Hypotension in Peritoneal Dialysis

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Disclosures

• none

Overview

• Epidemiology
• Pathophysiology
• Outcomes
• Treatment
The Patient

68 year old male with DM, CHF, COPD on CAPD for 2 years.
- Hypertensive prior to starting dialysis
- Progressively declining blood pressures since month 5
- Orthostatic symptoms for past 6 months
- Stopped all anti-hypertensive medications
- 1.5% for all exchanges
- Progressive increase in weight with 2 admissions for CHF exacerbations

Prevalence of Hypotension in CAPD

Percent of CAPD patients

<table>
<thead>
<tr>
<th>Study</th>
<th>Percentage</th>
</tr>
</thead>
</table>
| Prevalence of Hypotension in CAPD
| Canañ et al, 1979    | 10         |
| Marquez-Julio et al, 1979 | 15         |
| Khanna et al, 1981   | 20         |
| Shetty et al, 1996   | 25         |
| Malliara et al, 2002 | 30         |

Hypotension in HD vs PD

- 10-50% of HD treatments
- Most Common Causes:
  - Hypovolemia
  - Autonomic insufficiency
- 12-25% of CAPD patients
- Most Common Cause:
  - Hypovolemia

**Epidemiology of Hypotension in PD**

<table>
<thead>
<tr>
<th>Group</th>
<th>Patients (n %)</th>
<th>Age (years)</th>
<th>Months on PD</th>
<th>Months to hypotension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydropsic</td>
<td>32 (39.3)</td>
<td>62.7±14.4</td>
<td>58±13.9</td>
<td>32±12.8</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>19 (18.5)</td>
<td>66±10.8</td>
<td>40±20.5</td>
<td>52±12.3</td>
</tr>
<tr>
<td>Anthypertensive treatment</td>
<td>11 (13.4)</td>
<td>64±17.5</td>
<td>36±20.8</td>
<td>16±10.9</td>
</tr>
<tr>
<td>Unknown: cause</td>
<td>23 (28.4)</td>
<td>66±15.7</td>
<td>47±12.3</td>
<td>35±12.3</td>
</tr>
</tbody>
</table>

Total hypotensive patients: 81 (100%) 83.5±14.2 49.5±20.1 30±12.4

Mallana, Adv Perit Dial, 2002

**Volume Status and Blood Pressure**

- ISPD guidelines recommend frequent assessment of volume and holding anti-hypertensive medications until volume is optimized

  **Volume overload:**
  - Clinical evaluation: 25% volume overload
  - Bioimpedance spectroscopy: 36-72% volume overload; 20-25% severe
  - Lung Ultrasound: 46% volume overload in asymptomatic patients

- **Hypovolemia:**
  - No predictive clinical markers – physical exam, spot UNa, hemodynamic monitoring


**Volume Status and Blood Pressure in PD**

- Volume and blood pressure not highly correlated in PD patients
- Total peripheral resistance is the most important determinant of blood pressure

Cheng et al, Perit Dial Int 2008; Panuccio et al, Perit Dial Int 2013
Volume Status and Outcomes in PD

- Fluid overload worsens CV mortality in PD patients
- Both overhydration and dehydration associated with loss of residual renal function


Physiology of Arterial Hypotension

<table>
<thead>
<tr>
<th>Decreased Cardiac Output</th>
<th>Nervous System Disorders</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Contractile Dysfunction</td>
<td>- Autonomic Neuropathy</td>
</tr>
<tr>
<td>- Heart failure</td>
<td>- Sympathetic Dysfunction</td>
</tr>
<tr>
<td>- LVH</td>
<td>- Decreased sensitivity to catecholamines</td>
</tr>
<tr>
<td>- Diastolic dysfunction</td>
<td>- Impaired Pressure Control</td>
</tr>
<tr>
<td>- Myocardial Infarction</td>
<td>- Mechanisms</td>
</tr>
<tr>
<td>- LVH</td>
<td>- Baroreceptor and chemoreceptor feedback</td>
</tr>
<tr>
<td>- Myocarditis</td>
<td>- CNS ischemia</td>
</tr>
<tr>
<td>- Decreased Preload</td>
<td>- RAS impairment</td>
</tr>
</tbody>
</table>

Passadakiset al, Int J Art Organs 2002

Autonomic Dysfunction in (hemo)Dialysis

- Chronic autonomic dysfunction due to uremia
- 23 chronic HD patients – 7 hypotension-prone and 16 non-hypotensive
- Direct measurement of volume changes, heart rate, vascular resistance, and peripheral blood flow
- Discontinued all anti-hypertensive medications prior to study
- All same dialysate

Converse et al, J Clin Invest 1992
Autonomic Dysfunction in (hemo)Dialysis

<table>
<thead>
<tr>
<th>Nonopinephrine</th>
<th>Hypotension Resistant</th>
<th>Hypotension Prone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>613 +/- 117</td>
<td>525 +/- 68</td>
</tr>
<tr>
<td>Finish</td>
<td>657 +/- 140</td>
<td>591 +/- 23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Epinephrine</th>
<th>Hypotension Resistant</th>
<th>Hypotension Prone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>83 +/- 18</td>
<td>52 +/- 9</td>
</tr>
<tr>
<td>Finish</td>
<td>96 +/- 53</td>
<td>143 +/- 53</td>
</tr>
</tbody>
</table>

Autonomic Dysfunction In HD Is Due To Decreased Blood Volume

- Chronic autonomic dysfunction due to uremia?
- Studies repeated on interdialysis day showed no difference between the two groups.
Autonomic Dysfunction in (hemo)Dialysis

- Hypovolemia → Sympathetic inhibition → Vasodepressor effect
- Ventricular mechanoreceptors stimulated by excessive deformation of a nearly empty ventricle in forceful contraction

1. Decreased catecholamines
2. Paradoxical response to volume depletion

Converse et al., J Clin Invest 1992

Hypotension in Peritoneal Dialysis

Leenen et al., Perit Dial Bull 1983

Sodium Supplementation in CAPD

- 5 patients
- NaCl tablets 5-10 g per day
- Dose titrated based on BP and tolerance
- Clinically-determined volume control maintained by adjusting dialysate

Leenen et al, Perit Dial Bull 1983
Sodium Supplementation in CAPD

- Increased blood volume
- Increased extracellular volume
- Stable body weight

Sodium Supplementation in CAPD

Response to NE Infusion

Sodium Balance Affects Sympathetic Responsiveness

Rankin et al, Hypertension 1981
CAPD vs APD

- Higher sodium removal in CAPD

- Volume control not significantly different between CAPD and APD
  - Bioimpedance spectroscopy:
    - ECF volume
    - Height-adjusted ECF volume
    - ECF/TVBW ratio
Outcomes for Hypotensive PD Patients

- Those who respond quickly have improved outcomes – mostly hypovolemia
- Overall survival:
  - 3 years – 78%
  - 5 years – 54%
  - No difference based on etiology of hypotension

Malliara, Adv Perit Dial, 2002

Outcomes for Hypotensive CAPD Patients

- Decreased survival

Malliara, Adv Perit Dial, 2002
Outcomes for Hypotensive CAPD Patients

- Decreased survival
- Significant complications
  - Increased cardiovascular events
  - Anterior Ischemic Optical Neuropathy

Malliara, Adv Perit Dial, 2002

Anterior Ischemic Optic Neuropathy

- Acute blindness
- Usually bilateral
- Hypotension
- Adults and children
- PD is well-described risk in children

DiZazzo et al, Perit Dial Int 2015

Outcomes for Hypotensive CAPD Patients

- Unclear changes in survival
- Significant complications
  - Increased cardiovascular events
  - Anterior Ischemic Optical Neuropathy
  - Decreased quality of life

Malliara, Adv Perit Dial, 2002
Treatment of Hypotension in PD

- Salt loading
- Change prescription / modality
- Midodrine

Summary

- Causes of hypotension include hypovolemia, cardiac disease, altered autonomic response, and decrease in sympathetic activity
- Salt losses in PD likely contribute to hypotension
- Salt supplementation may be an effective treatment for chronic hypotension
- Research opportunities!!!