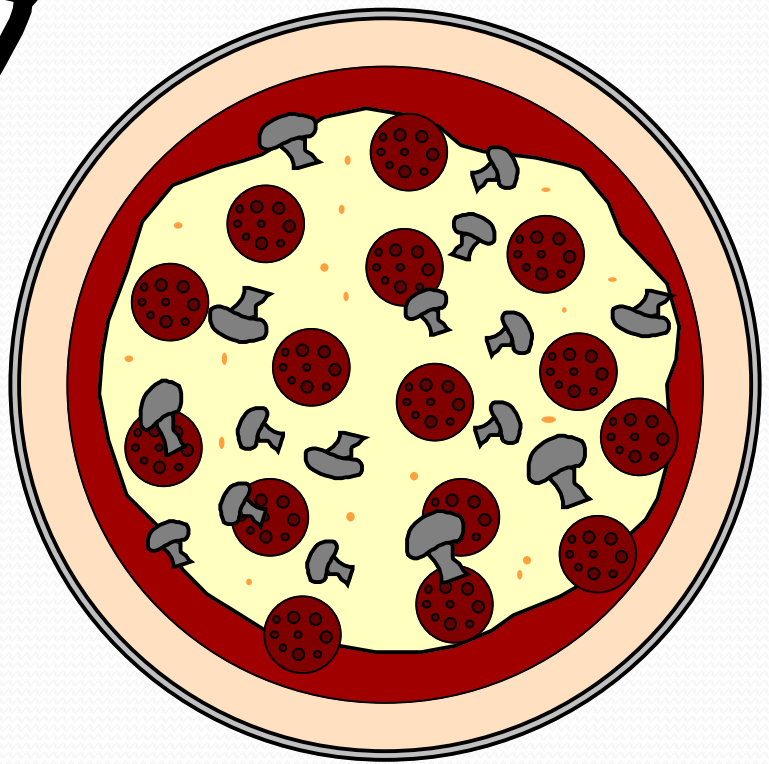
IV Therapy

Goals of IV Therapy

- Expand ECF volume and improve circulatory and renal function (Isotonic solution .9%NS,LR, 0.45saline 5% dextrose water)
- K+ after kidney function is assessed
- Begin oral feedings

When to resume normal diet?





Conditions causing Fluid Imbalances

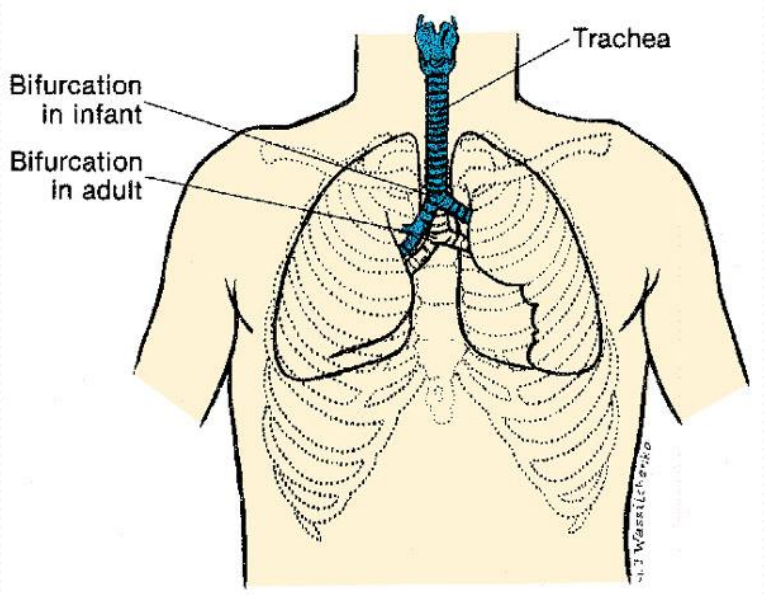
- Phototherapy
- Increased RR
- Fever
- Vomiting
- Diarrhea *(Gastroenteritis)*
- Drainage tubes, blood loss
- Burns

Phototherapy

Infant under phototherapy. Note that the eyes are shielded and a diaper is used to contain the diarrheal stools.

*Wallaby

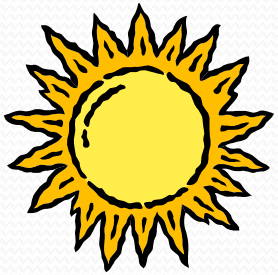
Tachypnea

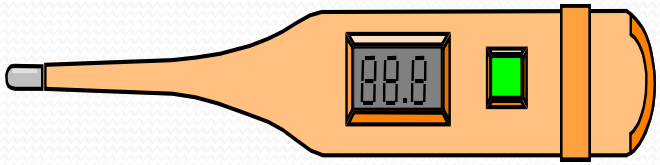


- Respiratory Alkalosis
- Increase in rate and depth of breathing
- Loss of CO_2

Causes of hyperventilation (tachypnea):
Fear, pain, fever, CHF, anemia

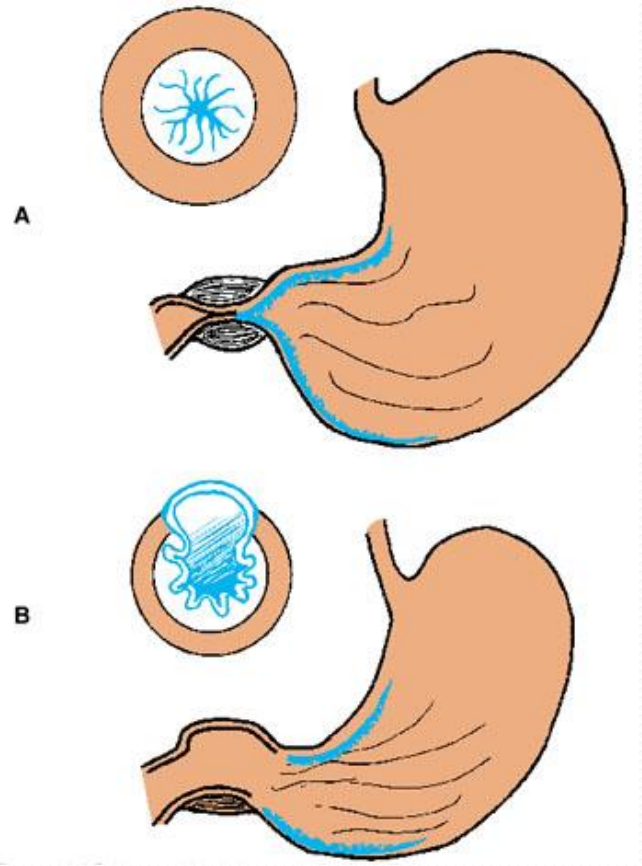
Fever





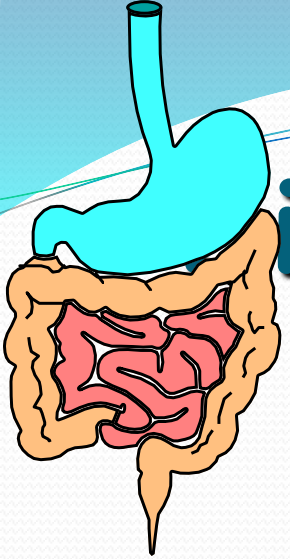
- **Each degree of fever increases basal metabolic rate (BMR) 10%, with a corresponding fluid requirement**

Vomiting

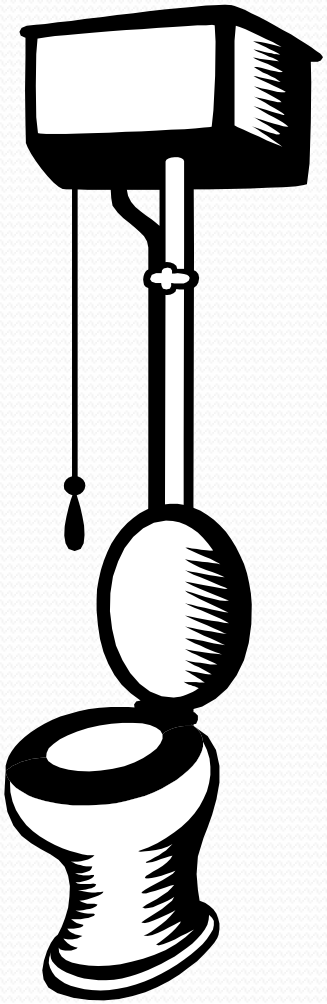


Example: Pyloric Stenosis

- Metabolic Alkalosis
- Loss of acid from stomach
- pH ↑
- HCO_3 ↑
- H^+ ↓
- Treatment: Prevent further losses and replace lost electrolytes

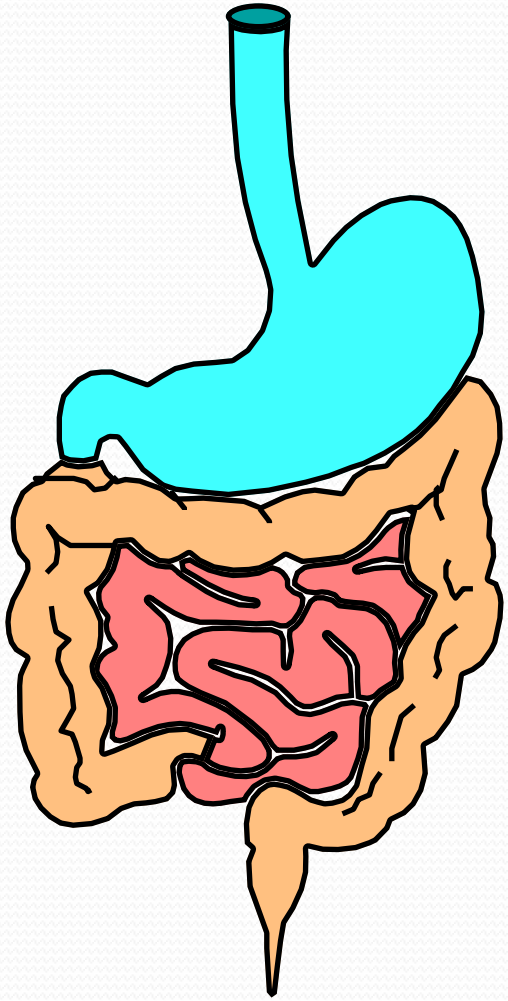


iarrhea



- Metabolic Acidosis
- loss of HCO_3 from G.I. Tract
- ↓ pH
- ↓ HCO_3
- Treatment: Correct base defecit, replace losses of with $NaHCO_3$

Drainage Tubes/ Blood loss



Burns

- Fluid loss is 5-10 X greater than from undamaged skin
- Abnormal exchange of electrolytes between cells and interstitial fluid

Water intoxication

- Free Water
- Decrease in serum Na+
- Central nervous system symptoms (water moves into the brain more rapidly than Na+ moves out)
- May appear well hydrated, edematous, dehydrated
    - Eg. Formula preparation, swimming

Case Study--Diarrhea

ALI is 4 years old and his brother, Adam, is 5 months old. Both children are brought to the clinic by their mother because of diarrhea and fever. Brian has also vomited twice. The nurse assesses the children and determines that they are mildly dehydrated.

How would the nurse know they were mildly dehydrated?

- ✓ Mucous Membranes
- ✓ Skin & skin color
- ✓ Eyes
- ✓ Perfusion
- ✓ Blood pressure
- ✓ Heart rate

What are your recommendations to this family?

ALI's recommendations:

Adam's recommendations:

Reasons why infants & children are at > risk for developing fluid & electrolyte imbalance

- Increased % of body weight is H2O
- Large volume of ECF
- Increased BSA (insensible loss)
- Increased Metabolic rate
- Immature Kidneys

Why is it necessary to use a pump or other volume control when infusing Ivs into children?

- Avoid overload
- Specifically monitor input

The most common type of dehydration in children is…..

- **Isotonic**

How would you measure U.O. for a child who is not toilet trained?

Weigh diaper

1 gram = 1 cc

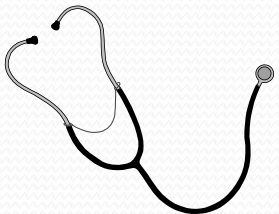
What is considered oliguria in an infant or child?

How will you assess for hydration in a 6 month old?

- Mucous Membranes
- Skin
  - Eyes

- Perfusion
  - Blood Pressure

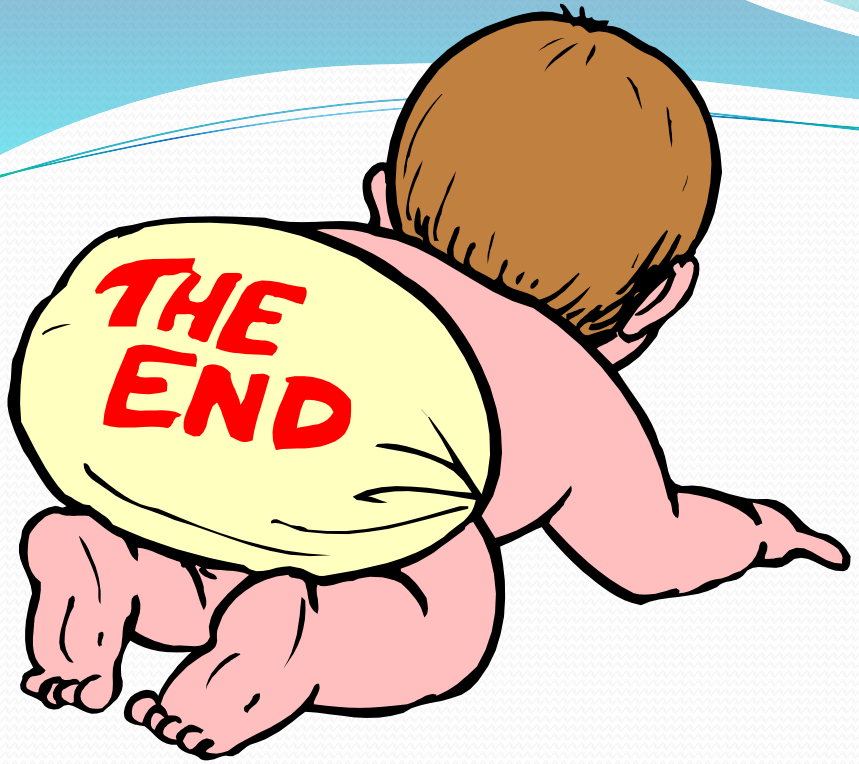
- Heart Rate

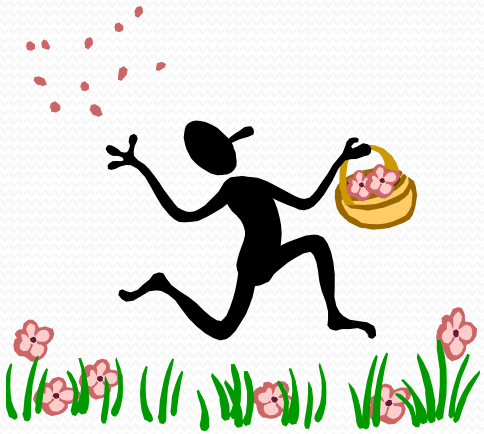


What lab tests provide useful information when the concern is dehydration?

What are your nursing responsibilities when caring for a child with Fluid and Electrolyte imbalance?

- I & O
- Weights
- Initiate IV and maintain
- Accurate infusion, type and rate
- Protect IV site
- Assess hydration status
- Parental support


THE
END



Shock

Dr Ahmed Abdulkader

Introduction

- Shock is a syndrome that results from inadequate oxygen delivery to meet metabolic demands
- Oxygen delivery (DO_2) is less than Oxygen Consumption (< VO_2)

- Untreated this leads to metabolic acidosis, organ dysfunction and death

Oxygen Delivery

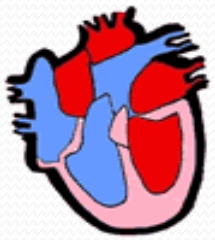
- Oxygen delivery = Cardiac Output x Arterial Oxygen Content

  $(DO_2 = CO \times CaO_2)$

- Cardiac Output = Heart Rate x Stroke Volume

  (CO = HR x SV)

  - SV determined by preload, afterload and contractility



Classification of Shock

- **Hypovolemic**
  - Hemorrhage
  - Fluid loss
  - Drugs
- **Distributive**
  - Analphylactic
  - Neurogenic
  - Septic
- **Cardiogenic**
  - Myocardial dysfunction
  - Dysrrhythmia
  - Congenital heart disease
- **Obstructive**
  - Pneumothorax, CardiacTamponade, Aortic Dissection
- **Dissociative**
  - Heat, Carbon monoxide, Cyanide
  - Endocrine

Other Classification of Shock

- COMPENSATED
  - blood flow is normal or increased and may be maldistributed; vital organ function is maintained
- UNCOMPENSATED
  - microvascular perfusion is compromised; significant reductions in effective circulating volume
- IRREVERSIBLE
  - inadequate perfusion of vital organs; irreparable damage; death cannot be prevented

Early Signs of Shock

- sinus tachycardia
- delayed capillary refill
- fussy, irritable

Late Signs of Shock

- bradycardia
- altered mental status (lethargy, coma)
- hypotonia, decreased DTR's
- Cheyne-Stokes breathing
- hypotension is a very late sign
- Lower limit of SBP = 70 + (2 x age in years)

Cardiovascular Assessment

- Heart Rate
- Blood Pressure
- Peripheral Pulses
- Skin Perfusion
- CNS Perfusion
- Renal Perfusion

Heart Rate

- Too high:

  180 bpm for infants

  160 bpm for children >1year old

Blood Pressure

- Lower limit of SBP = 70 +

(2 x age in years)

Peripheral Pulses

- Present/Absent
- Strength (diminished, normal)

Skin Perfusion

- Capillary refill time
- Temperature
- Color
- Mottling

CNS Perfusion

- Recognition of parents
- Reaction to pain
- Muscle tone
- Pupil size

Renal Perfusion

- UOP >1cc/kg/hr

Hypovolemic

- # 1 cause of death in children worldwide
- Causes
  - Water Loss (diarrhea, vomiting with poor PO intake, diabetes, major burns)
  - Blood Loss (obvious trauma; occult bleeding from pelvic fractures, blunt abdominal trauma, “shaken baby”)
- Low preload leads to decreased SV and decreased CO.
- Compensation occurs with increased HR and SVR.

Hypovolemic Shock

- Mainstay of therapy is fluid
- Goals
  - Restore intravascular volume
  - Correct metabolic acidosis
  - Treat the cause
- Degree of dehydration often underestimated
  - Reassess perfusion, urine output, vital signs…
- Isotonic crystalloid is always a good choice
  - 20 to 50 cc/kg rapidly if cardiac function is normal
  - NS can cause a hyperchloremic acidosis

Treatment

Solution	Na+	Cl-	K+	Ca++	Mg++	Buffer
NS	154	154	0	0	0	None
LR	130	109	4	3	0	Lactate
Plasmalyte	140	98	5	0	3	Acetate & Gluconate

- Inotropic and vasoactive drugs are not a substitute for fluid, however…
  - Can have various combinations of hypovolemic and septic and cardiogenic shock
  - May need to treat poor vascular tone and/or poor cardiac function

Hemorrhagic Shock

- is PRBCs or whole blood
  - Treat the cause if able (stop the bleeding)
  - Transfuse if significant blood loss is known or if patient unstable after 60cc/kg crystalloid
    - In an emergency can give group O PRBCs before cross matching is complete or type specific non-cross-matched blood products

Cardiogenic

- Low CO and high systemic vascular resistance
- Result of primary cardiac dysfunction:
  - A compensatory increase in SVR occurs to maintain vital organ function
  - Subsequent increase in LV afterload, LV work, and cardiac oxygen consumption
  - CO decreases and ultimately results in volume retention, pulmonary edema, and RV failure

Cardiogenic Shock

Etiologies

- CHD
- Arrhythmias
- IHD
- Myocarditis
- Myocardial injury
- Acute and chronic drug toxicity
- Late septic shock
- Infiltrative diseases
  - mucopolysaccharidoses
  - glycogen storage diseases
- Thyrotoxicosis
- Pheochromocytoma

Cardiogenic Shock

- Initial clinical presentation can be identical to hypovolemic shock
- Initial therapy is a fluid challenge
- If no improvement or if worsens after giving volume, suspect cardiogenic shock
- Usually need invasive monitoring, further evaluation, pharmacologic therapy

Cardiogenic Shock

- Balancing fluid therapy and inotropic support can be very difficult.
  - *Call an intensivist and/or a cardiologist*

- If you are sure that it is cardiogenic shock start:
  - Lasix (diuretics)
  - Dobutamine (inotropic drugs)
  - Supportive therapy (keep upright)

Obstructive Shock

- Low CO secondary to a physical obstruction to flow
- Compensatory increased SVR
- Causes:
  - Pericardial tamponade
  - Tension pneumothorax
  - Critical coarctation of the aorta
  - Aortic stenosis
  - Hypoplastic left heart syndrome

Obstructive Shock

- Initial clinical presentation can be identical to hypovolemic shock
- Initial therapy is a fluid challenge
- Treat the cause
  - pericardial drain, chest tube, surgical intervention
  - if the patient is a neonate with a ductal dependent lesion then give PGE
- Further evaluation, invasive monitoring, pharmacologic therapy, appropriate consults

Distributive Shock

- High CO and low SVR (opposite of hypovolemic, cardiogenic, and obstructive)
- Maldistribution of blood flow causing inadequate tissue perfusion
- Due to release of endotoxin, vasoactive substances, complement cascade activation, and microcirculation thrombosis
- Early septic shock is the most common form

Distributive Shock

- Goal is to maintain intravascular volume and minimize increases in interstitial fluid (the primary problem is a decrease in SVR)
  - Use crystalloid initially
  - Additional fluid therapy should be based on lab studies
  - Can give up to 40cc/kg without monitoring CVP
  - Vasoactive/Cardiotonic agents often necessary
  - Treat the cause (i.e.. antimicrobial therapy)

Distributive Shock

Etiologies

- Anaphylaxis
- Anaphylactoid reactions
- Spinal cord injury/spinal shock
- Head injury
- Early sepsis
- Drug intoxication
  - Barbiturates, Phenothiazines, Antihypertensives

Thank You