PD Adequacy Guidelines: What’s New?

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Adequacy as Defined by Quantity of Clearance

- **Quantity of Clearance** refers to clearance of small easily measureable molecules felt to reflect ‘uremia’
- Historically in PD these were:
  - **UREA** reported as Weekly \(Kt/V_{urea}\)
  - **CREATININE** reported as Weekly Creatinine Clearance
- Current guidelines and consensus statements favor use of \(Kt/V_{urea}\) as the ‘standard’ measure for a clearance target

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**Peritoneal Dialysis Adequacy**

- Multidimensional Assessment Of Optimal Dialysis: Potential Measures
- Potential/Dialytic Strategies To Achieve
  - Treatment Duration
  - Treatment Frequency
  - Incremental Stages
  - Presentation of Residual Kidney Function
  - Consideration of Home Dialysis

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**Abstract**

In the early days of chronic dialysis therapy, there was recognition that patients receiving peritoneal dialysis with greater volume of dialysate had better survival. It was suggested that, among small low molecular weight solutes, urea was more efficiently removed from the peritoneal cavity than creatinine. However, recent studies have shown that creatinine clearance has been superior in removing creatinine as compared with urea clearance. The publication of the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (K/DOQI) guidelines has emphasized the importance of residual kidney function as a significant predictor of outcomes in patients initiating dialysis and those with advanced renal disease. The use of \(Kt/V_{urea}\) as a measure of adequacy of peritoneal dialysis therapy is recommended.

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**We Use \(Kt/V\) Urea as a Measure of Adequacy of Peritoneal Dialysis**

Joanna M. Bargman
Division of Nephrology, University Health Network, Toronto, Ontario

**ABSTRACT**

In the early days of chronic dialysis therapy, there was recognition that patients receiving peritoneal dialysis with greater volume of dialysate had better survival. It was suggested that, among small low molecular weight solutes, urea was more efficiently removed from the peritoneal cavity than creatinine. However, recent studies have shown that creatinine clearance has been superior in removing creatinine as compared with urea clearance. The publication of the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (K/DOQI) guidelines has emphasized the importance of residual kidney function as a significant predictor of outcomes in patients initiating dialysis and those with advanced renal disease. The use of \(Kt/V_{urea}\) as a measure of adequacy of peritoneal dialysis therapy is recommended.
Comparison of HRQOL Across Chronic Illness Groups
(PedsQL youth self-report data)

Peritoneal Dialysis Adequacy
What outcomes are important to peritoneal dialysis patients and their caregivers?

Manara K, et al. CJASN 2019
Intrapersonal
Psychological and emotional
Parents experience shock about the diagnosis and live in a state of uncertainty surrounding the child's prognosis. Depression and anger are common. Lack of confidence in providing adequate care and being forced to readjust to new roles and responsibilities also reported.

Physical
Parents report constant fatigue and the need to exercise vigilance and describe the loss of personal freedom.

Interpersonal
Friends (social life)
Parents report lack of understanding. Some receive support from friends, especially from other parents of CKD children. Restriction on social life improved after transplant.

Staff
Parents receive comfort from staff and appreciate continuity of care. Some parents report dissatisfaction and tense relationships with staff and being forced to relinquish control of the ill-child to the clinical team.

Family
Parents report either support or lack of understanding from their partner. Siblings provide support; some become jealous and resentful. Overprotectiveness over the ill child, neglect of other family members, and disruption to family life are common. Parents face uncertainty about how to discuss transplantation with the child recipient.

Medical regimen, transplantation and child well-being
Parents are responsible for adhering to the medical regimen and observing symptoms and are concerned about their child's appearance, education, and development.

Diet and nutrition
Parents struggle to adhere with liquid and diet restrictions and provide adequate nutrition.

Household care
Parents struggle to balance and integrate medical care with competing domestic duties.

External
Transport, relocation and employment
Parents face financial hardship and difficulties in arranging transport and accommodation.

Information
Parents pursue information about disease and treatment. Some perceive that they have inadequate information.
PD Adequacy

Patient or Person Centered Care
Medical care that is “respective of and responsive to individual patient preferences, needs and values and...that ensures that patient values guide all clinical decisions”

Institute of Medicine

“Today, I want to lay out what it would look like to pay for kidney health, rather than kidney disease – and pay for Americans with kidney disease to actually get good outcomes, rather than the endless, life-consuming procedures that you all know so well”

Alex Azar
Secretary, HHS

Dialysis Initiation

• We suggest initiating dialysis in children at an estimated glomerular filtration rate (eGFR) of <10ml/min/1.73 m² or when the child with CKD has uremic symptoms refractory to medication and/or dietary management.
• Level of evidence – Grade 2D
Rationale

The timing of dialysis initiation is a complex decision that should take into account the eGFR as well as signs and symptoms of uremia that include:

- Inability to maintain euvolemia with development of hypertension and/or significant peripheral edema
- Deterioration in nutritional status or growth failure and declining weight and/or height centiles
- Biochemical abnormalities such as hyperkalemia, hyperphosphatemia or acidosis

Proportion of Children Initiated on Dialysis Early by Year of Initiation and Dialysis Type

Adjusted Hazard Ratio (95% CI) P-value

<table>
<thead>
<tr>
<th>Years 1995‐2015</th>
<th>All patients (N=14,696)*</th>
<th>Patients initiated on hemodialysis (N=8,794)</th>
<th>Patients initiated on peritoneal dialysis (N=5,902)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted Hazard</td>
<td>1.36 (1.24‐1.50)</td>
<td>1.65 (1.47‐1.86)</td>
<td>1.09 (0.93‐1.28)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Years 2006‐2015</th>
<th>All patients (N=6,757)**</th>
<th>Patients initiated on hemodialysis (N=4,151)</th>
<th>Patients initiated on peritoneal dialysis (N=2,606)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted Hazard</td>
<td>1.42 (1.18‐1.71)</td>
<td>1.80 (1.43‐2.28)</td>
<td>0.88 (0.64‐1.23)</td>
</tr>
</tbody>
</table>

Adjusted Hazards of Death for Early Initiation of Dialysis by Modality Type for Entire Cohort and in Analysis Restricted to the Years 2006-2015

<table>
<thead>
<tr>
<th>Years 2006-2015</th>
<th>All patients</th>
<th>Patients initiated on hemodialysis</th>
<th>Patients initiated on peritoneal dialysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted Hazard</td>
<td>2.07 (1.98-2.15)</td>
<td>3.80 (3.69-3.91)</td>
<td>1.88 (1.72-2.04)</td>
</tr>
</tbody>
</table>

Winnicki et al. (revised), 2019
Bedside Formula

- eGFR = 0.413 [Ht/Scr]
  - Ht in cm
  - % within 30% of iGFR = 78.4%
  - % within 10% = 37.0%
  - Accuracy determined between 15 and 80 ml/min per 1.73 m²

Schwartz G et al., JASN, 2009

Estimated GFR in Young Adults

DK Ng, Kidney International, 2018

Estimating glomerular filtration rate at the transition from pediatric to adult care

Hans Pettef, Jonas Björk, Arvid Börjesson, Ulla Berg, Kaisa Åkerström, etc.

Pettet et al., in press, 2018
Modality Selection

Selection of the dialysis modality should be based upon the child’s age and size, presence of co-morbidities, family support available, modality contraindications, expertise of the dialysis team and the child and parents or caregivers choice. Preserving dialysis access, both peritoneal and vascular access, must be considered when selecting the optimal dialysis modality for a child.

Level of evidence - ungraded

Cross-Sectional Trends in Pediatric ESRD Modality at Initiation, by Patient Age, 1996-2016

PD Modalities
Assessment of Hydration Status

- We suggest assessing the patient's dry weight at each clinic visit with clinical evaluation, including measurement of weight and blood pressure, laboratory parameters and objective measurements of fluid status using bioimpedance spectroscopy, where available, in order to help guide their PD prescription and ultrafiltration requirements.
- Level of evidence – Grade 2C

CONCOMITANT DRUG THERAPY

[Bar chart showing percentage of patients on antihypertensives for PD and HD]
Leading causes of death: USRDS and CDC, 2011

General population 1-24 years
- Accidents (38%)
- Homicides (14%)
- Suicides (12%)
- Cancer (7%)
- Cardiac (3%)
- All other (26%)

Hemodialysis 0-19 years
- Cardiac (32%)
- Infections (11%)
- Withdrawal (5%)
- All others (50%)

Peritoneal dialysis 0-19 years
- Cardiac (28%)
- Infections (15%)
- Malignancy (2%)
- Other hemorrhages (2%)
- Hyperkalemia (2%)
- All others (48%)

Transplant 0-19 years
- Infections (25%)
- Cardiac (22%)
- Malignancies (8%)

Characteristics Associated with Hgb Distribution

<table>
<thead>
<tr>
<th>Hgb range (g/dL)</th>
<th>No. of observations</th>
<th>&lt; 8.5 (n=244)</th>
<th>8.5 – 9.99 (n=697)</th>
<th>10.0 – 11.49 (n=1272)</th>
<th>11.5 – 12.99 (n=1067)</th>
<th>13.0 – 14.49 (n=359)</th>
<th>&gt;14.5 (n=87)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>9.9 ± 5.4</td>
<td>9.9 ± 5.4</td>
<td>9.2 ± 4.9</td>
<td>10.1 ± 4.4</td>
<td>11.1 ± 5.1</td>
<td>10.6 ± 5.4</td>
<td></td>
</tr>
<tr>
<td>% pubertal male</td>
<td>9.9 ± 5.4</td>
<td>9.9 ± 5.4</td>
<td>9.2 ± 4.9</td>
<td>10.1 ± 4.4</td>
<td>11.1 ± 5.1</td>
<td>10.6 ± 5.4</td>
<td></td>
</tr>
<tr>
<td>Use of intraperitoneal PD fluids (%)</td>
<td>22.1</td>
<td>22.1</td>
<td>22.1</td>
<td>22.1</td>
<td>22.1</td>
<td>22.1</td>
<td></td>
</tr>
<tr>
<td>Estimated deviation from dry weight (%)</td>
<td>2.0 ± 3.7</td>
<td>2.0 ± 3.7</td>
<td>2.0 ± 3.7</td>
<td>2.0 ± 3.7</td>
<td>2.0 ± 3.7</td>
<td>2.0 ± 3.7</td>
<td></td>
</tr>
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<td>2.0 ± 3.7</td>
<td>2.0 ± 3.7</td>
<td>2.0 ± 3.7</td>
<td></td>
</tr>
<tr>
<td>Ultrafiltration volume (L/m²/day)</td>
<td>0.65 ± 0.41</td>
<td>0.56 ± 0.35</td>
<td>0.55 ± 0.37</td>
<td>0.50 ± 0.32</td>
<td>0.57 ± 0.41</td>
<td>0.53 ± 0.45</td>
<td></td>
</tr>
<tr>
<td>Urine volume (L/m²/day)</td>
<td>0.40 ± 0.52</td>
<td>0.55 ± 0.57</td>
<td>0.61 ± 0.53</td>
<td>0.71 ± 0.59</td>
<td>0.87 ± 0.66</td>
<td>0.72 ± 0.68</td>
<td></td>
</tr>
<tr>
<td>ESA dose (*1000 U/m²/week)</td>
<td>7.1 ± 4.6</td>
<td>8.6 ± 4.8</td>
<td>8.4 ± 4.6</td>
<td>8.9 ± 4.8</td>
<td>10.1 ± 4.9</td>
<td>10.8 ± 4.6</td>
<td></td>
</tr>
<tr>
<td>% hypertensive</td>
<td>49.8</td>
<td>42.8</td>
<td>36.9</td>
<td>36.4</td>
<td>32.1</td>
<td>42.7</td>
<td></td>
</tr>
<tr>
<td>% LVH</td>
<td>62.5</td>
<td>43.2</td>
<td>41.5</td>
<td>39.4</td>
<td>37.3</td>
<td>43.8</td>
<td></td>
</tr>
</tbody>
</table>

Serum ferritin (ng/mL) | 262 (125-486) | 234 (121-402) | 188 (85-356) | 160 (75-312) | 164 (66-336) | 128 (59-304) |
| PlasmaPTH (pg/mL) | 112 (57-212) | 102 (50-208) | 89 (45-166) | 71 (39-146) | 62 (24-121) | 59 (24-121) |
| % Hypertensive | 49.8 | 42.8 | 36.9 | 36.4 | 32.1 | 42.7 |
| % LVH | 62.5 | 43.2 | 41.5 | 39.4 | 37.3 | 43.8 |
Management of Hydration Status

- Dietary sodium and fluid restriction
- Promoting residual diuresis and use of RAS inhibitors (with appropriate monitoring for hyperkalemia)
- Modification of the dialysis prescription by adjusting the fill volume, dwell time and/or dialysate dextrose concentration can be assisted by reassessment of the Peritoneal Equilibration Test (PET) in patients suspected of having altered peritoneal membrane transport characteristics.
- Use of icodextrin to enhance ultrafiltration

Anterior Ischemic Optic Neuropathy

For every 250 mL urine, a 36% reduction in mortality risk

Adequacy of Peritoneal Dialysis
Preservation of RKF

- ACEI/ARBs
  - monitor for hyperkalemia
- Avoid volume depletion
- Avoid/minimize exposure to nephrotoxins (NSAIDS, aminoglycosides, radiocontrast material)
- Continue low-dose immunosuppression in post-transplant patients
- High dose loop diuretics

Residual Diuresis by Diuretic Therapy

Peritoneal Transport Rates (Children)
**Alternative Osmotic Agents: Icodextrin**

- Derived from cornstarch
- Structural relationship to glycogen
- Mixture of oligosaccharides of variable chain length (4 to >300 glucose units)
- Weight average MW 13,000 to 19,000 daltons

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**Adapted Automated Peritoneal Dialysis**

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Icodextrin and Fill Volume

Solute Clearance

- We suggest that the PD prescription should be adjusted with the goal of achieving a normal serum phosphate level. The total weekly Kt/Vurea in children on peritoneal dialysis should not be less than 1.7.

- Level of evidence – 2D

PD Patients and Phosphorus Management
### Coronary Artery Calcification

![Coronary Artery Calcification Graph](image)


### Recommended Maximum Oral and/or Enteral Phosphorus Intake for Children with CKD

<table>
<thead>
<tr>
<th>Age</th>
<th>DRI (mg/d)</th>
<th>High PTH, Normal Phosphorus</th>
<th>High PTH, High Phosphorus</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 6 mo</td>
<td>100</td>
<td>≤100</td>
<td>≤80</td>
</tr>
<tr>
<td>7 – 12 mo</td>
<td>275</td>
<td>≤275</td>
<td>≤223</td>
</tr>
<tr>
<td>1 – 3</td>
<td>460</td>
<td>≤460</td>
<td>≤370</td>
</tr>
<tr>
<td>4 – 8</td>
<td>500</td>
<td>≤500</td>
<td>≤400</td>
</tr>
<tr>
<td>9 – 18</td>
<td>1250</td>
<td>≤1250</td>
<td>≤1000</td>
</tr>
</tbody>
</table>

Recommended Maximum Oral and/or Enteral Phosphorus Intake for Children with CKD

a. 100% of DRI; b. 80% of DRI

KDOQI Nutrition Guidelines; AJKD, 2009

KDOQI Nutrition, 2008

### Total Fluid Turnover and Dialytic Phosphate Clearance in 60 Children on Automated Peritoneal Dialysis

![Total Fluid Turnover and Dialytic Phosphate Clearance](image)

Schmitt, Peritoneal Dialysis International 2009
Peritoneal Dialysis Adequacy

Geometry of Diffusion

Fill Volume

Primary Goal
- Clearance
- Maximize exposure of peritoneal membrane/blood supply to dialysate
- Generally the easiest/cheapest modification

OFTEN IS & SHOULD BE FIRST OPTION
Linear Mixed Effects Model of Dialysis Efficacy

<table>
<thead>
<tr>
<th>Dialytic Kt/V urea</th>
<th>Estimate (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dialysate dextrose (%)</td>
<td>0.033 (0.023, 0.043)</td>
<td>0.245</td>
</tr>
<tr>
<td>Nighttime fill volume (100 ml/m²)</td>
<td>0.108 (0.068, 0.148)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Number of cycles per 24h</td>
<td>0.095 (0.054, 0.136)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total time (hours)</td>
<td>-0.062 (0.052, 0.072)</td>
<td>0.344</td>
</tr>
<tr>
<td>Daytime fill volume (100 ml/m²)</td>
<td>0.121 (0.078, 0.164)</td>
<td>0.010</td>
</tr>
</tbody>
</table>

* Adjusted for age, sex, PD vintage and residual urine output

Benner L, et al. (in preparation)

Prescribing Peritoneal Dialysis For High Quality Care

Potential Elements To Consider

- Small Solute Clearance
- Volume Status / Blood pressure / Cardiac Geometry
- Residual Kidney Function
- Bone Mineral Disorder Parameters
- Clearance of other uremic toxins (i.e. middle molecules, protein bound)
- Anemia
- Patient Reported Outcomes (i.e. QOL, symptoms)
- Prescribing Peritoneal Dialysis For High Quality Care
- Markers of systemic peritoneal inflammation
- Metabolic Parameters: (i.e. Body composition / Body Mass Index, lipids, glycaemic control)
- Potential Elements To Consider
- Potential Interventions in the context of available resources
- Evaluation of Cycler performance and membrane choice
- Evaluation of Catheter longevity: Biocompatibility, Use
- Evaluation of patient outcomes
- Evaluation of adherence to protocol
- Evaluation of quality of life
- Evaluation of resource utilization
- Evaluation of economic outcomes

Challenges Associated with Shared Decision Making

- Need to educate patient/family to facilitate their contribution to decision process
- Allocation of time necessary to conduct education in a health literate manner
- Current mandate to meet targets as defined by regulators

Benner L, et al. (in preparation)
New PC term for non-dialysis supportive care
David Johnson, 10/31/2018
PD prescription and surrogate markers of CKD-MBD (linear mixed effects models, adjusted for age, sex, PD vintage, residual urine output)

<table>
<thead>
<tr>
<th>Serum inorganic phosphorus [mmol/l]</th>
<th>Estimate [95% CI]</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-dialysate calcium content (1.75 mmol/l)</td>
<td>‐ 0.03 [‐0.11, 0.05]</td>
<td>0.543</td>
</tr>
<tr>
<td>Nighttime fill volume [100ml/m²]</td>
<td>0 [0, 0.01]</td>
<td>0.986</td>
</tr>
<tr>
<td>Number of cycles [per 24h]</td>
<td>‐0.01 [‐0.01, 0]</td>
<td>0.393</td>
</tr>
<tr>
<td>Daytime fill volume [100 ml/m²]</td>
<td>0 [‐0.01, 0]</td>
<td>0.393</td>
</tr>
<tr>
<td>Icodextrin use</td>
<td>‐0.06 [‐0.10, ‐0.02]</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Benner L, et al. (in preparation)
Adequacy of Peritoneal Dialysis

For every 250 mL urine, a 36% reduction in mortality risk

Churchill et al, JASN, 1996

What is Adequate PD?

Adequacy often refers to the quantity of clearance delivered but in a broader sense it is often meant to reflect on the quality of the dialysis prescription as a whole

Handbook of Dialysis, 5th Ed, Chap. 25
Blake and Daugirdas

Kt/Vurea

- Fractional Clearance of Body Urea
  - Unitless / Non-Physiologic measure
  - Created to address a need in prior studies*
- “K” is representative of CLEARANCE in formula
  - Kt or clearance of dialysis delivered
  - Kr or clearance of ‘residual’ renal function
- “t” is time that dialysis is delivered over
  - In PD calculations t is normally considered 24 hours/1 day...ie the calculation is based on full day of dialysate/urine output (then scaled*)
- “V_{urea}” is the volume of distribution for urea in the PD patient
  - Equivalent to total body water
PedsQL 4.0 Generic Core Scales from Child Self-Report and Parent Proxy-Report for Dialysis vs. Transplant Patients

<table>
<thead>
<tr>
<th>Scale</th>
<th>Dialysis</th>
<th>Transplant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Score**</td>
<td>23 46 69.77 14.90 39 78.94 14.24</td>
<td></td>
</tr>
<tr>
<td>Physical Health*</td>
<td>8 46 69.62 19.11 39 80.76 20.93</td>
<td></td>
</tr>
<tr>
<td>Psychosocial Health*</td>
<td>15 46 69.88 15.04 39 77.86 13.46</td>
<td></td>
</tr>
<tr>
<td>Emotional Functioning</td>
<td>5 46 71.88 18.61 39 79.04 18.70</td>
<td></td>
</tr>
<tr>
<td>Social Functioning</td>
<td>5 46 75.19 17.52 39 82.31 17.54</td>
<td></td>
</tr>
<tr>
<td>School Functioning*</td>
<td>5 46 62.34 20.45 39 72.31 18.13</td>
<td></td>
</tr>
</tbody>
</table>

Parent proxy-report

<table>
<thead>
<tr>
<th>Scale</th>
<th>Dialysis</th>
<th>Transplant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Score**</td>
<td>23 50 64.27 16.84 45 75.57 17.75</td>
<td></td>
</tr>
<tr>
<td>Physical Health**</td>
<td>8 50 64.75 22.18 45 78.38 24.65</td>
<td></td>
</tr>
<tr>
<td>Psychosocial Health**</td>
<td>15 50 64.08 16.48 45 74.14 17.50</td>
<td></td>
</tr>
<tr>
<td>Emotional Functioning**</td>
<td>5 50 62.50 18.91 45 75.67 18.36</td>
<td></td>
</tr>
<tr>
<td>Social Functioning*</td>
<td>5 50 68.90 18.93 45 78.56 22.20</td>
<td></td>
</tr>
<tr>
<td>School Functioning</td>
<td>5 47 60.66 23.52 41 66.06 18.53</td>
<td></td>
</tr>
</tbody>
</table>

* p<0.05, ** p<0.01. Dialysis includes Peritoneal and Hemodialysis.

School Attendance

- Choice of peritoneal dialysis fluid (PDF), with particular reference to dextrose concentration (and the associated ability to meet ultrafiltration needs) and its biocompatibility for peritoneal membrane preservation
- Tolerance of the prescribed fill volume, determined by patient report, at times with the assistance of intraperitoneal pressure (IPP) measurement
- Dwell time of dialysis exchanges adapted to the individual patient's needs
Linear Mixed Effects Model of Dialysis Efficacy

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dialysate dextrose (%)</td>
<td>239 (219, 259)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Nighttime fill volume (100 ml/m²)</td>
<td>14.2 (9.97, 18.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Number of cycles per 24h</td>
<td>5.0 (1.1, 8.9)</td>
<td>0.012</td>
</tr>
<tr>
<td>Fluid remaining (100 ml/m²)</td>
<td>14.3 (10.2, 18.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Daytime fill volume (100 ml/m²)</td>
<td>5.4 (2.0, 8.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Icodextrin use</td>
<td>-40.2 (-72.2, -8.1)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

* Adjusted for age, sex, PD vintage and residual urine output.

Sodium Losses on PD

- Infants might need higher UF rate per BSA as compared to adults to achieve adequate nutrition.
- In such cases, UF-related convective solute transport is considerable.

Solute Clearance
Association Between Dialytic Phosphate Clearance and Dialysate-to-plasma ratios (D/P) of Creatinine and Phosphate

Binder study slide Renalgel

35 patient phos study
Residual Kidney Function

<table>
<thead>
<tr>
<th>EFR (mL/min)</th>
<th>Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100</td>
<td></td>
</tr>
<tr>
<td>100-1000</td>
<td></td>
</tr>
<tr>
<td>&gt; 1000</td>
<td></td>
</tr>
</tbody>
</table>

International Pediatric Peritoneal Dialysis Network (IPPN)

PD Prescription

Verrina et al., Pediatr Nephrol, 2009

Ultrafiltration response to dextrose

- 1.5% dextrose
- 2.5% dextrose
- 4.25% dextrose

Time (hr) vs. Net UF (mL)
Peritoneal Membrane Characteristics

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PD Modalities

Clinical Indications for Repeat Peritoneal Membrane Transport Testing

- Presence of unexplained volume overload
- Decreasing drain volume (DV) on: overnight dwell (CAPD), or daytime dwell (APD)
- Increasing clinical need for hypertonic dialysate dwells to maintain DV
- Worsening of hypertension
- Change in measured peritoneal solute removal (Kt/Vurea)
- Unexplained signs or symptoms of uremia
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"Individualizing the prescription is the key to improving patient outcome and long-term PD therapy success. The challenge to the individual practitioner is to make prescription management an integral part of everyday patient management."

Ad Hoc Committee on PD Adequacy
Characteristics Associated with Hgb Distribution

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<tr>
<th>Hgb range (g/dL)</th>
<th>&lt; 8.5 (n=419)</th>
<th>8.5 – 9.99 (n=62)</th>
<th>10.0 – 11.49 (n=1127)</th>
<th>11.5 – 12.99 (n=1617)</th>
<th>13 – 14.49 (n=1067)</th>
<th>&gt;14.5 (n=87)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>9.9 + 5.4</td>
<td>11.2</td>
<td>9.2 + 4.9</td>
<td>10.3 + 4.4</td>
<td>11.1 + 5.0</td>
<td>10.6 + 4.6</td>
</tr>
<tr>
<td>% pubertal male</td>
<td>22.1</td>
<td>26.8</td>
<td>28.6</td>
<td>31.8</td>
<td>34.6</td>
<td>36.6</td>
</tr>
<tr>
<td>Use of biocompatible PD fluids (%)</td>
<td>22.1</td>
<td>26.8</td>
<td>31.8</td>
<td>34.6</td>
<td>36.6</td>
<td>38.7</td>
</tr>
<tr>
<td>Estimated deviation from dry weight (%)</td>
<td>19.1 ± 3.7</td>
<td>21.5 ± 3.4</td>
<td>19.1 ± 3.7</td>
<td>21.5 ± 3.4</td>
<td>19.1 ± 3.7</td>
<td>21.5 ± 3.4</td>
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<tr>
<td>Urinary sodium (mEq/L/d)</td>
<td>86 ± 42</td>
<td>75 ± 37</td>
<td>78 ± 39</td>
<td>80 ± 41</td>
<td>82 ± 43</td>
<td>83 ± 45</td>
</tr>
<tr>
<td>Urine volume (L/m²/day)</td>
<td>0.65 + 0.41</td>
<td>0.56 + 0.35</td>
<td>0.55 + 0.37</td>
<td>0.50 + 0.32</td>
<td>0.57 + 0.41</td>
<td>0.52 + 0.45</td>
</tr>
<tr>
<td>Ultrafiltration volume (L/m²/day)</td>
<td>0.40 + 0.52</td>
<td>0.55 + 0.57</td>
<td>0.61 + 0.53</td>
<td>0.71 + 0.59</td>
<td>0.87 + 0.66</td>
<td>0.77 + 0.88</td>
</tr>
<tr>
<td>Plasma PTH (pg/mL)</td>
<td>452 (177-740)</td>
<td>325 (122-675)</td>
<td>218 (99-494)</td>
<td>213 (104-436)</td>
<td>215 (95-465)</td>
<td>197 (79-412)</td>
</tr>
<tr>
<td>% hypertensive</td>
<td>49.8</td>
<td>45.5</td>
<td>36.9</td>
<td>36.4</td>
<td>30.1</td>
<td>42.7</td>
</tr>
<tr>
<td>% LVH</td>
<td>62.5</td>
<td>69.5</td>
<td>47.5</td>
<td>38.4</td>
<td>30.3</td>
<td>40.9</td>
</tr>
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Adapted Automated Peritoneal Dialysis

- Volume (L) over time (h)
Children’s Perspectives of Living with Dialysis

- Physical appearance
- Behavior
- Socio-emotional

Eating difficulties

Perspectives of children on living with dialysis

- Feelings of patients
- Parental perceptions
- Interactions with society
- Restrictions

Adjusted Hazards of Death for Early Initiation of Dialysis by Modality Type in 2006-2015

<table>
<thead>
<tr>
<th>Modality Type</th>
<th>Adjusted Hazard Ratio (95% CI)</th>
<th>P-value</th>
</tr>
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<tbody>
<tr>
<td>All patients</td>
<td>1.42 (1.18 - 1.71)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Patients initiated on hemodialysis</td>
<td>1.80 (1.43 - 2.28)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Patients initiated on peritoneal dialysis</td>
<td>0.88 (0.64 - 1.23)</td>
<td>0.46</td>
</tr>
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</table>
Thematic Schema Depicting Themes Underpinning Rankings of Outcomes

Manera K, et al. CJASN, 2019

PTH levels and Carotid IMT

Shroff et al., JASN, 2007

Weekly Dialysis Kt/V
24 Hr D/P Urea x 24-Hr Drained Volume x 7

Weekly Renal Kt/V
Volume of 24-Hr Urine in mL x Urine Urea Nitrogen Conc. x 1440 min/day x Blood Urea Nitrogen Concentration

Daily Renal Urea Clearance
mL/min Urea clearance x 1440 min/day x 7
1000 mL x V
Trends in ESRD Modality at Initiation, by Patient Age, 1996-2013

USRDS, 2015