Paediatric continuous ambulatory peritoneal dialysis

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SUMMARY Ten children in end-stage renal failure were treated by continuous ambulatory peritoneal dialysis (CAPD). This represents a total of 3·4 patient years. Biochemical control was good, and parent and patient acceptability high. Peritonitis was the chief complication, but after the institution of a specific CAPD education and training programme the incidence declined 10-fold. We regard CAPD as an effective short- and medium-term treatment for children with end-stage renal failure as part of an integrated dialysis and transplant programme, but it requires a devoted and enthusiastic trained staff to ensure success.

Recent data suggest that 1·5 children per million population under age 15 years require dialysis and transplant in order to survive. If full facilities are available treatment is directed towards regular haemodialysis and transplant with a 5-year survival rate of up to 83%. There are many problems associated with haemodialysis—such as expense, time spent on inpatient training, access sites for shunts and fistulas, and blood loss. Despite such drawbacks, home haemodialysis for children is regarded as a feasible and acceptable treatment.

In 1976, Popovich et al. reported the initial experience with adult patients of continuous ambulatory peritoneal dialysis (CAPD) and they subsequently described it in detail. The technique appeared to offer clear theoretical advantages particularly in children. Since 1978, we have used it as a primary form of treatment in any child presenting in end-stage renal failure and considered suitable for a subsequent transplant. We report our experience with the first 10 patients.

Patients

Newcastle upon Tyne is the regional referral centre for patients in renal failure, and serves a paediatric population of nearly three-quarters of a million. Patients are cared for by a team of paediatricians, nephrologists, transplant surgeons, and nurses. During the three years 1978–80, 10 children (2 boys, 8 girls) were considered suitable for CAPD. Their ages ranged from 5 to 14 (mean 9·6) years.

Methods

The CAPD regimen used was similar to that previously described in our adult patients. Briefly, under general anaesthetic a permanent Silastic Tenckhoff peritoneal dialysis catheter was inserted through the anterior abdominal wall. The dialysis then consisted of having 1 l of dialysis fluid (Travenol) in the peritoneal cavity continuously for 24 hours a day, except for periods of 20–30 minutes while the mother exchanged the equilibrated solution for fresh solution. Exchanges were performed, using a sterile technique, four or five times a day. Between exchanges the dialysis fluid bag and tubing remained attached to the Silastic catheter and were wrapped up and strapped to the anterior abdominal wall, thus allowing the child to carry on with normal activities.

The first 5 children were started on CAPD at a time when there was no specific programme for this technique. However, since 1979 a nursing sister has been employed full-time to run a programme both for children and adults; subsequently three staff nurses have been specifically co-opted to manage training and help with follow-up in the home dialysis training unit. Each parent was advised to weigh her child daily, watch for oedema, and judiciously to use hypertonic (3·8% dextrose) solutions in consultation with the renal unit. In addition, specific instructions were given to watch for turbidity of the effluent fluid and catheter leaks. Should either occur the child was seen at hospital immediately so that a full screen for peritonitis could be undertaken.

There were no dietary or fluid restrictions, but a high protein intake was encouraged to make good obligatory protein losses in the dialysis effluent. Low phosphate diets were not attempted but aluminium containing phosphate-binding agents
were given as necessary with meals. Most patients at some stage received calcium supplements, and 1-α-hydroxycholecalciferol was administered if there was any evidence of secondary hyperparathyroidism or osteomalacia.

Results

The mean period of CAPD treatment was 18 (range 4–32) weeks comprising a total patient experience of 3.4 years. The training period ranged from 11 to 32 (mean 18) days.

Biochemical control. Biochemical control was satisfactory throughout the period of study. Serum urea was well controlled at between 15 and 20 mmol/l (90.4 and 120.5 mg/100 ml) and creatinine at between 600 and 700 μmol/l (6.8 and 7.9 mg/100 ml) (Figs 1 and 2). Plasma sodium, potassium, chloride, and bicarbonate levels were all normal; for potassium the mean concentration ranged from 4.0 to 4.7 mmol/l, with 5.6 mmol/l the highest recorded level. Effluent protein concentrations were not routinely measured unless the concentration ranged between 2 and 9 g/l as in some cases of peritonitis. The mean albumin and total protein concentrations were below the normal range but tended to rise during the

![Fig. 1](http://adc.bmj.com)  
*Fig. 1 Serum urea levels during CAPD treatment. Number of patients being dialysed shown above mean value. Shaded area represents normal range.*

![Fig. 2](http://adc.bmj.com)  
*Fig. 2 Serum creatinine levels during CAPD treatment.*

![Fig. 3](http://adc.bmj.com)  
*Fig. 3 Total serum protein and albumin levels during CAPD.*
time on CAPD (Fig. 3). Serum ionised calcium levels were low at the start of treatment but rose to within the normal range, but phosphate levels were persistently high (Fig. 4).

**Quality of life.** Attempts to measure the quality of life are difficult to interpret in a heterogeneous group of patients. However, 7 of the 10 children were able to return to their normal schools and they seemed to cope well. Six children living near their schools were able to return home at lunchtime for an exchange. For one child this was not possible, so the school nurse was instructed in the technique and this arrangement worked satisfactorily. Of the 9 children hypertensive at the start of CAPD, it was possible in 6 to stop antihypertensive therapy altogether within 8 weeks. The mental attitude both of children and parents towards the treatment was excellent throughout except in the case of 2 children in whom there was quite a profound period of depression. However, in neither case was it felt that the technique itself played a significant aetiological role.

**Complications.** The main problem was peritonitis. Altogether there were 11 separate episodes of infection in the 10 children. There was however, a pronounced difference in the peritonitis rates in the first 5 patients placed on CAPD before the specific training programme compared with the 5 subsequent ones (one episode per 6-3 patient weeks, compared with one per 60 patient weeks). Antibiotics were administered intraperitoneally for 5 days—initially gentamicin and latterly cefuroxime—and with the exception of one, all the children were admitted, generally for 3 or 4 days until the infection had cleared.

Three catheters had to be replaced under general anaesthetic for blockage, generally for outflow obstruction. One boy developed an inguinal hernia and later a persistently sterile eosinophilic exudative peritonitis which was asymptomatic and abated spontaneously. Finally, after intraperitoneal cefuroxime for peritonitis one patient developed diarrhoea associated with *Clostridium difficile* and its toxin.

**Outcome.** Three of the 10 patients continue with CAPD while 4 have been successfully transplanted (2 using living related donors). Three patients who died had been managed before setting up the programme, 2 of whom had failed second transplants; the remaining patient had suffered a severe stroke. In no case was death directly related to the technique of CAPD.

**Discussion**

CAPD is now widely accepted both in North America and Europe as a satisfactory method of treating adult patients in end-stage renal failure. It has many advantages. The patient has a sense of well-being and there are few dietary or fluid restrictions; the technique is simple, and a steady state biochemical control can be achieved with a decrease in hypertension and reduction in anaemia. The technique offers potentially a more suitable and acceptable form of treatment than haemodialysis in children. Since 1978 therefore, we have used this method as our first choice of treatment in all children although full haemodialysis services were available. Currently we have no children on haemodialysis.

The use of CAPD in children is now being
evaluated in a few centres and there have been some studies published abroad. In our experience the major problem is peritonitis, but meticulous training by specially trained staff in an area set aside for CAPD reduces this risk. Biochemical control was satisfactory in every patient although protein loss and high phosphate levels are still a problem. It was not possible to make an accurate assessment of growth, mainly because CAPD has been for short periods. However, growth does pose potential problems particularly if the technique is going to be offered to very young children.

We feel that CAPD is an acceptable form of short- and medium-term treatment in children. Its initial acceptability justifies its use for several more years, in order to find out if the long-term results will prove as satisfactory as those of haemodialysis. Its success will depend on any further development that might reduce the risk of peritonitis. There is also a need for further assessment of problems of growth and bone disease. It nevertheless appears to be a major advance in dialysis treatment, integrated into a renal replacement programme of dialysis and transplantation.

Addendum

During the last 12 months we have had experience with a further 6 patients, the youngest being 11 months at the start of treatment. Our total experience is now 9 patient years, the longest period on CAPD is 2½ years. Our infection rate per patient remains unchanged. Hyperphosphataemia has been better controlled by increasing the intensity of the phosphate binder therapy. We continue to be enthusiastic and optimistic about this form of dialysis.

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References


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