Fluids and Electrolytes

CPN Review Course

Distribution of Body Fluids

- TBW (total body water)
- 45-80% of body weight
- Divided into two parts:
    - ICF (intracellular)
    - ECF (extracellular)

Intracellular Fluid

- Fluid contained within the cells
- Primary electrolytes: K+, Mg

Extracellular Fluid

- Fluid outside the cells
    - Intravascular (plasma)
    - Interstitial (surrounding cell)
    - Transcellular (contained within specialized body cavities: i.e. cerebrospinal, pleural)
- Primary electrolytes: Na, Cl
- ***percentages change with age
    - -at birth: ECF>ICF (35-45% of TBW)
    - -at two: 24% of TBW is ECF (approx. = to adult)

Developmental Considerations

- BSA (Body Surface Area)
    - -larger than adult resulting in greater insensible loss
- BMR (Basal Metabolic Rate)
    - -2-3 times greater than adult resulting in higher production of metabolic waste products
- Children have increased fluid requirements as compared to adults
    - -50% of ECF is exchanged daily in infants resulting in larger fluid requirement
- Renal function
    - -immature function, continues to develop through age 2

In Summary:

- Infants have little reserve
- Infants and young children are especially vulnerable to fluid and electrolyte imbalances

•A dehydrated child can quickly progress to a life threatening scenario

Fluid Balance

GOAL:
Intake=output + insensible losses
Regulation of Fluid Balance
•Renal regulation
-renin-angiotensin system
•Hormonal regulation
-aldosterone
-ADH (antidiuretic hormone)
•CNS regulation
-thirst

Clinical problems resulting in increased fluid requirements
•Fever
•Vomiting, diarrhea
•High-output renal failure
•Diabetes insipidus
•Burns
•Shock
•Tachypnea

Clinical problems resulting in decreased fluid requirements
•Congestive heart failure
•SIADH (syndrome of inappropriate antidiuretic hormone)
•Mechanical ventilation
•Oliguric renal failure
•Increased intracranial pressure

Common Causes of Fluid and Electrolyte Imbalances in Children
•GI Disorders
-gastroenteritis
-diarrhea: acute vs. chronic
-vomiting
•Burns
•Shock states

Assessment of hydration status

•Skin
(color and warmth are indicators of perfusion)
-color
-temperature
-mottling
-CRT (capillary refill time)

**normal <3 sec

•**Turgor**
-normal vs. tenting

•**Mucous membranes**
-mouth
-eyes
**normal finding: tears by 4 months

•**Fontanel**
**normal finding: anterior fontanel should be even with contour of skull
-full vs. flat vs. depressed

•**Systemic perfusion**
**normal finding: HR & B/P WNL for age
-peripheral pulses strong
-brisk capillary refill time
**decreased ECF=decreased peripheral circulation

•**Weight**
-pre-illness vs. post-illness
-****1000cc=1kg**

•**Intake & Output**
-urine
-stool
-vomiting
-wound drainage
-insensible fluid loss

Behavioral Assessment
●Decreased activity levels
●Anorexia
●Neurologic changes
Significant changes:
-anxiety, restless, irritability and lethargy
-high-pitched cry in infants
LATE SIGNS:
-extreme lethargy and coma

Serum Lab Values

BUN (blood urea nitrogen)
-cleared from blood by kidneys
- Normal values: 5-20 mg/dl
- Increased in a dehydrated patient

Hgb/Hct (hemoglobin/hematocrit)
-Hgb carries oxygen in blood

-Hct: volume of cells in circulation
-Normal values: Newborn: 18 gm/dl, 54%
2-3 year: 12 gm/dl, 36%
- Increased in a dehydrated patient

Creatinine
-levels rise with kidney dysfunction
-levels rise with decreased renal perfusion
- Normal values: 0.5-1.5 mg/dl
- Increased in a dehydrated patient

Osmolality
-indicates amount of solute in serum
-general indication of hydration status
-parallels Na levels
- Normal values: 270-285 mOsm/kg
- Increased in dehydration or hypernatremia

Urine Lab Values

Specific Gravity
-measures concentrating and diluting ability of kidney
-indicator of hydration status in children
-not reliable in infants
- normal values = 1.002-1.030
- increased in dehydration

Osmolality
-measure solutes in urine
-more exact than specific gravity
-best indicator of kidney's ability to concentrate urine
- normal values = 0-4 month: 50-600mOsm/Kg H_2O
>5 month: 50-1400mOsm/kg H_2O
- increased in dehydration

pH
-measures acidity/alkalinity
- normal values = 5.0-8.0
<5.0 diarrhea, dehydration, acidosis, nephritis
>7.0 UTI, vomiting, pyloric obstruction

Ketones
-formed when fat is burned
- normal value = negative
- positive in dehydration and diabetic ketoacidosis

Calculation of Maintenance Fluids

Hourly Method:

1-10 kg: 4cc/kg/hr
11-20 kg:
40cc + 2cc/kg/hr (for 11-20 kg)
>20 kg:
60cc + 1cc/kg/hr (for every kg >20)

Daily Method:

1-10 kg:
100cc/kg/day
11-20 kg:
1000cc + 50cc/kg/day
(for kg 11-20)
>20 kg:
1500cc + 20cc/kg/day
(for every kg >20)

Dehydration

- Simply defined: total output of fluid exceeds total intake

Causes

- **excessive loss of fluids and electrolytes
- Third-spacing
- Decreased intake
- Inappropriate hormonal/renal regulation
- Burns
- DKA (diabetic ketoacidosis)

Types

- **Isotonic:** electrolyte and water deficits are present in approximately balanced ratio
  - **primary form of dehydration in children
  - **hypovolemic shock
- **Hypotonic:** electrolyte deficit exceeds water deficit
- **Hypertonic:** water deficit exceeds electrolyte deficit
  - **most dangerous type
  - **cerebral changes are serious and may result in permanent damage

***Degrees of Dehydration - see table in Appendix

Management of Dehydration

GOAL: correct fluid balance and treat underlying cause
- Determine degree of dehydration
- Treat appropriately
- ****FIRST PRIORITY**** restoration of circulation by rapid expansion of ECF volume

Rehydration
- Oral rehydration therapy
- Parenteral fluid therapy
- Fluid resuscitation
  PALS (20cc/kg)
  - Fluid replacement
  ½ estimated deficit over first 8-16 hours, ½ over next 16-24 hours.
  **fluid recovery 24-48 hours

Electrolyte replacement:
- Sodium Bicarb added to correct acidosis usually associated with severe dehydration
- Potassium not added until kidney function is restored
- **Rapid fluid replacement in isotonic and hypotonic only
- **Contraindicated in hypertonic dehydration; risk of water intoxication

Fluid Volume Excess
- Water intoxication or "water overload"
- Simply defined: Intake >Output

Causes
- Excessive PO intake
- IV rehydration therapy
- Rapid dialysis
- Tap water enemas
- **common cause in children: inappropriately prepared formula
- Failure to excrete:
  -renal insufficiency
  -congestive heart failure
  -malnutrition

Edema
- Abnormal accumulation of fluid and subsequent tissue expansion within the interstitial tissue
- Develops when a defect exists in normal circulation or lymphatic drainage
- Peripheral (generalized palpable swelling of interstitial space)
- Ascites (fluid in abdominal cavity)
- Pulmonary (end result of increased interstitial volume)
- Cerebral (**life threatening)
- Overall (often associated with kidney disease)
- Pitting: +1 to +4 rating

Practice Questions

1. After an initial fluid bolus, what is the BEST indicator of improving hydration status:

A. Patient crying during assessment
B. Tolerating PO feedings
C. HR increased, B/P decreased
D. Capillary refill time decreased to 2 seconds

2. Grace is a 4 month old infant with history of diarrhea x3 days. Based on pediatrician's weight of 5.2 and current weight of 4.7, approximately how much fluid has Grace lost?:

A. 1000cc
B. 500cc
C. This cannot be determined with data provided
D. 1500cc

3. Using the hourly calculation for maintenance fluids, at what rate would Grace be administered IV fluids?:

A. 20cc/hr
B. 18.8cc/hr
C. 15.6cc/hr
D. 15cc/hr

4. Based on the clinical picture, the nurse would expect to which of the following in Grace's lab values:

A. Increased BUN , Decreased Hgb/Hct , Decreased urine specific gravity
B. Increased BUN, Increased urine specific gravity, Increased urine pH
C. Decreased BUN , Decreased Hgb/Hct , Decreased urine specific gravity
D. Increased BUN, Increased Hgb/Hct, Decreased urine pH

Answer key:

1. D
2. B
3. B
4. D

Appendix – Degrees of Dehydration

	Mental Status	HR	RR	BP	Mucous membranes	Fontanel and eyes	Tears	Pulses	Urine output	Weight loss
Mild Dehydration	Alert and oriented	Normal to slightly increased	Normal	Normal	Normal to slightly dry	Normal	Present	Strong central and peripheral	Normal to slightly decreased	No more than 5%
Moderate Dehydration	Often irritable	Tachycardic	Normal to rapid	Normal to slightly decreased	Dry	Slightly sunken	Absent	Decreased peripheral	Decreased	7-9%
Severe Dehydration	Lethargic	Severe tachycardia	Rate and pattern changes	Hypotension	Dry, cracked	Severely sunken	Absent	Weak to absent peripherally	Oliguria to anuria	>9%