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Aggressive therapy of infants with renal failure

Edward C. Kohaut, John Whelchel, F. Bryson Waldo, and Arnold G. Diethelm

Department of Pediatrics and Surgery, University of Alabama at Birmingham, 1600 Seventh Avenue South, Birmingham, AL 35233, USA

Abstract. Nine infants, who presented with renal failure within the first 3 months of life, were treated with continuous ambulatory peritoneal dialysis (CAPD). Seven infants survived to an age of 12–15 months, when they received transplants. Two patients died while on CAPD. Six infants are alive with a functioning renal allograft, at an average age of 35.5 months and an average of 22 months post-transplant. Neurological development is normal in four of the six infants tested. The mean current height of the six transplant recipients is just below 2 SD from the mean.

Key words: Infants – Nutritional management – CAPD – Transplantation – Neurological development – Growth

Introduction

Until recently infants with chronic renal insufficiency (CRI) were managed conservatively and dialysis and/or transplantation was only undertaken if they survived to a certain age or size. However, this approach is not ideal. During the first 2 years of life normal infants achieve 30% of their growth potential. In 1972 Betts and McGrath [1] reported that infants with CRI grow poorly during the first 2 years of life. Once growth potential is lost, it is rarely regained since catch-up growth during dialysis or following successful renal transplantation is seen rarely [2–4].

It has been reported that CRI early in life is associated with serious permanent neurological dysfunction [5–7]. Both malnutrition [7] and aluminum toxicity [8] are potential causes for this defect.

Transplantation is the optimal therapy for end-stage renal disease (ESRD). However, in one series of 16 infants who underwent renal transplantation during the first year of life, 11 died [9]. Alternatively, infants with CRI can be managed by hemodialysis followed by renal transplantation [10]: this requires specialized equipment and is expensive.

Continuous ambulatory peritoneal dialysis (CAPD) provides an adequate alternative to hemodialysis in the management of children with CRI [11–15]. Although its use in infants has been recommended [11–14], experience is limited [16, 17].

Patients and methods

Since 1981 nine infants less than 3 months of age have been treated with CAPD at the Children's Hospital of Alabama (Table 1). Infants who were placed on CAPD after 3 months of age were excluded in order to prevent complications caused by conservative therapy affecting the analysis. All the infants were treated for at least 1 year, except for the two infants who died after 2 months and 6 months of therapy. All infants had a creatinine clearance of less than 5 ml/1.73 m^2 and eight were started on dialysis because of failure of conservative management to maintain adequate body composition; in the ninth infant CAPD was started at 43 days of age because of poor growth in length and head circumference. The infants were compared to a population of older children (mean age 8.2 years, range 0.5–18 years) treated concurrently at our center.

Initially a double-cuff Tenkhoff catheter was inserted [18] but erosion of the cutaneous cuff was common. Therefore, subsequently only the single peritoneal cuff catheter was used. Catheter leakage occurred when it was placed in the midline but this was virtually eliminated by inserting the catheter into the peritoneal cavity under the lateral edge of the rectus muscle and by using a purse-string suture [18]. The catheter exit site was placed above the waistline to avoid soiling in the dia-

Offprint requests to: E. C. Kohaut

Table 1. Patient population

Age starting CAPD (days)	Cause of ESRD	Age CAPD stopped (months)	Reason CAPD stopped
5	Renal aplasia	2 months	Death
12	Obstructive uropathy	13 months	TPX
16	Obstructive uropathy	12 months	TPX
18	Renal dysplasia	14 months	TPX
21	Renal dysplasia	15 months	TPX
25	Obstructive uropathy	12 months	TPX
28	Renal dysplasia	14 months	TPX
43	Obstructive uropathy	14 months	TPX
68	Acute renal failure	8 months	Death

CAPD = continuous ambulatory peritoneal dialysis; ESRD = end-stage renal disease; TPX = transplantation

Table 2. Complications per patient months in infants and older children

	Infants (n = 9)	Children (n = 38)
Total months experience	96	392
Mortality	1/48	1/185 $P<0.01$
Peritonitis	1/4	1/7 NS
Significant hypotension	1/7	1/98 $P<0.01$
Catheter loss[a]	1/3	1/11 $P<0.01$
Hyponatremia	1/3	1/78 $P<0.01$

[a] Does not include catheters removed post-transplant or because of changes in therapy not related to catheter problems or peritonitis

per area. Catheter loss was more common in the infants than in the older children (Table 2) and was due to either persistent peritonitis or blockage by the omentum. When the latter occurred, a partial omentectomy was performed before the catheter was reinserted [19].

Dianeal PD-2 was used instead of Dianeal 137 because of its higher lactate and lower magnesium content [20]. Dialysate volume, which is a major determinant of ultrafiltration [21], varied greatly depending on patient tolerance and the dialysis and ultrafiltration requirements. In the seven infants with a residual urinary output the dialysis volume averaged 600 ml/m^2, whereas in the two anuric infants 1200 ml/m^2 was required to achieve adequate ultrafiltration. Five exchanges were performed each day, though occasionally the frequency was increased in the anuric infants.

Results

One episode of peritonitis occurred every 4.5 patient months. This is similar to that observed by others in older children on CAPD [22], but higher than the rate of one every 7.6 months among older children treated in our unit. The most common organism was *Staphylococcus epidermidis.* Hypotension and hyponatremia occurred more commonly than in older children; a relatively low sodium intake and renal sodium wasting may account for this difference.

Two infants died and mortality was therefore higher than in the older children (Table 2). One death was due to inadequate dialysis caused by multiple mechanical problems leading to congestive cardiac failure. The other occurred from sepsis, which resulted from a segment of bowel being caught in a column disc catheter, which should not be used in such a young infant. The seven surviving infants have been successfully transplanted.

Growth (Table 3) was less satisfactory than in older children [23]. In the latter, the mean stan-

Table 3. Growth

Standard deviation scores				Present age (months)	Transplant donor[d]	Time post-transplant (months)	Current creatinine (mg/dl)
Start CAPD	End CAPD	6 Months post-transplant	Latest value				
−0.8	−2.0[a]				–		
+0.4	+0.1[b]				CAD		
−0.4	−1.8	−2.4	−2.5	30	LRD	18	0.4
−0.5	−2.5	−2.5	−2.2	43	LRD	29	0.7
−1.0	−1.7	−2.1	−1.9	36	CAD	24	0.9
−0.8	−1.8	−1.9	−1.7	41	LRD	26	0.7
−2.4	−3.2	−3.1	−3.0	25	CAD	12	0.6
−0.4	−1.3	−1.6[c]	−1.8	39	CAD	25	1.2
−1.2	−1.6[c]						
M −.79	−1.74	−2.26	−2.18				

[a] Died after 2 months on CAPD
[b] Died 2 months post-transplant
[c] Died after 8 months on CAPD
[d] CAD = cadaver donor graft; LRD = live related donor graft

Table 4. Head circumference

SD score			Current developmental status	Age at assessment (months)	Comments
Start CAPD	End CAPD	Latest			
−0.2	−0.4				
−0.7	−0.4				
+0.8	+0.2	0	Normal	24	
−0.3	−0.5	−0.7	Normal	36	
−0.7	−1.8	−2.1	Delayed, all areas	36	Repeat CAT scan Cerebral atrophy
−1.2	−1.6	−1.4	Delayed, gross motor	19	
−0.6	−0.8	−0.4	Normal	24	
+0.2	+0.6	+1.0	Normal	24	
+0.3	+0.4				
−0.38	−0.46	−0.43			

dard deviation score (SDS) was −1.62 at the start of therapy, which improved to a mean score of −1.38. In the infants the SDS deteriorated from −0.79 to −1.74.

The changes in head circumference and the results of the developmental assessment are shown in Table 4. The SDS remained within 1 SD of normal for all infants, except for one who had cerebral atrophy on a CAT scan and another who started CAPD at 43 days of age with a reduced head circumference. Three of the six infants who underwent developmental assessment had minor delays in gross motor function prior to transplantation; one had marked delay in all areas and two were developmentally normal. CAT scans were carried out on five of the seven surviving patients and were normal in four.

The seven infants who were transplanted were aged between 12 and 15 months, with body weights ranging from 8.0 to 10.4 kg at the time of transplantation. Three received live related donor grafts and four cadaver donor grafts. All the kidneys were obtained from adult donors. In one case transplantation was undertaken because of poor growth and borderline neurological status, whereas in the rest the timing of transplantation was elective. The transplanted kidney was placed retroperitoneally with anastomosis of the renal artery to the inferior aorta. Six of the seven recipients are alive with a functioning graft (Table 3). One infant with prune-belly syndrome died 2 months postoperatively, having had to be maintained on a ventilator following surgery. Growth continued to decline in the 6 months post-transplant but has improved subsequently (Table 3). Following transplantation head growth remained normal and neurological status improved (Table 4).

Discussion

It is obviously difficult to know when to institute dialysis in an infant with CRI. However, if aggressive nutritional management, including feeding by nasogastric or transpyloric tube, is insufficient to maintain body composition or if the infant loses one standard deviation of height or if head growth is below normal, then we would recommend that dialysis should be started.

The treatment of infants with CAPD is basically similar to that of older children; however, it is important to recognize that the infant cannot spontaneously satisfy thirst and therefore fluid intake must be controlled. A low fluid intake can lead to hypotension and may require nasogastric feeding. In infants with only a small residual urinary output dialysis ultrafiltration should be increased to allow an increased fluid and, therefore, energy intake. Protein intake should be increased to allow for protein losses in the dialysate. The stress of caring for an infant on CAPD is considerable and usually falls on the mother. We have found that constant transpyloric tube feeding undertaken by whoever is caring for the child is preferable to the anxiety and tension created by constant attempts to improve the child's nutritional intake spontaneously. While renal transplantation remains the purpose of treatment, the use of aggressive early nutritional support and CAPD to maintain normal growth and development allows transplantation to be undertaken electively when the infant is older and bigger. Thus six of the seven infants who received renal transplants are alive with a functioning allograft.

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