Session Summary

This presentation will provide a general overview of electrolyte management and common electrolyte disorders to help participants prepare for certification exams.

Session Objectives

Upon completion of this presentation, the participant will be able to:

- describe the principles of fluid homeostasis in the premature neonate;
  - body water composition
  - insensible water loss
  - physiologic extrauterine changes
- describe the three phases of fluid management;
- discuss differential diagnosis and treatment of hyper/hyponatremia in the micropremie;
- discuss differential management and treatment of hyper/hypokalemia in the premature neonate.

Test Questions

Case studies and questions are presented during the session.

References


Session Outline

See handout on the following pages.
Common Fluid & Electrolyte Problems in the Neonate

Carol Botwinski, EdD, ARNP, NNP-BC

Objectives

- Describe the principles of fluid homeostasis in the premature neonate
- Body water composition
- Insensible water loss
- Physiologic extrauterine changes
- Describe the three phases of fluid management
- Discuss differential diagnosis and treatment of hyper/hyponatremia in the micropremie
- Discuss differential diagnosis and treatment of hyper/hypokalemia in the premature neonate

Case Study

- Baby A is a 650 gm infant with an EGA of 25 weeks. Extensive bruising noted due to SVD with breech presentation, phototherapy started. Infant on a “giraffe-type” warmer.
- What would you anticipate starting fluids at?

Total Body Water

- Extracellular Fluid
  - intravascular and interstitial fluid
  - 1/3 of TBW
- Intracellular fluid
  - difference between TBW & ECF
  - separating barrier is cell membrane
Factors Affecting Water Balance

- Redistribution of body water
  - Shift of water from intracellular compartment to extracellular compartment
  - Redistribution is known as “contraction”
    - normal part of postnatal adaptation
    - ? Role of atrial natriuretic peptide

Contraction of TBW

<table>
<thead>
<tr>
<th>Birthweight</th>
<th>TBW loss(%)</th>
<th>Duration (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1000 gm</td>
<td>13-20</td>
<td>10-14</td>
</tr>
<tr>
<td>1001-1500</td>
<td>10-15</td>
<td>7-10</td>
</tr>
<tr>
<td>1501-2000</td>
<td>7-10</td>
<td>5-8</td>
</tr>
<tr>
<td>2001-2500</td>
<td>5-7</td>
<td>3-5</td>
</tr>
<tr>
<td>&gt;2500</td>
<td>3-5</td>
<td>2-3</td>
</tr>
</tbody>
</table>

Fluid Output

- Urine
- Insensible water loss
- Fluid replacement is calculated to allow for:
  - normal loss of ECF
  - while, preventing dehydration due to insensible water loss

Phases of Fluid Management

- Initial therapy
  - prevent shock
  - prevent hypoglycemia
Phases of Fluid Management

- Prediuretic Phase
  - Daily alteration in body weight
    - No weight loss or weight gain reflects impaired sodium and/or excretion
  - Serum Sodium
    - Hyponatremia suggests water excess
    - Hypernatremia suggests water deficit
  - Urine Volume
    - <1 ml/kg/day → investigate
    - 2–4 ml/kg/day → suggests normal hydration
    - >6 ml/kg/day → investigate

- Post diuretic/natriuretic phase
  (Maintenance therapy)
  - diuresis & improved pulmonary function
  - fluids increased
  - nutritional needs

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Postnatal Fluid & Electrolyte Adaptation in VLBW Infants

<table>
<thead>
<tr>
<th>Phase</th>
<th>Prediuretic</th>
<th>Prediuretic</th>
<th>Prediuretic</th>
<th>Prediuretic</th>
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</thead>
<tbody>
<tr>
<td>Age</td>
<td>Birth to 7 dp</td>
<td>Birth to 7 dp</td>
<td>Birth to 7 dp</td>
<td>Birth to 7 dp</td>
</tr>
<tr>
<td>Weight</td>
<td>Lower limit</td>
<td>Lower limit</td>
<td>Lower limit</td>
<td>Lower limit</td>
</tr>
<tr>
<td>Sodium excretion</td>
<td>Minimal</td>
<td>Minimal</td>
<td>Minimal</td>
<td>Minimal</td>
</tr>
<tr>
<td>Prolactin excretion</td>
<td>Minimal</td>
<td>Minimal</td>
<td>Minimal</td>
<td>Minimal</td>
</tr>
<tr>
<td>Water balance</td>
<td>Lower limit to nadir 1 ml</td>
<td>Lower limit to nadir 1 ml</td>
<td>Lower limit to nadir 1 ml</td>
<td>Lower limit to nadir 1 ml</td>
</tr>
<tr>
<td>Urine volume</td>
<td>&lt;1 ml/kg/day</td>
<td>&lt;1 ml/kg/day</td>
<td>&lt;1 ml/kg/day</td>
<td>&lt;1 ml/kg/day</td>
</tr>
<tr>
<td>Sodium balance</td>
<td>Hyponatremia</td>
<td>Hyponatremia</td>
<td>Hyponatremia</td>
<td>Hyponatremia</td>
</tr>
<tr>
<td>Potassium balance</td>
<td>Correction to normal</td>
<td>Correction to normal</td>
<td>Correction to normal</td>
<td>Correction to normal</td>
</tr>
<tr>
<td>Glomerular filtration rate</td>
<td>Low</td>
<td>Abnormal increase</td>
<td>Abnormal increase</td>
<td>Abnormal increase</td>
</tr>
<tr>
<td>Emotional state of infant</td>
<td>Variable</td>
<td>Stable</td>
<td>Stable</td>
<td>Stable</td>
</tr>
<tr>
<td>Nutritional intake of infant</td>
<td>Variable</td>
<td>Variable</td>
<td>Variable</td>
<td>Variable</td>
</tr>
<tr>
<td>Bowel insatiability</td>
<td>Variable</td>
<td>Variable</td>
<td>Variable</td>
<td>Variable</td>
</tr>
<tr>
<td>Urinary frequency</td>
<td>Variable</td>
<td>Variable</td>
<td>Variable</td>
<td>Variable</td>
</tr>
</tbody>
</table>

Guidelines for Initiating & Adjusting Fluid & Electrolyte Therapy in Newborns

<table>
<thead>
<tr>
<th>Water</th>
<th>Prediuretic Day 1</th>
<th>Adjustments During the Prediuretic Phase</th>
<th>Adjustments During the Natriuretic Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;15 ml/kg/day</td>
<td>Increase by 10 ml/kg/day per day</td>
<td>Increase by 10 ml/kg/day per day</td>
<td>Increase by 10 ml/kg/day per day</td>
</tr>
<tr>
<td>15–20 ml/kg/day</td>
<td>Increase by 10 ml/kg/day per day</td>
<td>Increase by 10 ml/kg/day per day</td>
<td>Increase by 10 ml/kg/day per day</td>
</tr>
<tr>
<td>&gt;20 ml/kg/day</td>
<td>Increase by 10 ml/kg/day per day</td>
<td>Increase by 10 ml/kg/day per day</td>
<td>Increase by 10 ml/kg/day per day</td>
</tr>
</tbody>
</table>

Sodium

<table>
<thead>
<tr>
<th>Sodium</th>
<th>Prediuretic Day 1</th>
<th>Adjustments During the Prediuretic Phase</th>
<th>Adjustments During the Natriuretic Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyponatremia</td>
<td>Decrease by 1 mEq/L per day</td>
<td>Decrease by 1 mEq/L per day</td>
<td>Decrease by 1 mEq/L per day</td>
</tr>
<tr>
<td>Hypernatremia</td>
<td>Increase by 1 mEq/L per day</td>
<td>Increase by 1 mEq/L per day</td>
<td>Increase by 1 mEq/L per day</td>
</tr>
</tbody>
</table>

Lorenz. (2008). NeoReviews (9);3
Infant’s chemistry panel on admission showed: Na of 130; K of 4.8; Ca of 8.8…what would you do with these labs?

The resident wants to add NaCl to the IVF…what do you think?

Sodium Requirements

- 0 - 1 mEq/kg/day (initial phase)
- 2 - 3 mEq/kg/day (transitional phase)
- 3 - 5 mEq/kg/day (maint or growth phase)

Hyponatremia: Serum Na⁺ < 135 mEq/L
Hyponatremia: Serum Na⁺ > 147 mEq/L

Case Study

- The infant is now 38 hrs of age and his Na is 152
- What’s going on?
- What will you do?
- What other information do you need?

The Problem: Hypernatremia

- What is the infant’s weight?
- What is their skin texture and turgor?
- What is total fluid intake compared to total output?
- How are serum sodium’s trending?
The Problem: Hypernatremia

- Is there tachycardia, or problems with blood pressure?
- Is the infant receiving medications that contain sodium?
- What is the infant’s environment?

Differential

- Excess sodium intake
- Drug induced
  - Albumin
  - NaHCO3
  - Antibiotics
- Hypovolemia
  - Increased IWL
  - Decreased free water
- DI

The Problem: Hypernatremia

Treatment

- Determine underlying cause
- Limit exogenous sources
- Take measures to decrease IWL
- Replace water deficit slowly
  - correct over a 12 - 24 hour period
  - decrease serum sodium no more than 5 mEq in six hours

Case Study

The infant is now 10 days old and has failed two courses of indocin for his PDA. The infant underwent PDA ligation and 36 hours post-op his chemistry panel shows: Na of 123

- What do you think?
- What other information do you need?
The Problem: Hyponatremia

Differential Diagnosis

- Are seizures occurring?
- How much sodium and free water is the infant receiving?
- What is the urine output?
- Are renal salt-wasting medications being given?

Differential Diagnosis

- Inadequate sodium intake
- Syndrome of inappropriate antidiuretic hormone (SIADH)
- Drug induced hyponatremia
- Volume overload
- Fictitious levels

The Problem: Hyponatremia

Treatment

- Inadequate sodium intake
  - replace deficit & include maintenance sodium
- SIADH
  - fluid restriction
- Drug induced losses
  - increase sodium needed
- Volume overload
  - fluid restriction

The Problem: Hyponatremia

Differential Diagnosis

- Overhydration
  - Hyponatremia
  - Increased weight gain
  - Increased urine output
  - Low urine osmo
- SIADH
  - Hyponatremia
  - Increased weight gain
  - Decreased urine output
  - High urine osmo
Calculate Sodium Deficit

- \((CD - CA) \times VD \times \text{Kg} = \text{mEq required}\)

- Example: 1 kg infant with a sodium of 117
  - 130 - 117 \times 0.6 \times 1 = 7.8 \text{ mEq}
  - Just to correct the deficit
  - Need to also provide maintenance sodium & ongoing losses

Symptomatic Hyponatremia

- Medical Emergency!
  - Infant with seizure activity
  - Infant with serum sodium < 120

- Treatment: Hypertonic NaCl (3%)
  - 6 ml/kg IV over 1 to 2 hours
  - Watch for pulmonary edema & fluid overload

Potassium Requirements

- 0 mEq/kg/d (initial phase)
- 1 - 2 mEq/kg/d (transitional phase)
- 2 - 3 mEq/kg/d (maint or growth phase)

- Hyperkalemia: serum \(K^+ > 6.5\) mEq/kg/d
- Hypokalemia: serum \(K^+ < 3.5\) mEq/kg/d

Case Study

- At 11 days of age (POD #1 s/p PDA ligation)
  - His morning labs show a K of 6.5

- What’s going on?
- What will you do?
- What other information do you need?
The Problem: Hyperkalemia

- Is that a real value?
- How was the specimen collected?
- What is the central value?
- How much potassium is the infant receiving?
- What is the BUN, creatinine and urine output?

The Problem: Hyperkalemia

- Does the EKG show changes characteristic of hyperkalemia?
  - 7 mEq (peaked T waves)
  - 8 mEq (absent P)
  - 10 mEq (widened QRS)
  - 11 mEq (aberrant QRS)
  - 12 mEq (V-fib)

The Problem: Hyperkalemia

**Differential**

- Falsely elevated K+ level
- Increased intake
- Endogenous K+ release
- Ionic shifts
- Impaired renal excretion

The Problem: Hyperkalemia

**Treatment**

- Hyperkalemia with EKG changes is treated as a medical emergency!
  - Calcium gluconate
    - 100 mg/kg/dose over 5 to 10 minutes
  - Sodium bicarbonate
    - 1-2 mEq/kg/dose over 10 to 30 minutes
  - Insulin/glucose push
    - 0.1 U/kg/dose with 2-3 ml of D10W
    - continuous insulin drip
The Problem: Hyperkalemia

Treatment

- Hyperkalemia without EKG changes
- Stop administration of potassium
- Adequate fluid intake
- Consider Lasix
- Kayexelate enema
- Continuous insulin infusion
- Correct acidosis
- Calcium levels in high normal range

Case Study

This poor baby doesn’t get a break. He’s now 21 days old and has developed NEC with pneumotosis & PVG seen on abdominal films. His labs show a K of 2.5

The Problem: Hypokalemia

Differential

- Decreased intake/GI losses
- Renal losses
- Ionic shift
  - Insulin
  - Metabolic alkalosis
  - Medications
  - Hypothermia

The Problem: Hypokalemia

- What is the central potassium?
- Are potassium medications or digoxin being given?
- How much potassium is the infant receiving?
- Are GI losses occurring?
- Is the infant clinically symptomatic?
The Problem: Hypokalemia

Treatment

- Slow normalization of blood levels
- Corrections given over 12 - 24 hours
- Too fast or large bolus may cause cardiac arrest

The Good News...the Baby Eventually Goes Home Healthy & Happy!