The Importance of Volume Management in the Dialysis Patient

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Ms. GM is a 64 yo female who misses an average of 3 HD each month. She presents today with 7.7 kg weight gain after missing her last scheduled dialysis. Her prescribed HD time is 3.5 hrs. This was recently decreased when she agreed she would come to every treatment IF her treatment time was decreased. Her BP is 190/110, she has crackles in bilateral bases, 2+edema in LEs. She is upset you are not treating her high BP and she tells you upon arrival that she will only stay for 3 hours for today’s dialysis because she is too tired to stay longer.
Objectives

- Describe the consequences of volume overload
- Understand the impact of volume overload on morbidity & mortality
- Identify barriers to effective volume control
- Discuss strategies for managing volume
Figure 9.2 Prevalence of cardiovascular diseases in ESRD patients, by treatment modality, 2013

Data Source: Special analyses, USRDS ESRD Database. Point prevalent hemodialysis, peritoneal dialysis, and transplant patients at all ages, with Medicare as primary payer on January 1, 2011, who are continuously enrolled in Medicare Parts A and B from July 1, 2010 to December 31, 2010, ESRD service date is at least 90 days prior to January 1, 2011, and survived past 2012. Abbreviations: AFIB, atrial fibrillation; AMI, acute myocardial infarction; ASHD, atherosclerotic heart disease; CHF, congestive heart failure; CKD, chronic kidney disease; CVA/TIA, cerebrovascular accident/transient ischemic attack; CVD, cardiovascular disease; PAD, peripheral arterial disease; SCA/VA, sudden cardiac arrest and ventricular arrhythmias.
Figure 9.1 Causes of death in ESRD patients, 2013

Data Source: Reference Table H12. Abbreviations: AHD, atherosclerotic heart disease; AMI, acute myocardial infarction; CHF, congestive heart failure; CVA, cerebrovascular accident.
Proposed Pathogenesis of Cardiac Disease in Hemodialysis-SIMPLIFIED!

Daniel E. Weiner, Steven M. Brunelli, Abigail Hunt, Brigitte Schiller, Richard Glassock, Frank W. Maddux, Douglas Johnson, Tom Parker, Allen Nissenson

Improving Clinical Outcomes Among Hemodialysis Patients: A Proposal for a “Volume First” Approach From the Chief Medical Officers of US Dialysis Providers


http://dx.doi.org/10.1053/j.ajkd.2014.07.003
Physiological Effects

- Edema-may lead to skin breakdown, cellulitis
- Dyspnea-pulmonary complications
- GI complications-decreased appetite, PEW
- CV complications
CV Morbidity & Mortality

- Prevalence is high for dialysis population
- Different factors than general population
- Subclinical ischemia in dialysis is common
- Recurrent ischemia leads to heart failure
- CHF is frequent cause of death
- CHF management requires controlling extracellular volume (ECV)

CV Complications

- HTN-80% due to chronic hypervolemia
  - increases workload on heart
  - leads to LVH which is highly predictive of increased incidence of:
    - MI
    - CHF
    - Sudden death

CV Complications

LVH can lead to diastolic dysfunction which has been linked to increased incidence of intradialytic morbid events.

<table>
<thead>
<tr>
<th>Survival</th>
<th>CHF</th>
<th>Fluid overload</th>
<th>Pulmonary edema</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 yr</td>
<td>12.5%</td>
<td>20.2%</td>
<td>21.3%</td>
</tr>
<tr>
<td>2 yr</td>
<td>36.4%</td>
<td>48.3%</td>
<td>46.8%</td>
</tr>
<tr>
<td>1 yr</td>
<td>54.1%</td>
<td>65.8%</td>
<td>64.9%</td>
</tr>
</tbody>
</table>

Banerjee D, Ma JZ, et al. Long-term survival of incident hemodialysis patients who are hospitalized for congestive heart failure, pulmonary edema, or fluid overload. CJASN 2007; 2 (6); 1186-1190.
CV Complications: UF

Promotes non-physiological fluid shifts

hemodynamic instability

Flythe JE, Kimmel SE, Brunelli SM. Rapid fluid removal during dialysis is associated with cardiovascular morbidity and mortality. KI 2011 January; 79(2); 250-257.
Hemodynamic instability contributes to:

- tissue ischemia
- maladaptive cardiac structural changes
- myocardial stunning
- arrhythmia
- cardiac sudden death

Flythe JE, Kimmel SE, Brunelli SM. Rapid fluid removal during dialysis is associated with cardiovascular morbidity and mortality. KI 2011 January; 79(2); 250-257.
Prospective analysis by Flythe & colleagues

- to determine association between UFR & all-cause and CV-related mortality.
- also sought to identify threshold at which higher UFR to be associated with decreased survival.

Flythe JE, Kimmel SE, Brunelli SM. Rapid fluid removal during dialysis is associated with cardiovascular morbidity and mortality. KI 2011 January; 79(2); 250-257.
Flythe Study Results

- Significant association between CV mortality & UFR >13mL/hr/kg
- No significant association with UFR 10-13mL/hr/kg EXCEPT in patients with CHF

Flythe JE, Kimmel SE, Brunelli SM. Rapid fluid removal during dialysis is associated with cardiovascular morbidity and mortality. KI 2011 January; 79(2); 250-257.
Slow IV refill (due to high UFR)

- Decreased Circulating volume
- Transient ischemia
- Myocardial stunning (RWMA)

Irreversible loss of myocardial contractility
- Compromised systolic function
- Decreased Survival

Flythe JE, Kimmel SE, Brunelli SM. Rapid fluid removal during dialysis is associated with cardiovascular morbidity and mortality. KI 2011 January; 79(2); 250-257.
Treatment time

- Longer dialysis treatment
  - Allows more time for UF
  - Decreases risk of CV morbidity
  - Maintains UFR <13mL/hr/kg; closer to 10mL/hr/kg for high risk

Flythe JE, Kimmel SE, Brunelli SM. Rapid fluid removal during dialysis is associated with cardiovascular morbidity and mortality. KI 2011 January; 79(2); 250-257.
Shorter dialysis treatment

- Does not allow for safe and effective UFR
- Study by Tentori & colleagues: assessed association of TT with clinical outcomes:
  
  - used DOPPS data 1996-2008
  - 930 facilities in 12 countries
  - patient sample: 37,414

Tentori F, Zhang J, et al. Longer dialysis session length is associated with better intermediate outcomes and survival among patients on in-center three times per week hemodialysis: results from the Dialysis Outcomes and Practice Patterns Study (DOPPS). NDT 2012; 27; 4180-4188.
Results:

✓ Patients with longer TT—lower risk of all-cause & CV mortality

AND

✓ Strong association between longer TT and lower risk of sudden death

Tentori F, Zhang J, et al. Longer dialysis session length is associated with better intermediate outcomes and survival among patients on in-center three times per week hemodialysis: results from the Dialysis Outcomes and Practice Patterns Study (DOPPS). NDT 2012; 27; 4180-4188.
Longer TT

- Lower pre & post dialysis systolic BP
- Greater intradialytic weight loss
- Higher albumin levels
- Higher Hgb for same EPO dose
- Lower PO4 & WBC
- Decreased risk of hospitalization for CHF/fluid overload

Tentori F, Zhang J, et al. Longer dialysis session length is associated with better intermediate outcomes and survival among patients on in-center three times per week hemodialysis: results from the Dialysis Outcomes and Practice Patterns Study (DOPPS). NDT 2012; 27; 4180-4188.
Myocardial Stunning

McIntyre Study

- **Purpose:** determine difference in occurrence and severity of myocardial stunning in stable pts with different modalities

- **Results:**
  - Myocardial stunning decreased with increasing dialysis intensity - CHD3>CSD>HSD>HN
  - Myocardial stunning was associated with increased rate of intra/post dialytic ventricular arrhythmias

According to Chazot:

...to reach a consistently low ECF state in the constraints of intermittent HD therapy where large & variable volume swings can occur... while at the same time, avoiding intradialytic morbid events

- Avoid hypovolemia during dialysis sessions
- Preventing fluid overload between sessions

Complicated by many factors...

Inaccurate assessment of EDW

- No standard measure of EDW
- Obtained through trial and error
- Other methods: Crit-line, BIA, biochemical markers i.e. BNP, ANP have limitations... $$$
- Only setting goal for last post-weight, not EDW

Agarwal R. Volume overload in dialysis: the elephant in the room, no one can see. American Journal of Nephrology 2013. 38; 75-77.
Achieve optimal dry weight

- Usually determined by clinical assessment:
  - BP
  - Edema
  - Dyspnea
- Be aware of “silent overhydration”
- Edema may not appear until fluid overload of up to 10% of body weight
- Evaluate UFR/time
Barriers

- Inaccurate assessment of EDW
- Large IDWG
- Intra dialytic hypotension
- Poor cardiovascular status
  - Older
  - Diabetic with poor vascular and autonomic response
- Hyperglycemia
  - Medications causing dry mouth – antihypertensives (clonidine), antihistamines, antidepressants
  - Health professional/patient communication
WHO Adherence Meeting, June 2001:

“the extent to which a person’s behavior corresponds with the agreed recommendations of a HCP in terms of taking medications, following a recommended diet &/or executing lifestyle changes...”

Patient Adherence

I'll tell the doc I was swimming, and I started to drown, and I swallowed half the lake fighting to survive, and I managed to struggle to shore, and...
Non-adherence to fluid restriction

Prevalence is high:

**Self-reported non-adherence to fluid restrictions: 74.6%**


>40% of patients self-reported daily fluid restriction adherence <1 day per week

“advising dialysis patients to restrict fluid intake when they have not had advice on how to limit their salt intake is inhumane… and a waste of time”

Tomson CRV. Advising dialysis patients to restrict fluid intake without restricting sodium intake is not based on evidence and is a waste of time. NDT 2001; 16; 1538-1542.
Sodium/salt restriction

- Dietary salt restriction <2 gm/day
  - Read nutrition labels
  - If food tastes salty—it is!
  - Canned, processed foods have high sodium content
- Dialysate sodium concentration
Dialysate Sodium: Choosing the Optimal Hemodialysis Bath
Diuretic use

- Continue use of loop diuretics in pts with RRF
- Large doses promote loss of Na++ & water
- Effectiveness of therapy may be short
- Question often re: urine output
Guideline 4: Volume and Blood Pressure Control: Treatment Time and Ultrafiltration Rate

* 4.1 We recommend that patients with low residual kidney function (<2 mL/min) undergoing thrice weekly hemodialysis be prescribed a bare minimum of 3 hours per session. (1D)

* 4.1.1 Consider additional hemodialysis sessions or longer hemodialysis treatment times for patients with large weight gains, high ultrafiltration rates, poorly controlled blood pressure, difficulty achieving dry weight, or poor metabolic control (such as hyperphosphatemia, metabolic acidosis, and/or hyperkalemia). (Not Graded)

* 4.2 We recommend both reducing dietary sodium intake as well as adequate sodium/water removal with hemodialysis to manage hypertension, hypervolemia, and left ventricular hypertrophy. (1B)

* 4.2.1 Prescribe an ultrafiltration rate for each hemodialysis session that allows for an optimal balance among achieving euvolemia, adequate blood pressure control and solute clearance, while minimizing hemodynamic instability and intradialytic symptoms. (Not Graded)

2-year Retrospective analysis of Medicare claims 2004-2006 evaluating costs of fluid overload treatment

Results:

✓ 14.3% prevalent Medicare pts (25,291) had 41,699 care episodes over 2 years
✓ Est avg cost/episode--$6,372
✓ Total costs were ~ $266 million

Ms. GM presented to the ER c/o shortness of breath after missing her last dialysis. She was admitted and found to have recurrent bilateral pleural effusions requiring thoracentesis and pleurodesis as well as paracentesis.
Volume overload is an important risk factor for CV morbidity/mortality

High UFR >13mL/hr/kg increases risk of CV deaths

Cost of fluid overload over $266 million in one retrospective analysis

Many barriers to effective fluid management

Volume control must be part of dialysis adequacy assessment