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DIALYSIS / ORIGINAL ARTICLE

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The impact of supplemental feeding in young children on dialysis:

A report of the North American Pediatric Renal Transplant Cooperative Study

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Abstract Supplemental feedings are commonly recommended for young children on dialysis but their effect on growth parameters and mortality has not been well documented. We report the results of a North American Pediatric Renal Transplant Cooperative Study (NAPRTCS) survey on the impact of supplemental feedings on growth and mortality in children <6 years of age at dialysis initiation. Sixty-four nonsurvivors (NonS) were matched with 110 survivors (S) for age at dialysis initiation, primary renal disease, and year of entry into the NAPRTCS database. Questionnaires were completed by participating centers on 137 patients (51 NonS, 86 S). Supplemental feedings were given to 70% of patients and more commonly given to patients <2 years of age compared to those 2–5 years of age at dialysis initiation (P<0.001). Supplemental feedings were also more commonly given to patients with nonrenal disease in addition to renal disease compared to those with renal disease only (P<0.001). In patients receiving supplemental feedings, the method of supplemental feeding was most commonly by nasogastric tube in patients <2 years of age compared to those 2–5 years of age (P=0.027). Supplemental feeding use was not different in S compared to NonS. There were no differences in height standard deviation score (SDS), weight SDS, or change in height or weight SDS in patients receiving supplemental feedings compared to those who did not. The height and weight SDS did not improve over time on supplemental feeds. In summary, despite the common use of supplemental feedings in young patients on dialysis, height, weight, and mortality remain unaffected. Prospective long-term evaluation of this therapy is needed to determine the effectiveness of supplemental feeding.

Keywords End stage renal disease · Dialysis · Nutrition · Growth · Infants

Introduction

Inadequate nutrition in children with end-stage renal disease (ESRD) is a difficult problem that inevitably results in growth failure when caloric intake is <70% of the recommended daily allowance [1–5]. This often necessitates the use of a variety of supplemental feedings in infants and older children [6–9]. Since most infants and children with ESRD are unwilling to take in the required amount of nutrition orally, many of these patients are treated with supplemental feedings through either a nasogastric or a gastrostomy tube.

Although the methods of supplemental feeding have been well documented in children with ESRD, there has been little information available on the effects of supplemental nutrition on growth parameters and survival outcome in this group of children. With aggressive nutritional management, Brewer noted an increase in weight standard deviation score (SDS) in 11 of 14 and an increase in height SDS in 10 of 14 infants on peritoneal dialysis (PD) [10]; and Lederman reported an increase in height SDS in 12 infants on PD for at least 1 year [11]. To date, no multicenter experience on this subject has been published. The purpose of this special multicenter North American Pediatric Renal Transplant Cooperative Study (NAPRTCS) report was therefore aimed at reviewing the impact of supplemental feedings on growth parameters and survival outcomes in a large group of children with ESRD who initiated chronic dialysis at <6 years of age.

The North American Pediatric Renal Transplant Cooperative Study (NAPRTCS) is a voluntary collaborative effort comprising over 150 pediatric renal disease treatment centers in the United States, Canada, Mexico, and Costa Rica. It is supported by major, unrestricted educational grants from Novartis, AMGEN, and Genentech. Participating NAPRTCS centers are listed in the most recent NAPRTCS Annual Report: McDonald R, Donaldson L, Emmett L, Tejani A (2000) A decade of living donor transplantation in North American children: the 1998 annual report of the North American Pediatric Renal Transplant Cooperative Study (NAPRTCS). Pediatr Transplant 4:221–234

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Materials and methods

The organization and operation of NAPRTCS have been previously described [12] as has the organization of the dialysis registry of NAPRTCS [13]. In short, 2208 patients aged 0–21 years have been entered into the NAPRTCS dialysis registry from 140 participating NAPRTCS centers between 1 January 1992 through April 1996. Of the total dialysis database, 479 patients were 0–5 years of age (in other words, had not yet reached their 6th birthday) at initiation of dialysis. Of the patients from 0 to 5 years of age, 64 nonsurvivors were identified and matched with 110 survivors for age group at dialysis initiation, primary renal disease, and year of entry into the NAPRTCS database. Each center was asked to complete a special questionnaire (see Appendix) on the mortality risk factors for both survivors and nonsurvivors identified at their center. Of the total of 174 identified subjects, questionnaires were returned on 137 patients (79%), 51 nonsurvivors and 86 survivors, who constitute the subjects for this analysis.

Patients were divided into three groups for analysis based on age at dialysis initiation: <3 months, 3–23 months, and 2–5 years of age. Information contained in the usual NAPRTCS database and analyzed in these patients included race, primary renal disease, and gender. Growth hormone usage was recorded and growth hormone was only received in three patients. In addition, weight and height SDS at 30 days, 6 months and 1 year after dialysis initiation were analyzed in those patients who started dialysis after the beginning of the dialysis registry (after 1 January 1992); the change in weight and height SDS from 30 days to 6 months and 30 days to 1 year after dialysis initiation were calculated. Body mass index (BMI) was calculated from weight and height at 30 days, 6 months, and 1 year after dialysis initiation. Patient information derived from the special questionnaire included urine output described as anuria/oliguria or normal/polyuria, use and method of supplemental feedings begun prior to 30 days after dialysis initiation, presence of any nonrenal organ system disease, and cause of death in nonsurvivors. For nonrenal organ system disease, the questionnaire specifically addressed central nervous system, cardiovascular, pulmonary, liver, or gastrointestinal tract disease; each center was also asked to specify any other nonrenal disease. Supplemental feedings were defined as feedings provided by other than the oral route and included nasogastric tube, gastrostomy tube, oral gastric tube, transpyloric tube, and gastrojejunostomy, in addition to parenteral nutrition.

Pearson's chi-square test was used to compare the age groups at dialysis initiation, primary renal disease, urine output, presence of nonrenal disease, and survival in the patients with and without supplemental feedings. The presence of gastroesophageal reflux (GER) and gastrointestinal disease was compared between patients with and without supplemental feeding using Fisher's exact test. Similarly, the method of supplemental feeding was compared between the 0- to 2-year-old patients and the 2- to 5-year-old patients and survivors and nonsurvivors using Fisher's exact test. Weight and height at 30 days, 6 months, and 1 year after dialysis initiation were compared for patients with and without supplemental feeding using the *t*-test. An alpha value of 0.05 was used as the significance level for all testing.

Results

Of the 137 patients, 51 were <3 months of age, 52 patients were 3–23 months of age, and 34 patients were 2–5 years of age at dialysis initiation. There were 126 peritoneal dialysis patients (46 nonsurvivors and 80 survivors), 8 hemodialysis patients (4 nonsurvivors and 4 survivors), and 3 patients with dialysis type unknown among the 137 patients. One year survival was 83% in patients initiating dialysis at <3 months of age, 89% in the 3- to 23-month-olds, and 95% in the 2- to 5-year-olds (P=0.0001 for <3 months vs 2–5 years of age). The youngest infants appeared to demonstrate the greatest mortality during the first 12 months of dialysis [14]. Infection was the most common primary cause of death, accounting for 29% of deaths and being a contributing cause in an additional 10% of deaths. Other primary causes of death include central nervous system disease (8%), pulmonary disease (8%), dialysis complications (2%), cardiovascular disease (6%), dialysis withdrawal (12%), and other or unknown (35%) (14).

Table 1 Characteristics of patients who received supplemental feedings vs those who did not (*GER* gastroesophageal reflux, *GI* tract gastrointestinal tract, *FSGS* focal segmental glomerulosclerosis)

	Supplemental feedings	
	No *N* (%)	Yes *N* (%)
Age at dialysis initiation		
<3 months	10 (20%)	41 (80%)
3–23 months	11 (21%)	41 (79%)
2–5 years	20 (59%)	14 (41%)*
Primary renal disease		
Structural	20 (26%)	57 (74%)
Other	14 (27%)	38 (73%)
FSGS	7 (88%)	1 (13%)**
Urine output		
Anuria/oliguria	16 (26%)	46 (74%)
Normal/polyuria	22 (33%)	45 (67%)
Presence of nonrenal disease		
No	27 (53%)	24 (47%)
Yes	13 (16%)	70 (84%)*
GER/GI tract disease		
No	38 (39%)	59 (61%)
Yes	2 (5%)	35 (95%)***
Patient outcome		
Survivors	29 (34%)	57 (66%)
Nonsurvivors	12 (24%)	39 (76%)

*P<0.001 by chi-squared test, **P=0.002 by chi-squared test, ***P<0.001 by Fisher's exact test

Supplemental feedings were given to 96 of the 137 patients (70%). Supplemental feedings were initiated within 6 months of beginning dialysis (6.1±1.0 months); 17 patients initiated supplemental feeds in the month prior to dialysis initiation. Supplemental feedings were given to the majority of patients initiating dialysis prior to 2 years of age compared to patients initiating dialysis from 2 to 5 years of age (P<0.001) (Table 1). The use of supplemental feedings was also common in patients with all types of primary renal disease except for focal segmental glomerulosclerosis (FSGS) (P=0.002) (Table 1); however, FSGS was more commonly diagnosed in patients initiating dialysis from 2 to 5 years of age compared to the younger groups. Supplemental feedings were given regardless of urine output but were more commonly used in patients who had nonrenal disease in addition to renal disease (Table 1) (P<0.001). GER

Table 2 Method of supplemental feedings (*NG tube* nasogastric tube, *GT* gastrostomy tube/button, *other* oral gastric tube, transpyloric tube, gastrojejunostomy tube, parenteral nutrition, or a combination of these)

	NG tube only *N* (%)	GT only *N* (%)	NG+GT *N* (%)	NG+other *N* (%)	Other *N* (%)
Age at dialysis initiation					
<3 months	27 (68%)	6 (15%)	2 (5%)	2 (5%)	3 (8%)
3–23 months	21 (51%)	13 (32%)	6 (15%)	1 (2%)	0
2–5 years	4 (29%)	8 (57%)	0	0	2 (14%)*
Patient outcome					
Survivors	30 (54%)	15 (27%)	8 (14%)	2 (4%)	1 (2%)
Nonsurvivors	22 (56%)	12 (31%)	0	1 (2%)	4 (10%)**

*P=0.027 by Fisher's exact test, patients 2–5 years at dialysis initiation compared to younger groups;
**P=0.037 by Fisher's exact test

Table 3 Weight and height standard deviation scores (SDS) in patients receiving and not receiving supplemental feedings

	Supplemental feedings	
	No (X ± SEM)	Yes (X ± SEM)
Weight SDS		
30 days after dialysis initiation	–0.77±0.47	–1.33±0.31
6 months after dialysis initiation	–1.41±0.36	–1.99±0.23
1 year after dialysis initiation	–2.04±0.75	–1.70±0.41
Height SDS		
30 days after dialysis initiation	–1.75±0.26	–1.76±0.40
6 months after dialysis initiation	–2.36±0.27	–3.02±0.26
1 year after dialysis initiation	–2.89±0.69	–2.88±0.42

Table 4 Change in weight and height standard deviation scores (SDS) from 30 days to 6 months and 1 year postdialysis initiation

		Supplemental feedings	
		No (X ± SEM)	Yes (X ± SEM)
30 days to 6 months	ΔWeight SDS	–0.09±0.22	–0.20±0.32
After dialysis initiation	ΔHeight SDS	–0.43±0.27	–0.74±0.43
30 days to 1 year	ΔWeight SDS	–0.32±0.77	–0.32±0.48
After dialysis initiation	ΔHeight SDS	–0.63±0.66	–0.69±0.68

or gastrointestinal tract disease was more commonly seen in patients who received supplemental feedings (P<0.001).

In those who received supplemental feedings, the method of supplemental feeding was most commonly by nasogastric tube in the younger two groups, while in the 2- to 5-year-old group the method of supplemental feeding was more commonly gastrostomy tube (P=0.027) (Table 2). The method of supplemental feeding was different in the survivors who received supplemental feedings compared to nonsurvivors who received supplemental feedings (P=0.037) (Table 2); 95% of survivors used nasogastric tube, gastric tube, or both feeding methods.

Body mass index was not significantly different in survivors compared to nonsurvivors when analyzed in all patients (19.9±0.4 vs 19.4±0.7), in patients who received supplemental feedings (19.3±0.4 vs 19.0±0.7), or in patients who did not receive supplemental feedings (19.6±0.8 vs 19.9±1.4). Further, BMI did not correlate with changes in weight or height at any time after dialysis initiation.

There were no significant differences in weight or height SDS at 30 days, 6 months, and 1 year after dialysis initiation in those patients receiving supplemental feedings compared to those not receiving supplemental feedings (Table 3). Weight and height SDS tended to decrease over time in patients receiving supplemental feeds as well as in those patients who did not (Table 4). There were no significant differences in the change in weight or height SDS from 30 days to 6 months or 1 year after dialysis initiation in those patients receiving supplemental feedings compared to those not receiving supplemental feedings (Table 4). The time of initiation of supplemental feedings was not correlated with change in weight or height for 30 days to 6 months of 1 year after dialysis initiation. Further, there was no difference between survivors and nonsurvivors regarding the frequency of supplemental feeding usage irrespective of age group at dialysis initiation.

Discussion

The results of this study illustrate that supplemental feedings are commonly utilized in children <6 years of age who are on dialysis. This is in agreement with previous publications also noting its common use in an effort to increase caloric and protein intake. The primary renal disease, other than FSGS in the older children, or the volume of urine output does not appear to have any significant influence on whether a patient receives supplemental feedings. The lack of influence of urine output on the need for supplementation is not surprising since patients with oliguria/anuria as well as polyuria often receive less than adequate calories and require supplementation: the former patients with high calorie formulas and the latter with high volume supplementation.

Supplemental feeding was also noted to be more common in patients with non-renal disease in addition to ESRD. It is likely that this was a result of an increase in

the severity of illness with other organ involvement and the increased need for additional calories due to high metabolic demands. In particular, patients with GER or other gastrointestinal disease were noted to be frequent recipients of supplemental feedings. GER is commonly associated with chronic renal failure in children [15], and excessive vomiting and regurgitation often requires the provision of additional calories which can only be given by some form of tube feeding. The use of certain methods of supplemental feeding, such as nasogastric tube, may also predispose children to the development of GER [16].

The method of supplementation was different in the different age groups, with the nasogastric tube used most commonly in the younger age groups and the gastrostomy tube most commonly used in the 2- to 5-year-old group. Nasogastric tubes may have been used more commonly in the youngest groups due to the practical difficulties of placing gastrostomy tubes in infants already on peritoneal dialysis. The difference between the age groups may also have more to do with the aesthetic and psychosocial aspects of the feeding method rather than any specific clinical characteristics of the children [17]. The method of supplementation is more complex in nonsurvivors as 10% of these patients received supplementation by means other than nasogastric or gastrostomy tube methods and this factor may be related to overall disease and, thus, survival in these patients.

Disturbingly, there were no differences in weight or height SDS at 30 days, 6 months, or 1 year after dialysis institution in those children who received supplemental feeds compared to those who did not. Further, weight and height SDS deteriorated between 30 days and 6 months after dialysis initiation and between 30 days and 1 year after dialysis initiation in children who received supplemental feeds as well as in those who did not. The cause of the lack of improvement in the weight and height SDS despite the use of supplemental feedings cannot be determined in this multicenter study based on registry data due to the lack of available information on the type of formula utilized or the actual vs prescribed total caloric intake of the patients. However, in recent single center studies in young children with chronic renal failure or on peritoneal dialysis, height standard deviation score improved most after 1 year of supplemental feedings [18–20], and therefore continued follow-up of our patients may result in growth improvements.

The use or method of supplemental feeding also had no obvious influence on mortality in these young children on dialysis. Patients not receiving supplemental feedings were as likely to survive as patients who did. This may seem contrary to our expectations; however, supplemental feeding is now an accepted standard of practice for most infants with chronic renal failure and a lack of effect on mortality may reflect the almost universal use of supplemental feeding in any patient not meeting the recommended daily allowance for calories [5]. Further, the lack of improvement in weight in patients on supplemental feeds may play a role in the lack of effect of these feeds on mortality.

In conclusion, supplemental feedings were commonly used in young children on dialysis irrespective of the primary renal disease or the degree of urine output. Children with non-renal disease in addition to renal disease were more commonly treated with supplemental feeds. Height and weight gain remained poor despite the use of supplemental feedings and these feedings did not impact patient survival in these young children. Prospective long-term data on dietary caloric and protein intake coupled to a variety of outcome parameters, including weight, height, head circumference, and patient survival, is clearly necessary if the optimal approach to nutritional supplementation for young children on dialysis is to be determined.

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Appendix

Questionnaire completed by centers for each study patient

NORTH AMERICAN PEDIATRIC RENAL
TRANSPLANT COOPERATIVE STUDY (NAPRTCS)

RISK FACTORS FOR MORTALITY IN YOUNG CHILDREN ON DIALYSIS

Center Name: FIELD(1)
Center ID: FIELD(2)
Patient Name: FIELD(3) FIELD(4)
ID Number: FIELD(5)
Date of Birth: FIELD(6)

1. **At birth**

☐☐☐.☐ Weight (kg) ☐☐☐.☐ Length (cm) ☐☐.☐ Head circumference (cm)

2. ***Primary* (first ever) course of maintenance dialysis**

☐☐ ☐☐ ☐☐ Date began
M D Y

Urine output (check only one)
☐ Anuric or oliguric (< 1 ml/kg/hr)
☐ Normal or polyuric

3. **During primary (first ever) course of dialysis**

Forced feedings (check only one) ☐ Yes ☐ No

If yes, method of feeding (check all that apply)
☐ Nasogastric ☐ Gastrostomy ☐ Other, specify: _____

☐☐ Age (in months) when forced feedings began

4. **Did the patient have disease or dysfunction (i.e., congenital problem causing major organ system dysfunction) of other (than renal) major organ systems?** ☐ Yes ☐ No

If yes, check all that apply:
☐ Central nervous system, including seizures
☐ Cardiovascular, specify: _____
☐ Pulmonary, including hypoplasia
☐ Liver, specify: _____
☐ G.I. tract
☐ G.E. reflux
☐ Other, specify: _____

5. ***Primary* and *contributing* causes of death (omit for control patient)**

Primary (check one)	Contributing (check all that apply)	
☐	☐	Infection, specify: _____
☐	☐	Dialysis complications, specify: _____
☐	☐	Central nervous system, specify: _____
☐	☐	Cardiovascular, specify: _____
☐	☐	Pulmonary, including hypoplasia
☐	☐	Withdrawal of dialysis therapy By: ☐ Medical team suggests/parents agree ☐ Parents suggest/medical team agrees
☐	☐	Other, specify: _____

_____ _____
Signature of Person Completing Form Date

Submit completed form to: NAPRTCS, The EMMES Corporation, 11325 Seven Locks Rd Ste 214, Potomac MD 20854, (301) 299-3991 FAX