Nutritional management of children with CKD

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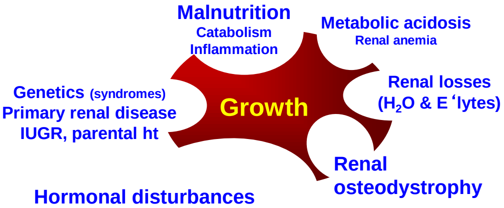
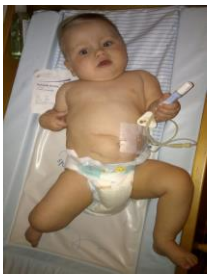
Pathophysiology of growth failure in CKD



Hormonal disturbances
GH- / IGF1- insensitivity
Hypergonadotropic hypogonadism (hypothyroidism)
Glucocorticoid treatment

Outline



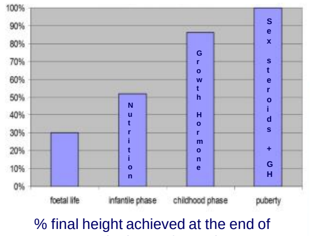
- Why bother?
- Enteral feeding
- Gastrostomy insertion
- What the guidelines recommend
- Case study

Why focus on nutrition?

"The dialysis is easy, it's the feeding that is difficult"
Alan Watson; 2006

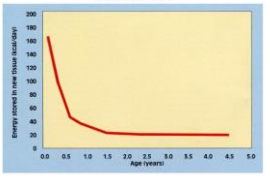
- Energy cost of growth 35% at 1 m, 3% at 12 m and 4% at puberty. Growth velocity sensitive indicator of energy status *(Butte et al 2000)*
- Serum albumin is a strong predictor of clinical outcome in children on dialysis *(Wong et al 2002)*
- Short stature at start of dialysis is a marker for poor outcome *(Furth et al 2002)*

Phases of growth



% final height achieved at the end of each phase of growth

Calories per day incorporated into new tissue



Growth pattern and dietary intake in children with CKD

>80% DRI → *normal* growth

<80% DRI → *reduced* growth velocity

<40% DRI → *cessation* of growth

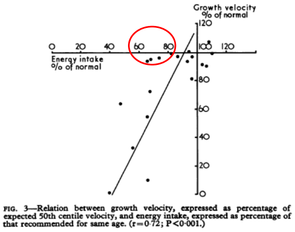


FIG. 3—Relation between growth velocity, expressed as percentage of expected 50th centile velocity, and energy intake, expressed as percentage of that recommended for same age. (r=0·72; P<0·001.)

Betts and Magrath; BMJ 1974

Causes of poor nutritional intake

In CKD

- ↓ Appetite:
  - Altered taste sensation
  - Multiple medications
  - Polyuria
  - Hormonal regulation of appetite and satiety
- Vomiting
  - Gastro-oesophageal reflux
  - Abnormal gastrointestinal motility due to elevated polypeptide hormones
- Disturbed feeding history
- Co-morbidities

On dialysis

- Fluid restriction
- Dialysate losses
- Peritoneal dialysis
  - Full abdomen and constipation

Altered gastrointestinal motility and appetite control

Polypeptide hormones

- cholecystokinin - delays gastric emptying / satiety
- gastrin - initiates post prandial motor activity

Ravelli AM Arch Dis Child 1992

Cytokines

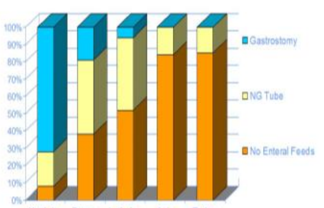
- leptin - regulator of food intake & energy homeostasis
  Increase levels in CRF / *reduce* appetite / *increase* metabolic rate
- ghrelin - appetite regulator ?role in CRF

Mak RH et al KI 2012

IPPN Infant Growth and Nutrition Study

153 children <2 years

- 41% of the patients were enterally fed
- Gastrostomy feeding was almost exclusively in the US and Europe



IPPN data

The advantages of gastrostomy feeding

- Improvement in vomiting, appetite, nutrition and growth
- No interference with oromotor skills
- Ease of administration of medications (and fluids post transplant)
- Hidden under clothes

% time with gastrostomy feeding was an important predictor of longitudinal growth

Final assessment	Demand	NG	Gastrostomy
Ht SDS	-2.7	-2.9	-1.7

International Pediatric Peritoneal Dialysis Network, JASN 2011

PEG tube

Open gastrostomy

Gastrostomy placement techniques

Open (Stamm) procedure

Percutaneous

Blind procedures

Surgical team

Endoscopy+/- laparoscopy (PEG)

Interventional radiology

Antegrade fluoroscopically guided
or
Retrograde placement

High risk of gastric contents spilling into peritoneum

Timing of gastrostomy insertion in the child on PD

- Before PD catheter insertion
- At the same time as a PD catheter insertion
- After commencing PD

High risk if endoscopic insertion of gastrostomy in a child on PD

Authors, year of publication	Peritonitis	PD catheter replacement
Schnakenburg et al, 2006	PEG Peritonitis – 10/27 (37%) Fungal - 7/27 (26%)	PEG – 8/27 - 4 transferred to HD - 2 deaths
Ledermann et al, 2002	Open - 1/9 PEG - in 4/5 pts (1-5 days post-op) - 1 fungal peritonitis	Open– 4/9 (1 related to g-tube) PEG - PD cath removed in 3/5 pts - 3 transfer to HD
Ramage et al, 1999	Pre G-tube – 6 per pt-mt Post G-tube- 8 per pt-mt	Pre G-tube – 0 Post G-tube - 12

K/DOQI 2008 Guidelines

- Ideally, placement of a g-tube should occur before PD catheter placement.
- The placement of a PEG while on PD is discouraged.
- **An <u>open</u> gastrostomy, can be performed safely in children on PD therapy with suitable precautions**.
- No evidence of an increased incidence of bacterial or fungal peritonitis with an established gastrostomy.
- Higher risk of infections after PEG insertion in malnourished children

Case based discussions

Case

- Male infant with PUVs and dysplastic kidneys
- Born at 38 weeks, birth weight of 2.1 kg, length 45 cm and head circumference 31cm (all 2nd centile).
  No respiratory support needed.
- The baby was catheterised at birth and passed 2- 3 mls/kg/hour of urine

Options: Would you

- Keep nil by mouth
- Withhold milk feeds and start clear fluids
- Start a low electrolyte feed if the mother does not want to breast feed
- Encourage breast feeding if that is what the mother wants to do
- Start a normal baby formula if the mother does not want to breast feed

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- Withhold milk feeds and start clear fluids
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- **Start a normal baby formula if the mother does not want to breast feed**

Case

- Support the mother in breast feeding or use a standard whey based infant formula
- The baby will need 2 to 3 hourly feeds in order to take adequate nutrition to maintain growth
- If the intake from breast feeding alone is inadequate (static weight) offer a standard infant formula by bottle as a supplementary feed

Age	Energy (kcal/kg)	Protein (g/kg)	Feed volume (ml/kg)
0-2 months	96-120	2.1	150-180

Energy requirements - KDOQI

Energy	100% Estimated Energy Requirements for chronological age Individually adjust for physical activity level & body size Adjust energy intake ..based upon the response in rate of weight gain or loss

Age	EAR (kcal/day)	EER (kcal/day)	EAR v. DRI
0-6 months	598	550	↑
7-12 months	892	710	↑
1-2 years	855	1019	↓
3-8 years	1448	1692	↓
9-13 years	2067	2175	↓
14-18 years	2672	2760	↓

Regular review of the dietary prescription is essential

Infant with CKD 5

- Expected weight gain 200gm per week
- So, if weight ↑ from 3.5 to 3.9 kg over 2 weeks
  - o Protein needs to increase from 8.75 to 9.75g
    - ➢(based on 2.5gm protein/kg/day)
  - o Calories from 490 to 546
    - ➢(based on 140cals/kg/day)
  - o Volume from 525 to 585mls
    - ➢(based on 150ml/kg/day)

Frequency of Nutrition Assessment

Table 1. Recommended Parameters and Frequency of Nutritional Assessment for Children with CKD Stages 2 to 5 and 5D

	Minimum Interval (mo)									
	Age 0 to <1 y			Age 1-3 y			Age >3 y			
Measure	CKD 2-3	CKD 4-5	CKD 5D	CKD 2-3	CKD 4-5	CKD 5D	CKD 2	CKD 3	CKD 4-5	CKD 5D
Dietary intake	0.5-3	0.5-3	0.5-2	1-3	1-3	1-3	6-12	6	3-4	3-4
Height or length-for-age percentile or SDS	0.5-1.5	0.5-1.5	0.5-1	1-3	1-2	1	3-6	3-6	1-3	1-3
Height or length velocity-for-age percentile or SDS	0.5-2	0.5-2	0.5-1	1-6	1-3	1-2	6	6	6	6
Estimated dry weight and weight-for-age percentile or SDS	0.5-1.5	0.5-1.5	0.25-1	1-3	1-2	0.5-1	3-6	3-6	1-3	1-3
BMI-for-height-age percentile or SDS	0.5-1.5	0.5-1.5	0.5-1	1-3	1-2	1	3-6	3-6	1-3	1-3
Head circumference-for-age percentile or SDS	0.5-1.5	0.5-1.5	0.5-1	1-3	1-2	1-2	N/A	N/A	N/A	N/A
nPCR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1*

Abbreviation: N/A, not applicable.
*Only applies to adolescents receiving HD.

NFK KDOQI : 2008 Update

Days 4 to 5

- Urinary sodium high
- Decreasing weight and BP
- Plasma changes below

Day of life	Na mmol/l	K mmol/l	HCO3 mmol/l	Urea mmol/l	PO4 mmol/l	Ca mmol/l	Creatinine mcmol/l	Wt kg
1	130	4.8	28	3.4	2.0	2.32	100	2.1
2	128	5.4	24	6.8	2.16	2.18	120	2.0
3	126	5.8	20	8.0	2.26	2.10	140	1.9
4	124	6.0	18	10.0	2.41	1.96	160	1.8

Options: Would you

- Give it a bit more time
- Stop the breast feeding and change to formula
- Insert a nasogastric tube to provide the daily nutritional requirements as top up to oral feeds
- Insert a nasogastric tube to provide the daily nutritional requirements as formula and allow breast feeds as 'extra'
- Start a sodium supplement
- Start sodium bicarbonate

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Day 5

- Calcium 1.96 mmol/l
- Phosphate 2.41mmol/l
- PTH 30 pmol/l
- Alkaline phosphatase 400u/l

- The calcium intake is 200mg/day
- The feed provides 1.2mcg 25(OH)D per 100mls
- The phosphate intake is 80mg

Options: Would you

- Increase the calcium intake
- Restrict the phosphate intake
- Give 25(OH)D
- Give 1,25(OH)D3
- Give calcium carbonate or calcium acetate
- Give sevelamer

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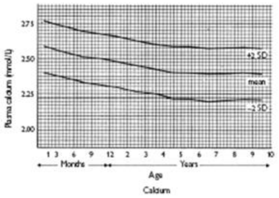
Management of calcium balance and control of bone disease

- The daily calcium balance in the first year of life is 500-600g, which is higher than at any other age
- Upper and lower limits of RNI are 524mg and 240mg/day
- Standard whey based formula has approx 5mg/ml of calcium
- We do not know how much calcium is absorbed from calcium containing PO4 binders
- The normal range for calcium is high in the first year of life



Serum Calcium levels

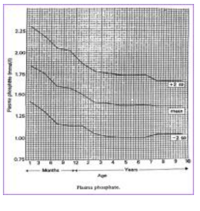
NEW 4.1.3: In children with CKD Stages 3a–5D, we suggest maintaining serum calcium in the age-appropriate normal range. (2C)

In children with CKD Stages 3a–5D, it is reasonable to base the choice of phosphate -lowering treatment on serum calcium levels.
(Not Graded)

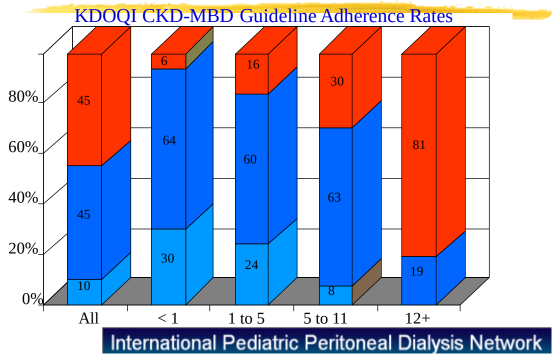
In children, calcitriol and vitamin D analogs may be considered to maintain serum calcium levels in the age-appropriate normal range (Not Graded).

Phosphate

- Upper limit for intake is 400mg
- Serum phosphate is high in infancy
- Phosphate content is low:
  - Breast milk 14mg/100ml
  - Whey based infant formulas on average 27mg per 100ml
- Phosphate binders may still be required



High P levels in 45% of PD patients



Serum Phosphate

NEW 4.1.1: In patients with CKD Stages 3a–5D, treatments of CKD-MBD should be based on serial assessments of phosphorus, calcium and PTH levels, considered together. *(Not Graded)*

NEW 4.1.2: In patients with CKD Stages 3a–5D, we suggest lowering elevated phosphorus levels towards the normal range. *(2C)*

It is reasonable to consider phosphate source (e.g., animal, vegetable, additives) in making dietary recommendations. *(Not Graded)*

ESPN recommendations on native and active vitamin D therapy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ndt
Nephrology Dialysis Transplantation

Special Report

Clinical practice recommendations for native vitamin D therapy in children with chronic kidney disease Stages 2–5 and on dialysis

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Case

- The weight and BP increase.
- Urine output falls to 0.5/ml/kg/hr
- There is oedema
- The bloods deteriorate

Day of life	Na mmol/l	K mmol/l	HCO3 mmol/l	Urea mmol/l	PO4 mmol/l	Calcium mmol/l	Creatinine mcmol/l	Wt kg
5	124	6.2	20	10.0	2.3	1.96	160	2.0
6	122	6.4	19	14.0	2.5	1.94	190	2.2
7	120	6.6	18	16.0	2.8	1.90	220	2.3

Options: Would you

- Change all feed to a low electrolyte formula (e.g. Renastart)
- Substitute some of the whey based formula with a low electrolyte formula
- Add in proprietary vitamins
- Start dialysis

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Low electrolyte feeds

Feed:180ml/kg for 2.3kg baby = 410ml	Energy (kcal)	Protein (g)	Potassium (mmol)	PO4 (mg)
410ml 13% typical standard infant formula	275 (120/kg)	5.2 (2.2/kg)	6.6 (2.9/kg)	98
410ml 13% Renastart renal infant formula	262 (114/kg)	4.1 (1.8/kg)	2.5 (0.96/kg)	49
50:50 mixture	269 (117/kg)	4.7 (2.0/kg)	4.6 (2.0/kg)	74

Case

- Good fluid balance but weight static

Results

HB 10.4g/dl
TSAT 30%
Na 138mmol/l
K 4.0 mmol/l
HCO3 27mmol/l
urea 5.2mmol/l
Creatinine 280mcmol/l
albumin 28g/l
Ca 2.5mmol/l
P 1.8mmol/l
PTH 5.6pmol/l

Medications

Erythropoietin 500u x 2 per week
Sytron 1ml daily
Calcium carbonate 250mg with each feed
1,25(OH)2D 0.2mcg daily
NaCl 1mmol/kg x 2 daily

Dialysis CCPD

16 hours, 14 cycles
Fill volume 800ml/m2
Last bag fill 400ml/m2
All 1.36% dialysate

Options: Would you

- Increase the dialysis
- Change any of the medications
- Increase the protein and calorie content of the feed
- Concentrate the feeds
- Add a vitamin and mineral supplement
- Start growth hormone

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Concentrating feeds to meet protein requirements for PD

- Aim for a urea < 20mmol/l, normal serum albumin and normal growth
- 160ml/kg for 2.3kg baby = 370ml
- Replace 0.28g/kg/day transperitoneal protein losses
- Increase energy intake
- The normal feed concentration of 13% is increased to 16%

Feed 160ml/kg for 2.3kg baby = 370ml	Energy (kcal)	Protein (g)	K (mmol)	PO4 (mg)
185ml 17% concentrated standard infant formula	162	3.1	3.9	58
185ml 15% concentrated Renastart renal infant formula	136	2.1	1.3	25
per kg	129	2.26	2.3	83

Protein intake - KDOQI

Protein	Stage 3: 100% - 140% Dietary Reference Intake (DRI) for ideal body weight Stage 4 - 5: 100% - 120% DRI for ideal body weight HD DRI + 0.1 g/kg/d PD DRI + 0.15-0.3 g/kg/d (depending on patient age to compensate for peritoneal losses)

Age	DRI (g/kg/d)	HD (g/kg/d)	PD (g/kg/d)
0-6 months	1.5	1.6	1.8
7-12 months	1.2	1.3	1.5
1-3 years	1.05	1.15	1.3
4-13 years	0.95	1.05	1.1
14-18 years	0.85	0.95	1.0

Case

- The baby continues to vomit with static growth despite
  - a continuous drip feed
  - maximum concentration of feeds
  - medications
  - optimised dialysis

Options: Would you

- Consider total parenteral nutrition
- Arrange a percutaneous gastrostomy
- Arrange a surgically placed gastrostomy

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Who is offered rhGH?

Most centres would offer rhGH to children with

• Ht SDS < -2SD and

• Ht velocity SDS < 25th centile despite optimal medical management

Factors affecting response to rhGH

- age
- Ht SDS and Ht velocity SDS
- severity of CKD, both before and after transplant
- adequacy of dialysis
- steroid therapy and dosage
- nutrition and metabolic control
- compliance

Cochrane Renal Group review of rhGH

10 RCTs involving 481 children

- 28 IU/m²/week for 1 year results in an average height increase of 4 cm regardless of pubertal stage and severity of CKD
- any benefit of continuing treatment is uncertain
- it is not known if the increase in height over one year will increase final height
- side effects are no different to controls

Conclusions

- Careful attention to nutritional requirements and early intervention is critical to prevent malnutrition rather than treat it.
- Input from a paediatric renal dietitian is essential
- Enteral feeding improves growth in (many) children on dialysis
- Caution with gastrostomy placement in children on PD
- Protein requirements increase in the child on PD and must be frequently monitored

Thank you!