Nutritional Challenges and Enteral Supplementation Strategies Across the CKD Spectrum

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Learning Objectives

• A case-based interactive review of nutritional challenges across the spectrum of CKD, HD, PD, and after transplantation.

• Nutritional interventions and solutions.

• To have a basic understanding of nutritional management across the entire CKD spectrum.
Goals of Nutrition Therapy

- Maintain adequate intake of macro and micronutrients
- Avoid uremic toxicity, metabolic imbalances, and renal bone disease
- Optimize growth and development
- Reduce risk of chronic morbidities and mortality in adulthood

CKD: Impact on All Organs

Bones can break, muscles can atrophy, glands can loaf, even the brain can go to sleep, and not endanger our survival, but should the kidneys fail in their task neither bone, muscle, gland nor brain could carry on.

From Dr. Homer W. Smith: Fish to Philosopher
## Unique Aspects & Impact on Nutrition

### CAKUT
- Polyuria, excessive thirst
- Salt wasting
- Decreased protein synthesis due to salt-wasting*

### GLOMERULAR
- Fluid and salt overload
- Hypertension
- Protein loss
- Dyslipidemia

- Metabolic acidosis: Decreased IGF-1 and GH receptors. Increased steroid production & protein degradation
- GH resistance

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## Altered Body Composition

- Lean mass deficit and increase in fat mass

- Impaired growth, short stature with altered trunk: limb ratio

- Increased Waist to Height Ratio

- Growth hormone resistance and decreased exercise capacity may be responsible for increased WHr

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Silverstein D. Growth and Nutrition in Pediatric CKD. Front. Pediatr., 14 August  
Causes of Malnutrition in CKD/ESRD

**Altered taste sensitivity**
- Micronutrient deficiencies (Zinc)
- Decreased # of taste buds*

**Anorexia and poor growth**
- Unpalatable prescribed diet and binder regimens
- Alterations in hormonal and neuropeptide signaling
- Altered microbiome with uremic toxins
- Renal osteodystrophy: adynamic bone disease or hyperparathyroidism; destruction of growth plate, epiphyseal displacement, metaphyseal fractures


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**Neuropeptide Alterations and Appetite**

- Decline in GFR With CKD Progression
- Increased Cytokines
- Decreased Ghrelin
- Increased Leptin and Insulin

- Decreased Neuropeptide Y Inhibits Appetite
Altered Microbiome in CKD


Impact of Dialysis on Nutrition

Hemodialysis-specific
- Stricter fluid and electrolyte limits pose significant challenges in younger anuric children
- Carnitine deficiency
- Negative protein balance at the end of HD
- Chronic inflammation/oxidative stress

PD-specific
- Delayed gastric motility, GER, and vomiting
- Early satiety
- Increased protein losses and glucose absorption

Nelms C. Optimizing Enteral Nutrition for Growth in Pediatric CKD. Front. Pediatr., 02 August 2018
Defining Malnutrition

- Defined as Wt/Ht or BMI ≤ -1 SDS*
  -1 to -1.9 mild
  <-2 to -2.9 moderate
  ≤-3 severe

- Height/age ≤ -3 SDS; consider non-nutritional factors

- Other parameters:
  - Nutritional intake
  - Rate of weight gain or loss
  - Growth velocity
  - Mid-upper arm circumference
  - WHr**
  - Trunk to limb ratio


Malnutrition and PEW

**Malnutrition**: “An imbalance between nutrient requirement and intake, resulting in cumulative deficits of energy, protein and micronutrients negatively affecting growth, development and other health outcomes”

Mehta et al. Defining Pediatric Malnutrition. JPEN Volume 37, Issue 4, July 2013, p 460-481

**Protein Energy Malnutrition**: State of decreased body stores of protein and energy

**Protein Energy Wasting**: Refers to multiple nutritional and catabolic alterations occurring in CKD which can’t be corrected by increasing energy intake

Protein Energy Wasting in Dialysis


Case 1: CKD to PD

- Male with CKD at 8 months sec. to PUV
- Started PD at 18 months, G-tube not placed
- Loss of appetite, decreased formula intake, stopped eating food
- Vomiting
- Decline in weight gain and growth velocity
## What will you do first?

| A. | Hakuna Matata |
| B. | Higher calorie containing oral formula |
| C. | Appetite stimulants |
| D. | Growth Hormone |
| E. | Pro-motility agent |
| F. | NG tube feeding |
| G. | G-tube feeding |
| H. | GJ-tube feeding |
| I. | Change to HD |

## Nutritional Options: Oral

- High caloric strength formulas and protein bars/powders
- High calorie and protein diet

*Advantages:*
- No need for surgery

*Disadvantages:*
- Expensive and inability to afford
- Unacceptable taste
- Non-adherence
- In children on PD <2 years, BMI decreased with oral feeding and increased with NG/GT feeding*

## Formula Options

<table>
<thead>
<tr>
<th>Formula</th>
<th>Age Group</th>
<th>Caloric Concentration</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Similac PM 60/40</td>
<td>Infant</td>
<td>20 kcal/oz</td>
<td>Low lytes</td>
</tr>
<tr>
<td>Or breastmilk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renastart</td>
<td>Pediatric</td>
<td>30 kcal/oz</td>
<td>Very low protein, very low lytes</td>
</tr>
<tr>
<td>Novasource Renal (or Nepro)</td>
<td>Adolescent/Adult</td>
<td>60 kcal/oz (54 kcal/oz)</td>
<td>High Protein, low Lytes</td>
</tr>
<tr>
<td>Suplena</td>
<td>Adolescent/Adult</td>
<td>54 kcal/oz</td>
<td>Moderate Protein, low Lytes</td>
</tr>
<tr>
<td>Renalcal</td>
<td>Adolescent/Adult</td>
<td>60 kcal/oz Enteral only</td>
<td>Low protein, Electrolyte Free</td>
</tr>
<tr>
<td>Ensure Clear</td>
<td>Pediatric/Adult</td>
<td>30 kcal/oz</td>
<td>Clear Liquid, no K or Phos</td>
</tr>
<tr>
<td>Blenderized diet</td>
<td>Custom designed recipe to meet nutrient needs via Gtube Limitations- bolus only, food safety, labor intensive</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Pharmacologic Therapies

### CURRENT
- Pro-motility agents
- Appetite stimulants
  - Megestrol acetate
  - Cyproheptadine

### FUTURE
- Ghrelin: Appetite stimulating hormone
  - S/C injections studied in PD patients, found to stimulate food intake over 3\* and 7** days
  - No adverse effects

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**Ashby et al. Kidney Int. 2000; 76:199-206
Enteral Nutrition Support

- Early intervention with enteral supplementation is the key*

<table>
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<tr>
<th>Route</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| NG    | - No surgical intervention  
       | - Easily removed          | - Likely to be pulled out  
       |                       | - Gagging, emesis, GER  
       |                       | - Post-traumatic feeding disorder |
| G-tube | - Best choice for long-term  
        | - Flexibility to give bolus and/or overnight feeds | - Surgical placement  
           |                       | - Risk of infection  
           |                       | - Placing G-tube prior to PD catheter reduces infection risk** |
| GJ tube | - Bypasses stomach, ensures nutrition in those with vomiting | - Slow continuous rate  
           |                       | - Difficult to replace  
           |                       | - May still have retching  
           |                       | - Certain medications can not be given |

* Mekahli et al. Long term outcome of infants with severe CKD. CJASN 2010. 5:10-17.
Case 2- Anuric Child on HD

• 2 year old ESRD, sec to ARPKD, on chronic HD, MWF
• Anuric, s/p bilat nephrectomies
• G-t dependent, refuses PO
• Fluid restriction 500 ml/day
• Caloric needs ~1120/day

What will you do?

A. Hakuna Matata
B. High caloric formula
(70 kcal/oz to meet needs within fluid limit)
C. Increase frequency of dialysis
D. Aggressive PO feeding therapy
E. Concentrated blenderized diet
F. Change to PD
Case 3: BMD affecting Nutrition and Growth

- ESRD sec. to ANCA+ GN at age 3 years
- Chronic HD from age 3 to 10
- Severe osteodystrophy
- Very poor growth, calcifications on HD
- Labs: Ca 11.0, Phosphorus 10.0, iPTH 3,200
- Improved growth post-transplant
Calcifications in soft tissue and arteries

What will you do?

A. Growth hormone
B. Low-phos diet
C. Increase calcium carbonate
D. Change calcium carbonate to sevelamer
E. Increase calcitriol dose
F. Add Cinacalcet
G. C, E and G

2018 ASPN MULTIDISCIPLINARY SYMPOSIUM
Solutions: Bone Management for Growth*

- Limit **phosphorus** intake to 80% of DRI when PTH and phosphorus levels elevated
- **Binders** (calcium vs. non-calcium)
  - Limit calcium intake to 2x DRI
- **25 hydroxy vitamin D**
  - <30 ng/mL - supplement to replete
  - Maintenance dose ≥30 ng/mL
- **Active vitamin D**: initiate when 25-hydroxy D>30 and PTH above target
- **Cinacalcet**: more evidence needed

*KDOQI Guidelines: Nutrition in Children with CKD: 2008*
Bone management - Cinacalcet

An open-label, single-dose study to evaluate the safety, tolerability, pharmacokinetics, and pharmacodynamics of cinacalcet in pediatric subjects aged 28 days to < 6 years with chronic kidney disease receiving dialysis

Winse Y. Sohn, Anthony A. Portale, Isidro B. Sabisky, Hu Zhang, Lucy L. Yan, Bella Erik, Shahnaz Shafikfa, Edward Lee, Bastian Dehnel, Bradley A. Warady

Rivest J. 6 May 2016/Revised: 7 August 2016/Accepted: 16 August 2016
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- 0.25 mg/kg shown to be a safe starting dose in children on dialysis < 6 years old

Cinacalcet as rescue therapy for refractory hyperparathyroidism in young children with advanced chronic kidney disease

Aura J. Armas Morales, Manoja J. Dileep, Chrysa P. Katsoufis, Wacharee Sohersanwong, Jayanthi Chandar, Gaston Ziberou, Michael Freundlich, Carolyn L. Abellin

Revised: 15 February 2016/Revised: 10 August 2016/Accepted: 15 August 2016
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- Cinacalcet may be used effectively and safely in infants/small children with refractory sHPT in advanced CKD. Cinacalcet successfully brings iPTH to target levels and supports growth when other treatments have been ineffective.

Nutritional Challenges Post-Transplant

- Rapid weight gain and obesity
- Metabolic Syndrome
- NODAT
- Phosphorus and magnesium wasting
- Recurrent UTIs, diarrhea related to antibiotics, and alteration of microbiome → inflammation
- Failure to thrive
Improved Growth Post-Transplant

Case: Post-Transplant Obesity
What will you do first?

A. Diet & exercise counseling
B. Depression screening/psychologist referral
C. Weight loss drugs
D. Bariatric surgery
Failure to Thrive Post-transplant

Malnutrition negatively impacts patient outcomes:

- Increased morbidity/mortality
- Increased hospitalization
- Increased risk of infection
- Increased length of stay
- Increased healthcare costs
- Poor cognition
- Decreased quality of life

Early Intervention is KEY!

Optimizing Nutrition

**CKD and ESRD**

- Ensure adequate protein and caloric intake (GT may be needed)
- Adequate dialysis provision
- Control metabolic acidosis and ROD
- GH therapy

**Post-Transplant**

- Screen and counsel for obesity and metabolic syndrome
- Screen and manage NODAT and dyslipidemia
- Phos, mag supplementation
- Bone health
- Bariatric surgery

- Vitamin D and other vitamins and micronutrient supplementation
- Promote aerobic and resistance building exercises.
- Screen and manage depression

**Conclusions- what we want to avoid:**

**Born:** February 8, 1968  
**Died:** May 28, 2010  
**Height:** 4’ 8” (1.42 m)