

Protein intake in children

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GUIDELINES

- a. **Children with chronic kidney disease should have a protein intake equivalent to or above the Food and Agriculture Organisation/ World Health Organisation/ United Nations University (FAO-WHO-UNU) recommendations for healthy children. (Level II evidence)**

SUGGESTIONS FOR CLINICAL CARE

(Suggestions are based on Level III and IV sources)

- **From nitrogen balance studies in 31 children on automated peritoneal dialysis (APD), it has been estimated that these children required a protein intake of 144% of WHO recommendations and an energy intake of 89% of recommended energy intake (REI) for height age to achieve a nitrogen balance of 50 mg/kg/day (Edefonti et al 1999). Nitrogen balance should be corrected for dietary protein and energy intake.**
- **Studies in 15 children on continuous ambulatory peritoneal dialysis (CAPD) found that protein losses of 0.22–0.28 g/kg/day occur in infants and children aged below 6 years and were significantly higher than the losses of 0.09–0.19 g/kg/day seen in older children (Broyer et al 1983).**
- **Studies in children on CAPD found that protein losses correlated inversely with body weight, body surface area and serum albumin levels (Salusky et al 1983, Quan & Baum 1996). Infants had peritoneal protein losses/m² body surface area (BSA) two-fold higher than children weighing more than 20 kg.**
- **Recommendations for protein intake in children on haemodialysis are based on nitrogen balance studies in adults (Slomowitz et al 1989).**

Background

Children with chronic kidney disease (CKD) or end-stage kidney disease (ESKD) receiving dialysis treatment frequently experience reduced linear growth and poor weight gain. In addition, they are significantly protein-depleted for chronological age (Baur et al 1994).

The optimal protein requirements of infants and children with CKD or ESKD have not been defined. It is generally recommended that infants and children with CKD should receive a protein intake equivalent to FAO-WHO-UNU recommendations for

chronological age (Food and Agriculture Organisation & World Health Organisation 1985). The FAO-WHO-UNU recommendations assume that all protein received is of high biological value and are based on the requirement of 97.5% of the population. To allow for peritoneal protein losses, it is recommended that infants and children on peritoneal dialysis should receive a protein intake equivalent to 100% FAO-WHO-UNU recommendations for chronological age with an additional increment of 0.5–1.0 g/kg/day. It is recommended that infants and children on haemodialysis should receive 100% FAO-WHO-UNU recommendations for protein for chronological age with an additional increment of 0.4 g/kg/day.

Children with CKD in developed countries have a protein intake higher than FAO-WHO-UNU recommendations (Foreman et al 1996, Rättsch et al 1992, Wingen et al 1997).

The objectives of this guideline are to review the available evidence for the benefits and adverse effects of recommended protein intakes in children with CKD or ESKD.

Search strategy

Databases searched: Medline (1996 to November Week 2 2003) and Embase (1980 to November 2003). MeSH terms for kidney disease were combined with MeSH terms and text words for protein intake. The Cochrane Renal Group Specialised Register of randomised controlled trials was also searched for relevant trials not indexed in Medline.

Date of searches: 1 December 2003.

What is the evidence?

A multicentre European randomised controlled trial (RCT), with 2-year follow up data on 191 of 226 randomised children, demonstrated that children with mild to moderate CKD, who received protein and energy intakes of 125% and 81% of WHO-FAU-UNU recommended amounts, did not differ significantly in height and weight standard deviation score (SDS) at baseline or at 2 years, from children with protein and energy intakes of 181% and 88% (usual intakes for children in Western Europe). In addition, the degree of renal functional deterioration did not differ significantly between the two groups (see Appendices) (Wingen et al 1997, Wingen et al 1992, Wingen 1993, Kist-van Holthe tot Echten et al 1993).

A multicentre RCT, with a 10-month follow up of 24 infants, showed that infants assigned to a protein intake of 1.4 gm/kg/day (100% FAO-WHO-UNU) grew slightly but not significantly less well in absolute length (mean difference: -2.4 cm; 95% CI -5.6,0.8) compared with children assigned to a protein intake of 2.4 gm/kg/day (protein content of standard infant milk formulae); weight gains in the 2 groups were similar (see Appendices) (Uauy et al 1994, Holliday et al 1993). During the second 6 months of the study (ages 12–18 months), the length velocity SDS in control patients was -0.1 SD whereas it was -1.0 SD in the low protein group. The interaction of diet group and time was significantly different (ANOVA 0.069). Energy levels in both

groups were 92% of RDA but one-third of infants received below 80% RDA on one or more occasions during the study.

Change in renal function did not differ between groups (Appendices). However, the short duration of the trial and the usual slow deterioration in renal function in infants mean that a difference in the rate of renal deterioration cannot be completely excluded.

Summary of the evidence

In children with CKD and aged over 2 years, growth rates did not differ between children receiving a protein intake close to the FAO-WHO-UNU recommendations and those receiving the standard protein intake in a Western European diet. In relation to growth and renal function deterioration, there appears to be no benefit to reducing protein intake below the standard intake in developed countries.

In infants, growth in length was reduced in those given a low protein intake. However, energy levels were often below recommended levels and protein use for growth is lower when energy intake is deficient since amino acids are used as energy sources. Hence, this study does not determine whether infants with CKD need a higher protein intake than is outlined in the FAO-WHO-UNU recommendations.

What do the other guidelines say?

Kidney Disease Outcomes Quality Initiative: Children treated with haemodialysis should have their initial dietary protein intake based on their recommended daily allowance (RDA) for chronological age with an additional increment of 0.4 g/kg/day (Evidence and Opinion). Children on peritoneal dialysis should have their initial dietary protein intake based on their RDA for chronological age with an additional increment based on anticipated peritoneal losses. No recommendations for children with CRF.

British Renal Association: No recommendations for children.

Canadian Society of Nephrology: No recommendations for children.

European Best Practice Guidelines: No recommendations for children.

Implementation and audit

Data on height, weight and head circumference in relation to energy, protein and sodium intake and the number of children who require nutritional supplementation by enteral feeding could be collected and analysed by paediatric renal dietitians and members of the Australian & New Zealand Paediatric Nephrology Association (ANZPNA).

Suggestions for future research

Further studies using total body nitrogen measurements should be performed to assess the impact of alterations in protein and energy intake on nitrogen accretion and growth.

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Appendices

Table 1 Characteristics of included studies

Study ID (author, year)	N	Study Design	Setting	Participants	Intervention (experimental group)	Intervention (control group)	Follow up (months)	Comments
Wingen 1997 Wingen 1993 Wingen 1992 Kist-van Holthe tot Echten 1993	Total 226 191 finished 2 yrs; 112 completed 3 yrs	Randomised controlled trial	European Multicentre, Universities	Age 2–18 yrs Creatinine clearance 15–60 mL/min/1.73m ² , Stratified by primary renal disease and rate of deterioration of renal function	Protein intake 0.8–1.1 gm/kg depending on age	No restriction on protein intake	2 yrs, optional to 3 yrs	Both groups advised to take 70% of WHO recommended energy intake = 80% RDA of US-FDA
Uauy 1994 Holliday 1993	Total 24; all completed	Randomised controlled trial	Multicentre, USA Universities	Age ≤ 8 mths GFR < 55 mL/min/1.73m ²	Protein intake 1.4 gm/kg/day to give protein: energy ratio of 5.6	Protein intake 2.5 gm/kg/day to give protein: energy ratio of 10.4	1 yr	Both groups prescribed 100%–120% of RDA for length prescribed

Table 2 Quality of randomised trials

Study ID (author, year)	Method of allocation concealment	Blinding			Intention-to-treat analysis	Loss to follow up (%)
		(participants)	(investigators)	(outcome assessors)		
Wingen 1997 Wingen 1993 Wingen 1992 Kist-van Holthe tot Echten 1993	Unclear	No	No	Not stated	No	8.4
Uauy 1994 Uauy 1989 Holliday 1993	Unclear	Yes	Yes	Yes	Yes	0

Table 3 Results for continuous outcomes in RCTs

Study ID (author, year)	Outcomes	Intervention group (mean [SD])	Control group (mean [SD])	Difference in means [95% CI]
Wingen 1997 Wingen 1992 Kist-van Holthe tot Echten 1993	Change in creatinine clearance after 2 yrs of dietary intervention 1. Schwarz formula	Non-progressive group: n = 50 -2.5 (7.5) mL/min/1.73m ² Progressive group: n = 47 -9.7 (8.0) mL/min/1.73m ²	Non-progressive group: n = 50 -4.3 (10.0) mL/min/1.73m ² Progressive group: n = 44 -10.7 (11.8) mL/min/1.73m ²	1.8 (-1.66, 5.26) 1.0 (-3.17, 5.17)
Wingen 1997 Wingen 1992 Kist-van Holthe tot Echten 1993	Change in creatinine clearance after 2 yrs of dietary intervention 2. Endogenous	Non-progressive group: n = 50 -4.3 (13.5) mL/min/1.73m ² Progressive group: n = 47 -10.6 (10.4) mL/min/1.73m ²	Non-progressive group: n = 50 -6.4 (11.8) mL/min/1.73m ² Progressive group: n = 44 -10.7 (19.3) mL/min/1.73m ²	2.1 (-2.87, 7.07) 0.1 (-6.33, 6.53)
Wingen 1997 Wingen 1992 Kist-van Holthe tot Echten 1993	Height standard deviation score at baseline	Non-progressive group: n = 50 -1.0 (1.5) SDS Progressive group: n = 47 -1.0 (1.4) SDS	Non-progressive group: n = 50 -0.8 (1.2) SDS Progressive group: n = 47 -1.0 (1.3) SDS	-0.2 (-0.73, 0.33) 0.0 (-0.55, 0.55)
Wingen 1997 Wingen 1992 Kist-van Holthe tot Echten 1993	Height standard deviation score after 2 yrs of dietary intervention	Non-progressive group: n = 50 -0.8 (1.4) SDS Progressive group: n = 47 -1.1 (1.5) SDS	Non-progressive group: n = 50 -0.7 (1.3) SDS Progressive group: n = 47 -1.0 (1.4) SDS	-0.1 (-0.63, 0.43) -0.1 (-0.7, 0.5)
Wingen 1997 Wingen 1992 Kist-van Holthe tot Echten 1993	Weight % ideal body weight at baseline	Non-progressive group: n = 50 102 (14)% Progressive group: n = 47 106 (25)%	Non-progressive group: n = 50 98 (21)% Progressive group: n = 47 104 (18)%	4.0 (-3.0, 11.0) 2.0 (-6.91, 10.91)
Wingen 1997 Wingen 1992 Kist-van Holthe tot Echten 1993	Weight % ideal body weight after 2 yrs of dietary intervention	Non-progressive group: n = 50 103 (16)% Progressive group: n = 47 108 (23)%	Non-progressive group: n = 50 104 (18)% Progressive group: n = 47 106 (19)%	-1.0 (-7.92, 5.92) 2.0 (-6.65, 10.65)
Uauy 1994 Holliday 1993	Length at start (8 mths) Length at end (18 mths)	65.2 (3.9) cm: n = 11 74.6 (3.7) cm: n = 11	66.3 (3.4) cm: n = 13 77.0 (4.3) cm: n = 13	-1.1 (-4.05, 1.85) -2.4 (-5.6, 0.8)
Uauy 1994 Holliday 1993	Weight at start (8 mths) Weight at end (18 mths)	6.88 (1.4) kg: n = 11 6.88 (1.0) kg: n = 11	9.16 (1.4) kg: n = 13 9.29 (1.0) kg: n = 13	0.0 (-0.99, 0.99) -0.13 (-1.12, 0.86)
Uauy 1994 Holliday 1993	Change in GFR	1.6 (0.8) mL/min: n = 11	1.2 (0.7) mL/min: n = 13	-1.2 (-3.67, 1.24)