The How and Why of Home Dialysis

IPRO Network 9 Webinar
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Michael A Kraus, MD FACP
Clinical Professor of Medicine – Indiana University
Associate CMO – NxStage Medical, Inc
Senior Medical Advisor – NxStage Kidney Care
Conflicts

Recently:
CMO Adult dialysis Indiana University Health
Medical Director of Home dialysis (IU Health, now DaVita)
Unrestricted grants over the last three years – NxStage, FMC, Davita, Satellite, Keryxx
MAB for NxStage Medical, Consultant for Satellite and FMC
Speaker for NxStage, DaVita, Satellite

Presently:
Associate CMO - NxStage Medical, Inc.
Senior Medical Advisor – NxStage Kidney Care
Certain risks associated with hemodialysis treatment are increased when performing solo home hemodialysis because no one is present to help the patient respond to health emergencies.

Certain risks associated with hemodialysis treatment are increased when performing nocturnal therapy due to the length of treatment time and because therapy is performed while the patient and care partner are sleeping.

Patients should consult with their doctor to understand the risks and responsibilities of home and/or more frequent hemodialysis.
What do patients want?

- Quality of Life
- Survival
- Safety/Quality
- Support
- Patient Centered Care
- EDUCATION

Dialysis provider(s) needs:

- Understand benefits
- Understand cardiovascular risk profiles
- Understand Salt and Water
- Improve infection
- Appropriate education/tools
- Well trained Nurses and Physicians
- Social work SUPPORT/Support groups
- Dieticians with understanding of home needs
- Family (Support Group) involvement
- Interdisciplinary teamwork
- Strive for improvement daily
What makes a program successful

- Knowledge as to benefits
- Need to understand
- Education of healthcare professionals and patients
- A multidisciplinary team
- Partnerships
- Dedication to patient centered care

Goals
- Understand why home dialysis is different
  - Benefits to patients
- Understand what infrastructure is needed
- Understand your role
- Make an action plan to increase home dialysis
Where it all begins

**The Patient**

- 52 yo black male
- APKD
- Prior PD, transplant times 13 years
- Transplant with acute failure due to Renal vein thrombosis, initiates thrice weekly HD (Texas)
- PD cavity is full of adhesions on laparoscopy
- Continues on in-center dialysis
- Transfers to your dialysis shift
Due to dialysis he abruptly “retired”  
Lives down south 6-months a year and wants to be more active

**Increased frequency home hemodialysis**
After training and going home

- Atrial Fibrillation
- Echo – LVH (1.4 cm septum and PW thickness), Decreased LVEF 30%, diastolic dysfunction
- Pulmonary Hypertension
- Minimal diffuse valvular changes
- Cardiac Catheterization with normal coronary anatomy

- Decision point – Too sick for home dialysis or not?
How important in frequency?

- 3 to 4 days
- 5 + days
A 2016 AJKD publication catalogs the peer-reviewed evidence* and the primary benefits across 5 domains:

- **Reduces left ventricular mass** and may lead to lower risks for adverse cardiac events.
- **Reduces blood pressure** and the need for antihypertensive medications.
- **Lowers serum phosphorus levels** and decreases the need for phosphate binders.
- **Addresses** both physical and mental aspects of **poor health-related quality of life**.
- Improves the tolerability of HD treatment by **reducing the risk for intradialytic hypotension** and **decreasing recovery time** after HD.

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5 – 6 days per week
Significantly reduced post-dialysis recovery time

Study of Medicare patients starting more frequent home hemodialysis with NxStage System One Key Findings:

- **87% improvement** in time to recovery and significant improvement in quality of life measures

SDHD Improves Mental & Physical Health (SF-36 Scores)

N = 155

Cardiovascular Clinical Considerations

Left Ventricular Hypertrophy

62%

Increase in cardiovascular events, 1 g/m² increase in LVMI per month²

Cardiovascular-related Deaths in Prevalent Dialysis Patients are Common

Over 41% of all deaths were cardiovascular-related, with nearly identical percentages in hemodialysis and peritoneal dialysis patients.¹

CHAPTER 1, FIGURE 2: Distribution of primary cause of death in hemodialysis patients, 2011 to 2013.²

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UF rate and Mortality

Slower UF & Longer HD Treatments are Safer

UFR and death – f/u
n = 118,394

RR of death with increasing UFR - <6.0 ref = 1.00

Ultrafiltration rate cc/hr/kg

RR of Death

<6  6 to 8  8 to 10  10 to 12  12 to 14  >14

1  1.03  1.09  1.15  1.22  1.43

Assimon and Flythe; Am J of Kid Dis 2016
UFR is Associated with All-cause Mortality

Kaplan-Meier Unadjusted

All-cause Mortality

- Chazot et al; Blood Purification 2017; 44:89-97
UF rates with more frequent dialysis

- 12961 patient weeks – 475 patients
  - Mean UFR 6.57ml/kg/hour - female
  - Mean UFR 5.73 ml/kg/hr - male
  - 86% below 10 and 95% below 13

- SDHD therapies. Increases with increased frequency (shorter runs) – 5-6 days weekly
  - 5.49 with 4
  - 7.17 with >=6

Thrice weekly - Mean 9.5 with 62% <10 and 82% < 13

- Weinhandl, Collins and Kraus –ADC 2017
- Flythe et al CJASN 2016
High Ultrafiltration Rates Correlated to Intradialytic Hypotension

Regional Wall Motion Abnormalities Shown to Increase Mortality Risk

Long interdialytic interval and mortality among patients receiving conventional, thrice-weekly hemodialysis; most events occurred on the day after the long interdialytic interval.

Annualized Mortality Rates

<table>
<thead>
<tr>
<th>Rate per 100 Person-Yr</th>
<th>All causes</th>
<th>Cardiac causes</th>
<th>Infectious causes</th>
<th>Vascular causes</th>
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</thead>
<tbody>
<tr>
<td>HD1</td>
<td>22</td>
<td>15</td>
<td>7</td>
<td>5</td>
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<tr>
<td>HD1+1</td>
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<td>14</td>
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<td>4</td>
</tr>
<tr>
<td>HD2</td>
<td>18</td>
<td>13</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>HD2+1</td>
<td>16</td>
<td>12</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>HD3</td>
<td>14</td>
<td>11</td>
<td>3</td>
<td>2</td>
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<tr>
<td>HD3+1</td>
<td>12</td>
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<td>1</td>
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<tr>
<td>HD3+2</td>
<td>10</td>
<td>9</td>
<td>1</td>
<td>1</td>
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</tbody>
</table>

I bars represent 95% confidence intervals. HD1 denotes the day of the first hemodialysis session of the week, HD1+1 the day after the first session, HD2 the day of the second hemodialysis session, HD2+1 the day after the second session, HD3 the day of the third hemodialysis session, HD3+1 the day after the third session and HD3+2 the second day after the third session. CHF denotes congestive heart failure, CVD cardiovascular disease and MI myocardial infarction.

Annualized Cardiovascular-related Hospitalization Rates

<table>
<thead>
<tr>
<th>Rate per 100 Person-Yr</th>
<th>Any CVD</th>
<th>CHF</th>
<th>MI</th>
<th>Dysthymia</th>
<th>Stroke</th>
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<tbody>
<tr>
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<td>45</td>
<td>30</td>
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<tr>
<td>HD1+1</td>
<td>40</td>
<td>28</td>
<td>18</td>
<td>9</td>
<td>4</td>
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<tr>
<td>HD2</td>
<td>35</td>
<td>25</td>
<td>15</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>HD2+1</td>
<td>30</td>
<td>22</td>
<td>12</td>
<td>6</td>
<td>2</td>
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<tr>
<td>HD3</td>
<td>25</td>
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<td>5</td>
<td>2</td>
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<tr>
<td>HD3+1</td>
<td>20</td>
<td>15</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>HD3+2</td>
<td>15</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

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Coming off heavy

- **Flythe – ADC 2018 – % of exposure period treatments >1kg above target weight – n= 113,561**
  - 5-29% of the time – 9% increase risk of 30 day mortality
  - 30-49% of the time – 82% increase risk of 30 day mortality
  - >50% of the time - 246% increase risk of 30 day mortality

- **Movilli 2013**
  - Only 182 patients but marked increase risk of mortality with only 0.3 kg
More Frequent Hemodialysis Regression of Left Ventricular Hypertrophy


5 – 6 days per week
Daily home hemodialysis patients had 20%-25% fewer CV hospital days per patient-year than in-center HD patients:

- 25% lower risk for cerebrovascular disease
- 41% lower risk for heart failure, fluid overload, and cardiomyopathy
- 16% lower risk for hypertensive disease
Addressing Unmet Needs in Cardiorenal Care

Chronic Fluid Overload and Mortality in ESRD

**FO = Fluid Overload**
Determined by Bioimpedence

Overhydrated
(Men: FO≥15%,
Women: FO≥13%)

Therapy Prescription: More Frequent Home Hemodialysis

Chronic Fluid Overload
62% higher risk of death

The Patient – follow up

- BP normal and no meds
- Activity increased
- Serial Echo with improved LVEF (60%) No wall motion abnormalities or Valvular disease
- No recurrence Atrial Fibrillation
Cardiovascular complications and interventions

- More frequent hemodialysis addresses fundamental issues
  - Left ventricular mass
  - Hypertension
  - Salt and water

- Better management of these can lower cardiovascular morbidity and hospitalizations
Why increased frequency?

- Improved QOL
- Improved LVH
- Improved BP control
- Improved UF rates
- Decreased CV stunning
- Less hospitalizations
- No Killer gap
Why home dialysis?

- Allows for increased frequency dialysis
- Evidence based increased frequency associated with:
  - Improved Quality of life
  - Improved Quantity of life
- Home dialysis allows for economical delivery of increased frequency dialysis, improving patient experience, reducing total costs and meets the needs for the changing medical environment
- CMS Conditions for coverage:
  - Mandates education of all modalities
  - Mandates provision of all modalities
- If done well, should improve physician and nurse satisfaction.
Home Dialysis: Key Points for Success

- Dialysis provider/organization must believe in the therapies
  - Support their use
  - Be the champion for them

- Develop (or be developed by) knowledgeable and dedicated nurses

- Make it as easy to do home dialysis (PD and HHD) as it is to do in-center HD
Any Home Program Must Provide:

- Seamless referral processes for incoming patients
- Flexible scheduling and rapid response time for the physicians’ needs
- Consistent training
- Good communication among nephrologists, staff, patients, families, surgeons and hemodialysis employees
- CQI meetings at the local and regional level
- Dedicated staff time
- Multi-disciplinary clinics, with good follow-up communications
- Home visits, as indicated
Assurance - Talking points

- Adequate education
- 24/7 backup
- Respite care available
- Knowledgeable support staff
- Fear of CANNULATION
- Home dialysis is not a loss of entitlement (culture)
- “Dialysis is a lot of work, but you will always have support”
What are the barriers

- **Patients**
  - Lack of adequate and timely education
  - Partner – Present/Burden - But solo may be an option
  - Home – adequate storage
  - Motivation
  - Quality of life
  - FEAR

- Education, Age, Well water, Payor status, IQ...
  - NOT BARRIERS TO THERAPY
  - Clues on how to teach!
Many of these Barriers can be overcome:

- Timely and appropriate education
- True Informed Consent
- Peer support groups
- Two week trials
- Excellent training by competent and professional nurses
- REASSURANCE

- Patient EMPOWERMENT
- Patient ADVOCATION
Dialyzer Urea Clearance

Dialysate Flow ($Q_d$) and Blood Flow Rate ($Q_b$)

When dialysate flow is below 200 ml/min this determines the basic clearance
D/P Ratio for Urea*
NxStage Polyether Sulfone Dialyzer

- Urea KoA in vivo 851 ml/min
- *Ken Leypoldt kinetics ASN 2017

NxStage System

Conventional Hemodialysis

Dialysate Flow Rate (Qd)

Dialysate/Plasma Ratio (D/P)
## Comparison of Dialysate Saturation

**NxStage – Lower $Q_d$**  
**Conventional – Higher $Q_d$**

<table>
<thead>
<tr>
<th>NxStage</th>
<th>Conventional HD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BFR 300 ml/min Qd 200</strong></td>
<td><strong>BFR 300 ml/min Qd 500</strong></td>
</tr>
<tr>
<td>• Urea Saturation: 85%</td>
<td>• Urea Saturation: 40%</td>
</tr>
<tr>
<td>• PO4 Saturation: 64%</td>
<td>• PO4 Saturation: 31%</td>
</tr>
<tr>
<td><strong>BFR 400 ml/min; Qd 200</strong></td>
<td><strong>BFR 400 ml/min; Qd 500</strong></td>
</tr>
<tr>
<td>• Urea Saturation: 93%</td>
<td>• Urea Saturation: 57%</td>
</tr>
<tr>
<td>• PO4 Saturation: 69%</td>
<td>• PO4 Saturation: 35%</td>
</tr>
</tbody>
</table>
High Saturation Dialysate:
Dialysate + UF = Volume Cleared (KxT)

- The high saturation of dialysate means for each liter of dialysate used it equals a liter cleared of solutes
  - Urea
  - Creatinine
  - PO4
- Ultrafiltration adds convective clearance removing solutes at the same concentration as in the blood
- The single pool volumes cleared each treatment is essentially the volume of dialysate plus the UF divided by the patient TOTAL Body Water
Leypoldt and Collins Dosing Protocol  
ASN Abstract/Poster - Based on V: Dialysate Volume rounded*

<table>
<thead>
<tr>
<th>Runs Per week</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
<th>55</th>
<th>60</th>
<th>65</th>
<th>70</th>
<th>75</th>
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<td>4</td>
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<td>30</td>
<td>35</td>
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<td>30</td>
<td>35</td>
<td>35</td>
<td>40</td>
<td>40</td>
</tr>
</tbody>
</table>

Dialysate Volume needed to nearest 5 liters
In Sum

5-6 days per week should be the goal

- Therapy Rx can be addressed in two parts
  - Volume to be removed per week by addressing UFR
  - Solute removal based on Normalized Volumes of Total Body Water cleared per week and per treatment
- UF volume per week is divided by tolerable UFR to obtain hours needed per week
- STD Weekly KT/V provides the target normalized volumes per week to be cleared overall
  - spKT/V is used to determine normalized volume cleared per treatment
  - Dialysate needed per treatment is computed based on saturation of the dialysate rounded up to the nearest 5 liters
- Increased frequency is required for optimizing CV benefit
- Increased frequency is necessary in larger people
- You can increase Kt/V by:
  - Increasing frequency
  - Increasing volume of dialysis
  - Decreasing dialysate flow (increasing time)
  - Extended therapies
Increased flexibility for patient needs

- Nocturnal Hemodialysis
- Solo hemodialysis
Why should we prescribe more frequent home hemodialysis?

- Mitigate the 2-day killer gap
- Better volume management with lower UF rates
  - Blood pressure control with significant reduction in BP medications
  - Diminish myocardial stunning
  - Reduce LV mass
- Better phosphorus control
- Decreased Na, K, H2O, Calcium, Mag shifts
- Improve recovery time
- Improve patient survival
- Improve quality of life
Intensive home hemodialysis approach

CONCLUSIONS

• Persistent lack of progress in CV events and intolerance of the therapy should be addressed with More Frequent HD

• MFHD addresses the unmet need centered on volume control.

• Patient with volume overload, heart failure, persistent hypertension and intolerance to conventional HD are candidates for more frequent HHD
Conventional Hemodialysis

- TO prescribe HD – maximize time and decrease ultrafiltration rates
- Frequency discussion is the same
- Increase $K_t/V$ (My preference of order)
  - Increase time
  - Increase $Q_b$ and $Q_d$
  - Increase dialyzer surface area
Peritoneal Dialysis

- Don’t forget peritoneal dialysis
  - Important part of a home unit
  - Important part of patient centered care
  - Advantages –
    - Needleless
    - daily
    - preserved renal function
    - “easy” solo therapy
Don’t forget PD

Peritoneal Equilibration Test (PET)
Twardowski Perit Dial Bull 7:138 1987
## Urea D/P at 1, 1.5 and 2 hour dwells

<table>
<thead>
<tr>
<th>Hours</th>
<th>Urea</th>
<th>% INCREASE</th>
<th>1 TO 1.5</th>
<th>1 TO 2</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Low</td>
<td>0.35</td>
<td>29.00%</td>
<td>57%</td>
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<tr>
<td></td>
<td>Low Avg</td>
<td>0.47</td>
<td>21%</td>
<td>40%</td>
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<tr>
<td></td>
<td>High Avg</td>
<td>0.56</td>
<td>21%</td>
<td>32%</td>
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<tr>
<td></td>
<td>High</td>
<td>0.69</td>
<td>13%</td>
<td>26%</td>
</tr>
<tr>
<td>1.5</td>
<td>Low</td>
<td>0.45</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Low Avg</td>
<td>0.57</td>
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<td>High Avg</td>
<td>0.68</td>
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<tr>
<td></td>
<td>High</td>
<td>0.78</td>
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<td>2</td>
<td>Low</td>
<td>0.55</td>
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<tr>
<td></td>
<td>Low Avg</td>
<td>0.66</td>
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<td>High Avg</td>
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<td></td>
<td>High</td>
<td>0.87</td>
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</table>
## Creatinine D/P at 1, 1.5, 2 and 4 hour dwells

<table>
<thead>
<tr>
<th>Hours</th>
<th>Low</th>
<th>Low Avg</th>
<th>High Avg</th>
<th>High</th>
<th>% Change</th>
<th>Low</th>
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<tbody>
<tr>
<td>1</td>
<td>0.26</td>
<td>0.35</td>
<td>0.45</td>
<td>0.62</td>
<td>1 to 1.5</td>
<td>15%</td>
<td>14%</td>
<td>24%</td>
<td>18%</td>
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<tr>
<td>1.5</td>
<td>0.3</td>
<td>0.4</td>
<td>0.56</td>
<td>0.73</td>
<td>1 to 2</td>
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<td>33%</td>
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<tr>
<td>2</td>
<td>0.34</td>
<td>0.45</td>
<td>0.6</td>
<td>0.78</td>
<td>1 TO 4</td>
<td>73%</td>
<td>63%</td>
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### UREA CLEARANCE

#### D/P*Vd*7 (9 hours)

<table>
<thead>
<tr>
<th>Total Volume</th>
<th>L</th>
<th>LA</th>
<th>HA</th>
<th>H</th>
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</thead>
<tbody>
<tr>
<td>8</td>
<td>30</td>
<td>35.8</td>
<td>40.3</td>
<td>47.6</td>
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<td>10</td>
<td>37.8</td>
<td>44.8</td>
<td>50.4</td>
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<td>12</td>
<td>45.4</td>
<td>53.7</td>
<td>60.5</td>
<td>71.4</td>
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#### D/P*Vd*7 (8 hours)

<table>
<thead>
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<th>L</th>
<th>LA</th>
<th>HA</th>
<th>H</th>
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</thead>
<tbody>
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<td>8</td>
<td>25.7</td>
<td>33.6</td>
<td>39.2</td>
<td>45.36</td>
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<tr>
<td>10</td>
<td>32.1</td>
<td>42</td>
<td>49</td>
<td>56.7</td>
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<td>12</td>
<td>38.9</td>
<td>50.4</td>
<td>58.8</td>
<td>68</td>
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#### 5 exchanges total volume

<table>
<thead>
<tr>
<th>Total Volume</th>
<th>L</th>
<th>LA</th>
<th>HA</th>
<th>H</th>
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<tbody>
<tr>
<td>10</td>
<td>30.8</td>
<td>38.5</td>
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<td>12.5</td>
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<td>15</td>
<td>46.2</td>
<td>57.8</td>
<td>68.2</td>
<td>79.8</td>
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#### 5 exchanges total volume

<table>
<thead>
<tr>
<th>Total Volume</th>
<th>L</th>
<th>LA</th>
<th>HA</th>
<th>H</th>
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<tbody>
<tr>
<td>10</td>
<td>28.0</td>
<td>36.4</td>
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<td>15</td>
<td>42.0</td>
<td>54.6</td>
<td>65.1</td>
<td>71.4</td>
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#### 6 Exchanges

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#### 6 Exchanges

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PD Prescription Key points

- Preservation of residual renal function IS important
- DRY days are generally not adequate
- More clearance with more time/volume
- Less clearance with increased exchanges

- CCPD “rules”
  - Avoid dry days – use last bag option
  - Minimum 9 hours at night
  - Start with 4 exchanges
  - Consider Midday exchanges
  - Especially without residual renal function and/or large size
Continuum of Care

Places for transitional care

ICU
Acute Dialysis
In-Center Hemodialysis
Skilled Nursing Facilities
Transitional Unit – A safe place for change

Incident Patients

- 90 day survival and hospitalizations high
- Volume overloaded
- Scared, uneducated

Other transition patients

- AKI patients
- PD loss
- Failed renal transplants

- Allows more time to prepare for home
- Also fluid issues, LVH, scared, Depressed

Home patients

- Respite therapy for patient or partner
- Ease through acute illness
- Allows room for machine, home, partner issues
- Space to retrain
  - Access, water ...
- Decreases thrice weekly back-up and losses
- Transient care?

Associated or part of the home dialysis unit

Overall Goal: best care for patient and CV optimization
PLAN on Success

- Dependent on everyone
- Communication
- Motivation

- Review quality
- Adjust prescription and reassess in a timely fashion
- Patient centered care
Questions?

- ANY time….

  - michael.kraus@nxstage.com
References