Fluid Management in Dialysis

Swimming Against the Tide

Objectives

- Discuss the physiologic effects of fluid volume in the renal patient
- Recognize nursing challenges in managing fluid volume excess and deficit
- Summarize the medical and non-medical strategies utilized in maintaining appropriate fluid volume

Body Fluid Estimates

- Total body water
  - 60% x body weight
- Intracellular
  - 2/3 total body water
- Extracellular
  - 1/3 total body water
- Plasma
  - 1/4 extracellular water

Fluid Regulation

- Kidneys
- Sympathetic nervous system
- Antidiuretic hormone (ADH)
- Renin-angiotensin-system
- Atrial natriuretic peptide (ANP)
- Thirst mechanism

Fluid Regulation

- Antidiuretic hormone (ADH)
  - Responds to body fluid osmolarity
  - Water retention
- Renin-angiotensin-aldosterone system
  - Macula densa mechanism
  - Baroreceptor mechanism
  - Beta-adrenergic mechanism
**Fluid Regulation**
- Atrial natriuretic peptide (ANP)
  - Responds to atrial distention
  - ANF-induced natriuresis

- Thirst mechanism
  - Physiologic
  - Habit

**Sodium Regulation**
- Intake
  - Tubular functions
    - Filtration
    - Absorption
    - Excretion

**Fluid Movement**
- Fluid shift from the interstitial space to the intravascular space
  - UF leads to fluid removal
  - Fluid removal leads to decreased hydrostatic pressure
  - Fluid removal leads to increased oncotic pressure
  - Fluid shift occurs

**Plasma Refilling**
- Maintains higher plasma volume
- Maintains a higher BP
- Allows continued fluid removal
  - UFR > plasma refilling rate = hypotension

**Plasma Refilling Rate**
- Depends on the following factors:
  - State of hydration
  - UF rate
  - Dialysate sodium concentration
  - Total protein balance
  - Capillary permeability

**Factors Affecting Relative Blood Volume**
- Hydration status
- Intravascular blood volume distribution
- Postural changes
- Exercise
- Food intake
- CV medications
- IV infusions
Estimated Dry Weight
- Clinical assessment
  - Trial and error
- Technological methods
  - Biochemical markers
  - Bioimpedance analysis
  - Blood volume monitoring
  - Echocardiographic studies

Defining Dry Weight
- The lowest weight a patient can tolerate without the development of symptoms or hypotension (Henderson)
- The lowest weight a patient can tolerate without intradialytic symptoms or hypotension, in the absence of overt fluid overload (Jaeger & Mehta)

Biochemical Markers
- Plasma natriuretic peptides
  - Plasma atrial natriuretic peptide
  - ANP
  - Brain natriuretic peptide
  - BNP
  - N-terminal pro-BNP
  - NT pro-BNP

Bioelectrical Impedance
- Based on electrical properties of body tissues
- Used to assess extracellular volume (ECV), intracellular volume (ICV), and total body water (TBW)
- Can be applied for dry weight determination
Bioelectrical Impedance
- Whole body (wrist-to-ankle) bioimpedance
- Segmental bioimpedance
  - Calf bioimpedance
    - Allows for continuous intradialytic monitoring
    - Based on the assumption that calf ECV directly reflects whole body ECV

Blood Volume Monitor (BVM)
- Special non-invasive device
- Continuously evaluates the relative blood volume (RBV)
- Expresses blood volume as a percentage of the starting blood volume

Blood Volume Monitoring
- Detects a rapid decrease in blood volume during HD when UF > plasma refilling rate
- Does not differentiate between EDW achieved or UF too high in relation to patient’s plasma refilling rate

Echocardiography of Inferior Vena Cava Diameter
- Noninvasive study
- Reliable
- Can be used to determine EDW as well as antihypertensive treatment
  - 8 - 11.5/m²
    - Normotensive
    - Normovolemic

Clinical Assessment
- Ongoing process
- Pre-dialysis assessment
- During HD treatment
- Post-dialysis assessment
- Triad
  - History
  - Physical assessment
  - Diagnostic studies

Assessment of Fluid Status
- Vital signs
- History
- Physical examination
- Laboratory studies
- Treatment history
Assessment of Fluid Status
- Vital signs
- History
  - General
  - Heart
  - Lungs
  - GI
  - Peripheral vascular
  - Skin

Assessment of Fluid Status
- Physical examination
  - Heart
  - Lungs
  - GI
  - Peripheral vascular
  - Skin

Assessment of Fluid Status
- Laboratory studies
  - Albumin
  - Glucose
  - Hematocrit
  - Serum sodium
- Treatment history

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<th>Pre wt</th>
<th>Post wt</th>
<th>EDW</th>
<th>Pre BP</th>
<th>Post BP</th>
<th>Low BP</th>
<th>Time on</th>
<th>Tx time</th>
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Fluid Volume Excess
- Vital signs
  - Elevated BP
  - Full, bounding pulse
  - Increased respirations
  - Increased weight

Fluid Volume Excess
- History
  - Cough
  - Dyspnea on exertion
  - Dyspnea
  - Orthopnea
  - Swelling
**Fluid Volume Excess**
- Physical exam
  - Periorbital edema
  - Distended neck veins
  - S3
  - Crackles, wheezes
  - Abdominal distention, ascites
  - Peripheral edema

- Laboratory studies
  - Decreased hematocrit
  - Decreased serum sodium

**Fluid Volume Excess**
- Treatment history
  - Elevated BP
  - Edema
  - Excessive IDWG
  - Missed or shortened HD treatments
  - Post weight > EDW

**Fluid Volume Deficit**
- Vital signs
  - Decreased BP
  - Orthostatic hypotension
  - Tachycardia
  - Increased temperature
  - Decreased weight

**Fluid Volume Deficit**
- History
  - Fatigue
  - Weakness
  - Dizziness
  - Muscle cramps
  - Nausea/vomiting
  - Diarrhea

- Physical exam
  - Dry mucous membranes
  - Flat neck veins
  - Poor skin turgor
  - Delayed capillary refill
  - Diminished pulses
**Fluid Volume Deficit**
- Laboratory studies
  - Increased hematocrit
  - Increased serum sodium

**Fluid Volume Deficit**
- Treatment history
  - Hypotension
  - Muscle cramps
  - Minimal or no IDWG
  - Weight < EDW
  - Interventions to treat symptoms (NS bolus, hypertonic saline)

**EDW Overestimated**
- Hypertension
- Cardiovascular disease
- Cerebrovascular disease
- Lean body mass changes

**Chronic Volume Overload**
- Left ventricular hypertrophy
- Left ventricular dilatation
- Arterial hypertension
- Congestive heart failure
- Increased CV mortality

**Strict Volume Control**

<table>
<thead>
<tr>
<th></th>
<th>SBP</th>
<th>DBP</th>
<th>CTI</th>
<th>IDWG</th>
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<tbody>
<tr>
<td>Start</td>
<td>150 ± 31</td>
<td>89 ± 16</td>
<td>0.50 ± 0.06</td>
<td>1440 ± 360</td>
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<tr>
<td>End</td>
<td>121 ± 14*</td>
<td>75 ± 8*</td>
<td>0.46 ± 0.05*</td>
<td>930 ± 240*</td>
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*P<0.001

**EDW Underestimated**
- Cramping
- Dizziness
- Hypotension
- Nausea
- Vomiting
- Diaphoresis
Sodium Modeling

- Step
  - Stepped patterns
- Linear
  - Straight line
- Exponential
  - Curved line

Sodium Modeling

- Sodium level highest at beginning of tx
  - 150 - 155
- Sodium level returned to baseline by end of tx
  - 138 - 140

Dialysate Sodium Concentration

- 140 mEq/l sodium concentration
- Increased interdialytic weight gains
- More difficult BP control
  - Higher percentage of patients required BP meds
  - Often, multiple classes of BP meds were prescribed

Ultrafiltration Profiling

- Improve patient comfort and stability during HD
- Allows equilibration between ICF and ECF compartments
- Various profiles to meet the needs of the patient

Study on Impact of Sodium and UF Profiling

- Study purpose
  - To evaluate the effects of sodium and UF profiling on blood volume, cardiac function and hypotensive episodes
- Study population
  - N = 8
  - Stable HD pts with hypotension in >20% of the HD treatments in previous 3 months


Treatment Protocols

- Control
  - Constant sodium (138) with constant UF
- Sodium profile
  - Linear sodium (148-131) with constant UF
- UF profile
  - Linear UF rate with constant sodium (138)
- Sodium + UF profile
  - Combination sodium and UF profile

**Patient Monitoring**
- Relative blood volume
- Mean BP
- Heart rate
- Interior vena cava diameter
- Stroke volume
- Cardiac output
- Plasma sodium concentration
- Symptomatic hypotensive episodes

**Frequency of IDH**

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Sodium</th>
<th>UF</th>
<th>Sodium + UF</th>
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<tr>
<td>With</td>
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**IDH Risk Factors**
- Diabetes mellitus
- Older age
- Autonomic neuropathy
- Cardiovascular disease
- Interdialytic weight gain > 3% body weight

**Mechanisms of IDH**
- Rate of UF exceeds CV compensation
- Cardiac dysfunction
- Decline in plasma osmolality and ECF volume
- Autonomic dysfunction
- Release of vasodilators


**Management of IDH Episode**
- Normal Saline
- Trendelenburg position
- Increase BP monitoring
- Decrease UF rate
- Turn off UF
- Hypertonic saline
- Mannitol
- Albumin


**Prevention of IDH Episode**
- EDW adjustment
- Patient education - fluid intake
- Sodium modeling
- UF profiling
- Lower dialysate temperature
- Extra treatment for UF only
- Use of Crit lines

**Dialysate Temperature Reduction**
- Beneficial effect on BP
- Increased peripheral resistance
- Decreased IDH
- No adverse effect on adequacy
- Optimal temperature setting is unknown
- Unpleasant thermal symptoms

**IDH Prevention - Medications**
- Midodrine
- Levocarnitine
- Fludrocortisone
- Caffeine
- Ephedrine
- Sertraline
- Vasopressin

**Intradialytic Morbid Events**
- Mainly due to UF-induced hypovolemia
- Most frequent complication during HD
- Increases patient discomfort
- Reduces treatment efficacy
- Increases patient morbidity

**Intradialytic Morbid Events**

<table>
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<tr>
<th>Symptoms</th>
<th>Frequency</th>
<th>%</th>
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<tr>
<td>Hypotension</td>
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<tr>
<td>Cramps</td>
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<td>Dizziness</td>
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<tr>
<td>Nausea</td>
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<td>Headache</td>
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<tr>
<td>Vomiting</td>
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<td>Others</td>
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<tr>
<td>Total</td>
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**Managing Fluid Intake**
- Habit
- Thirst
- Oral dryness

**HD Sessions with IME**

<table>
<thead>
<tr>
<th># of HD tx</th>
<th># of IME/tx</th>
<th>% of all tx</th>
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Managing Fluid Intake

- Patient education
- Behavioral strategies

Interdialytic Weight Gain

- Patterns
- Factors
- Interventions

IDWG During First Year of HD

- Retrospective study
- N = 27
- IDWG
  - Increased first 12 weeks
  - Decreased after 12 weeks
  - Increased after 32 weeks
- Implications for nursing

Cognitive Behavioral Therapy

- Glasgow University Liquid-Intake Program (GULP)
  - To assist adult nonadherent HD pts to improve their fluid restriction self-management
  - N = 56
    - 29 - immediate treatment group
    - 27 - deferred treatment group

Results

- Baseline assessment
  - 100% nonadherence
- Post-treatment assessment
  - 19.6% adherence
- Follow-up assessment
  - 37.5% adherence
Managing Sodium Intake

- Patient education
  - 2 Gm sodium diet
  - Read labels
  - < 400 mg/serving
- Behavioral strategies
  - "salt addiction"
  - Takes time for the taste threshold to reset

QUESTIONS?
References


