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Pediatric Nutrition and Kidney Disease

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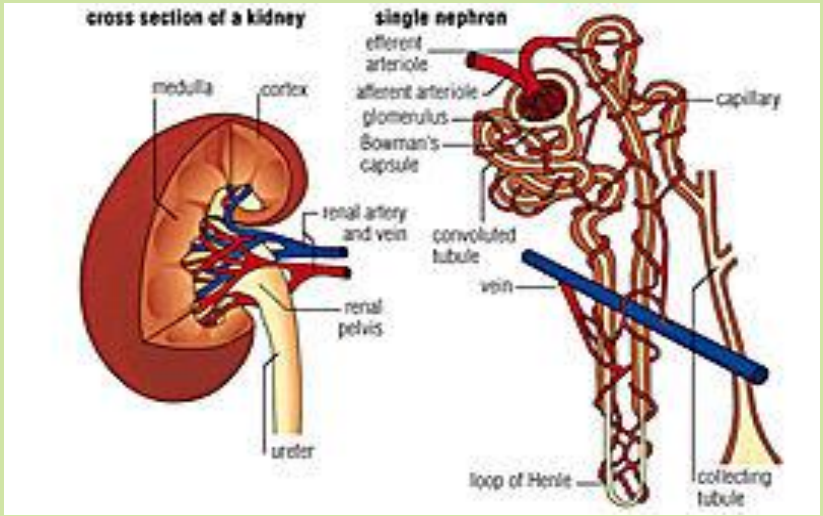
Objectives

- To learn the components of nutrition assessment of the pediatric renal patient
- To understand the factors that contribute to poor nutrition and growth among children with kidney disease
- To know nutrient recommendations for children in different stages of chronic kidney disease and renal replacement therapy

Chronic Kidney Disease (CKD)

- Normal GFR is 100-120 ml/min per 1.73 m^2
- Stage 1: Kidney damage GFR $\geq$90
- Stage 2: GFR 60-89
- Stage 3a: GFR 45-59
- Stage 3b: GFR 30-44
- Stage 4: GFR 15-29
- Stage 5: GFR <15 (ESRD)



Causes of Pediatric ESRD: 2006-2010

CAUSE	Incidence (Percentage)
Cystic/Congenital malformations	35%
Glomerular Disease (e.g. FSGS)	23.2%
Secondary Glomerular Disease/Vasculitis	11.3%
Interstitial nephritis/pyelonephritis (chronic)	5.2%
Hypertensive/large vessel disease	5%
Diabetes Mellitus	2%
Neoplasms/Tumors	2%
Complications of transplant	1.1%
Miscellaneous (e.g. SCD, HIVAN)	6.3%
Unknown	9.7%
Missing data	3.9%

Source: USRDS (usrds.org)-2012

Goals of Nutrition Therapy in Pediatric Renal Disease

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

Growth in Chronic Kidney Disease

Factors that impact growth include:

- ✓Poor nutrition
- ✓Sodium wasting
- ✓Renal osteodystrophy
- ✓Corticosteroids therapy
- ✓Metabolic acidosis
- ✓Growth hormone (GH) resistance

Growth in Chronic Kidney Disease

- Nutrition is primary factor during infancy
- Growth hormone during childhood
  - Decreased production of IGF-1
  - Decreased expression and function of growth hormone receptor
- Sex hormones during adolescence
- Nutrition support proven to improve growth in infants (no clear evidence in older children)

Kari J et al. Kidney Int 57:1681-1687, 2000.
Karlberg et al. Pediatr Nephrol 10:283-287, 1996.

Body Composition

- Studies suggest lean mass deficit and excess fat mass relative to height in children with CKD
- GH therapy may promote lower fat mass and greater lean mass for height in these children

Rashid et al. Pediatr Nephrol 21:1730-1738, 2006

Growth Hormone Therapy

- RCTs have shown benefit of rGH in children with CKD (ht SDS and growth velocity)
- International database of 240 children on rGH
  - Demonstrated continuous catch up growth
  - 40% reached normal adult height

Nissel et al. J Endocrinol Metab 2008. 93:1359-1365.

Growth Hormone Therapy

Indicated for children with kidney disease when:

- Height or growth velocity SDS score < -1.88
- No metabolic acidosis (C02 $\geq$ 22)
- Growth potential documented by open epiphyses and good bone health (PTH within acceptable range)
- Adequate nutritional status…but how is this defined?

Defining Malnutrition

- World Health Organization defines as wt/age, ht/age, and wt/ht $\leq$ -2 SDS for general pediatric population
- Definitions may not apply to children with CKD due to many non-nutritional causes of stunting and delayed maturation
- Wt/age SDS may not accurately reflect nutritional status and must be evaluated in context of ht/age (BMI for age, BMI for ht-age, or wt/length)

Nutrition Assessment: Parameters to be monitored

- Dietary intake (3 day record or recall)
- Est dry weight-for-age %ile/SDS
- Ht-for-age %ile/SDS and growth veloceity
- BMI-for-height-age %ile or SDS
- Head circumference-for-age %ile/SDS (≤3yrs)
- Normalized protein catabolic rate (nPCR)

Malnutrition in Kidney Disease

Altered/decreased taste sensitivity

- Accumulation of uremic toxins
- Micronutrient deficiencies (Zinc)
- Decreased # of taste buds

Reduced appetite and nutritional intake

- Unpalatable prescribed diet and binder regimens/ restriction of favorite foods due to low sodium, potassium, and phosphorus diets
- Delayed gastric motility, reflux, and vomiting
- Uremic inflammation
- Alterations in hormonal and neuropeptide signaling

Astback et al. Perit Dial Int. 1999;19 S 2:S315-23.

Malnutrition in Kidney Disease

- Dialysis procedure may promote wasting:

  - AA, peptides, protein, glucose, water- soluble vitamins, and other bioactive compounds

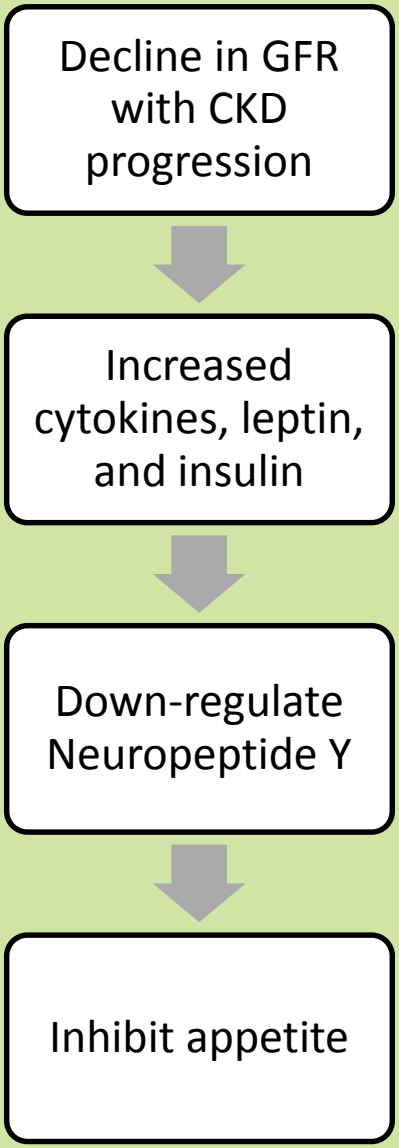
- Polyuria and urinary wasting:

  - Sodium and other electrolytes

- Chronic Inflammatory state

  - Hypercatabolism, anorexia, and increased cytokines.

Neuropeptide Alterations and Appetite



The “Renal Diet”

- There is not a standard “Renal Diet”
- Individualized dietary recommendations determined based on:

  ✓GFR and diagnosis
  ✓Age and sex
  ✓Protein and energy status
  ✓Growth parameters
  ✓Fluid status: urine output, electrolyte-wasting
  ✓Oral motor skills
  ✓Renal Replacement Modality

NFK KDOQI Clinical Practice Guideline for Nutrition in Children with CKD: 2008 Update

Nutrient Needs in **CKD Pre-dialysis**

Nutrient	Estimated Need
Calories	100% EER chronological age (Calculated per equations)
Protein	100 -140% of DRI (stage 3) 100 – 120% of DRI (stage 4 & 5) Avoid excessive intake
Sodium / Fluid	Supplement or restrict
Potassium	Restrict if levels elevated (1-3 mEq/kg/d)
Phosphorus	100% DRI in early CKD 80% DRI when phos elevated

KDOQI Clinical Practice Guideline for Nutrition in Children with CKD: 2008 update.

Fluid and Sodium Dichotomy in CKD

- Chronic intravascular depletion and impaired growth will occur in children with polyuric salt-wasting CKD, so supplemental NaCl and fluid are needed

- Conversely, fluid and sodium restriction may be needed in children with hypertension, nephrotic syndrome, and/or oliguira

Parekh et al. JASN 2001:12:2418-2426

Factors to Consider in Determining Pre-dialysis Protein Needs

- **Nutrition intervention with low protein diet does not delay progression of renal failure in children**
- **Concern over possible harms of strict low protein diet effect on growth in infants**
- **Excess protein intake contributes to uremia and metabolic acidosis**

Factors to Consider in Determining Pre-dialysis Protein Needs

Increased protein intake correlates with

- **Increased phosphorus load**
- **Increased risk of calcifications and bone disease**

Zerbi S et al. JCEM 2008;93:1121-1122

Potential Renal Solute Load (PRSL)

- The PRSL refers to all solutes of dietary origin that require excretion by the kidney

- **PRSL= N (mg)/28 + Na + Cl + K + Pa**

  Electrolyte units in mM, Pa=total mM phos in milk-based formulas or 2/3 of soy formulas; N(g)= g protein/6.25

Potential Renal Solute Load

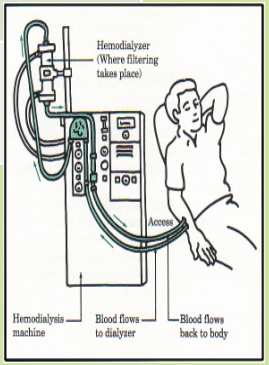
- For patients with decreased renal concentrating ability, choose formula with low PRSL

- PRSL of:
  - Whole cows milk= 46 mOsm/100 kcal
  - Soy infant formula= 24 mOsm/100 kcal
  - Milk infant formula= 20 mOsm/100 kcal
  - **Human breast milk= 14 mOsm/100 kcal**

Nutrient Needs in ESRD

Hemodialysis

Nutrient	Amount
Calories	100% EER chronological age
Protein	100%DRI + Dialytic losses (0.1 g/kg/d)
Sodium	Restrict (usual 2g/d)
Potassium	Restrict 1-3 mEq/kg/d
Phosphorus	Limit to 100%DRI (80% DRI when elevated)
Fluid	Replace UOP + other losses

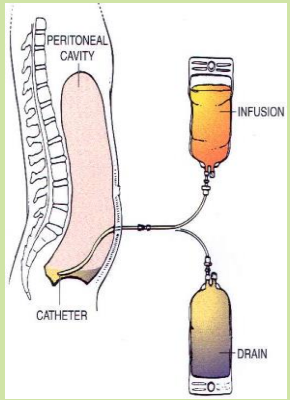


Normalized Protein Catabolic Rate (nPCR)

- Calculated measure of dietary protein intake per kg of patient weight
- Trends in nPCR have been shown to correlate with changes in dry weight in adolescent HD patients
- nPCR should be monitored monthly and targeted to age-specific protein guidelines for HD
- Modified Borah equation= 5.43x G/V1 + 0.17

Nutrient Needs in ESRD
Peritoneal Dialysis

- Calories: usual for chronological age – calories absorbed from PD solution (~40%)
- Protein: 100%DRI + dialytic losses
  - Losses range from 0.15-0.3 g/kg/d depending on age
- Fluid and Electrolytes: Individualize therapy
- Phosphorus: limit to 100% DRI (80% DRI when elevated)
- Potassium restriction rarely needed



Estimating Kcals Absorbed from PD

- Multiply total dialysate volume (24hrs) x concentration of dextrose solution (1.36%, 2.27%, or 3.83%) = Total grams of dextrose
- Multiply total grams of dextrose by estimated absorption (40% for CCPD; 43% +/-15% absorbed for acute PD in critical care setting)
- Multiply grams dextrose by 3.4 Kcal/gram

Podel et al. J Renal Nutrition 10:9307, 2000.

KDOQI: Protein Recommendations

Table 12. Recommended Dietary Protein Intake in Children with CKD Stages 3 to 5 and 5D

	DRI				
Age	DRI (g/kg/d)	Recommended for CKD Stage 3 (g/kg/d) (100%-140% DRI)	Recommended for CKD Stages 4-5 (g/kg/d) (100%-120% DRI)	Recommended for HD (g/kg/d)*	Recommended for PD (g/kg/d)†
0-6 mo	1.5	1.5-2.1	1.5-1.8	1.6	1.8
7-12 mo	1.2	1.2-1.7	1.2-1.5	1.3	1.5
1-3 y	1.05	1.05-1.5	1.05-1.25	1.15	1.3
4-13 y	0.95	0.95-1.35	0.95-1.15	1.05	1.1
14-18 y	0.85	0.85-1.2	0.85-1.05	0.95	1.0

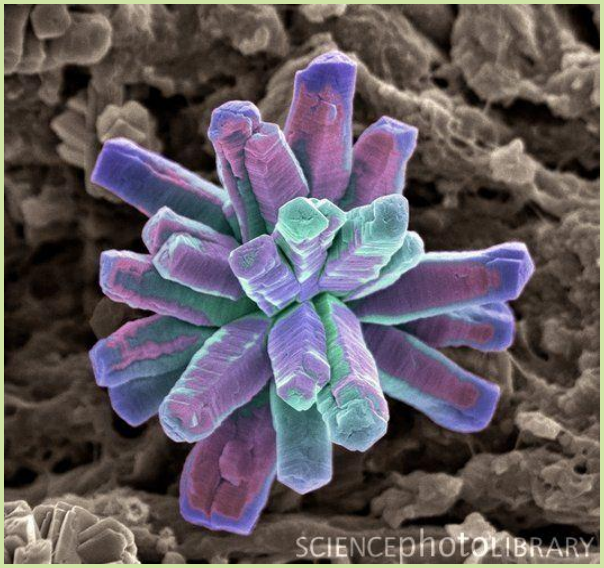
*DRI + 0.1 g/kg/d to compensate for dialytic losses.
†DRI + 0.15-0.3 g/kg/d depending on patient age to compensate for peritoneal losses.

NFK KDOQI Clinical Practice Guideline for Nutrition in Children with CKD: 2008 Update

Bone Management: Calcium CKD and Dialysis

- Minimum calcium intake: 100% DRI from diet + binders
- Maximum calcium: 200% DRI from diet + binders

AGE GROUP	DRI (mg/d)	MAX Calcium Intake (200%)
0-6 mon	200	400
6-12 mon	260	520
1-3 years	700	1400
4-8 years	1000	2000
9-18 years	1300	2600



Bone Management: Phosphorus

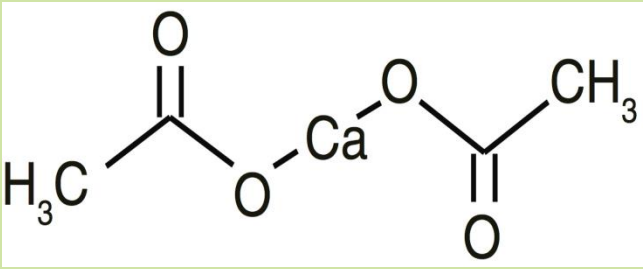
Limit intake to 80% of DRI when PTH and PHOS are elevated

AGE	PHOS DRI (mg/d)	HIGH PTH, HIGH Phos Limit (mg/d)
0-6 mon	100	80
6-12 mon	275	220
1-3 years	460	370
4-8 years	500	400
9-18 yrs	1250	1000

Phosphorus Binders

Calcium Based

- Calcium carbonate
- Calcium acetate
- Calcium carbonate suspension



Non-Calcium Based

- Renagel (Sevelamer hydrochloride)
- Renvela (Sevelamer carbonate)
- Fosrenol (Lanthanum carbonate)*

http://excelchemistry.wikispaces.com/Lanthanum

Vitamins and Trace Elements
CKD Stage 3-5 and Dialysis

CKD 3-5: goal to meet 100% DRI from diet for all vitamins, copper, and zinc; supplement only if deficient

Dialysis: add a daily water soluble vitamin supplement (dose for age):

- Nephrovite (tablet)
- Nephrocap (capsule)
- Nephronex (liquid)

Vitamin D
CKD and Dialysis

- 25-OH Vitamin D: monitor levels yearly; if <30, supplement with cholecalciferol or ergocalciferol

  5-15 ng/dL: 4000 Units/d x 12 weeks

  16-30 ng/dL: 2000 Units/d x 12 weeks

- 1,25-OH Vitamin D: initiate when serum PTH above target range for CKD stage

CKD Stage	GFR Range	Target PTH (pg/ml)
2	60-89	35-70
3	30-59	35-70
4	15-29	70-110
5	<15	200-300

Nutrition After Renal Transplantation

- Goal is to meet nutritional requirements while minimizing comorbidities associated with chronic immunosuppressive medications:

✓ Rapid weight gain/obesity
✓ Dyslipidemia
✓ Hypertension
✓ Post-Transplant diabetes mellitus
✓ Steroid- related osteoporosis

Dietary Modifications After Transplant

- Frequent dietary counseling to manage post-transplant weight gain, especially in the first 6 months
- Healthy diet with emphasis on limiting intake of saturated fats, simple sugars, and sodium
- Calcium and Vitamin D intake should meet 100% DRI

THANK YOU!