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A review of 10 children on continuous ambulatory peritoneal dialysis

PY Yik, SN Wong, CL Yu, PY Cheung, CY Yeung

The experience of continuous ambulatory peritoneal dialysis in children at the Queen Mary Hospital for the past 11 years was reviewed. Seven boys and three girls (aged 4.3 to 15.9 years) were treated for a mean of 27 months (range five to 58 months). There was significant biochemical improvement and patients led an active life while undergoing treatment. The commonest complications were peritonitis, which occurred on average once every 10 patient-months and were mostly due to *Staphylococcus* spp. The median catheter survival time was 30 months. There were two technique failures due to fungal peritonitis which necessitated transfer to haemodialysis. The only mortality was due to concurrent cardiac disease. This review supports that children with renal failure in Hong Kong can be maintained on long term continuous ambulatory peritoneal dialysis with a reasonable quality of life. However, significant morbidity due to infective and mechanical complications still exists. This remains a temporary treatment modality while patients are waiting for renal transplantation.

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Key words: Peritoneal dialysis; Child; Adolescence; End-stage renal disease

Introduction

Peritoneal lavage as a treatment for anuria in children was first described in 1949.[1] With the availability of commercially made catheters and dialysis solution in the 1950s, peritoneal dialysis became an established treatment modality for paediatric acute renal failure in 1962.[2] However, it was not until the introduction of silastic peritoneal catheters[3] and an automated de-livery system[4] by Tenckhoff in 1970, that chronic peritoneal dialysis for children became an established renal replacement therapy (RRT).[5] Over the past decade, continuous ambulatory peritoneal dialysis (CAPD) has become the preferred RRT modality in children in many countries such as Canada, the United States, Australia, New Zealand, and certain European countries such as the United Kingdom and Germany.[6]

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In Hong Kong, CAPD has been the most popular treatment modality for adult end-stage renal failure (ESRF) patients since 1987.[7] However, the treatment of ESRF in children has lagged behind. There has been no formal dialysis programme, even in the major hospitals, and each patient is managed individually at their paediatric unit as dialysis is needed. It is the purpose of this paper to report the treatment received and the outcome of these children with ESRF in the paediatric unit of a major regional hospital in Hong Kong.

Subjects and methods

Children less than 16 years of age who were treated by CAPD in the Department of Paediatrics, Queen Mary Hospital, between January 1983 and December 1993, were included in this retrospective review. All patients were managed personally by one or more of the authors. The records of these patients were analysed to review their clinical data, complications of CAPD, and outcome.

The children were treated with CAPD when their glomerular filtration rate progressively fell below 5 ml/min/1.73 m^2 and they developed uraemic symptoms or intractable fluid retention with hypertension and oedema. The families were motivated and the patients were capable of looking after their daily activities.

A Tenckhoff peritoneal catheter was used in each case and was surgically placed under general anaesthesia. As in most published standard protocols,[8] prophylaxis with cephalothin and tobramycin was given and the break-in phase involved hourly cycles with 10 ml/kg dialysate until the dialysate was clear. This was then gradually stepped up to 35 to 45 ml/kg over one week. In the three most recent patients, the catheters were inserted electively, and capped once the dialysate was clear. Continuous ambulatory peritoneal dialysis was commenced two weeks post-operatively when the abdominal wound had completely healed.

Initially, each patient was given four cycles per day with 1.5% Dianeal solution (Travenol Laboratories Inc., Deerfield, Illinois, US). Dialysis prescriptions were adjusted to keep patients free of uraemic symptoms and fluid retention, and to maintain a serum urea concentration of less than 20 mmol/L. Before discharge, all patients and at least one parent were instructed by one of the authors to perform the standard simple spike system. Usually, the patients need dialysis with 4.25% Dianeal solution for one cycle every one to two days to maintain adequate ultrafiltration. All patients were reassessed at the clinic once every two weeks with a close monitoring of their body weight, body height, record of fluid balance, blood pressure, and blood biochemistry.

Peritonitis was diagnosed when patients had fever, abdominal pain, and cloudy dialysate with a WBC count of >100/μL and 50% polymorphonuclear leucocytes with or without positive cultures for bacteria or fungi. Exit site infection was diagnosed when there was swelling, redness, pain, and discharge with or without positive bacterial cultures from the catheter exit site. A failure event in catheter survival was defined as the removal of a catheter due to obstruction or infection. A technique failure event was defined as change from CAPD to other dialysis modalities.

Results

Ten children (seven boys and three girls) with ESRF were treated by CAPD in the Department of Paediatrics, Queen Mary Hospital, from 1983 to 1993. At the time of commencing CAPD, their ages ranged from 4.3 to 15.9 years (median 15.3 years). The causes of their renal failure were renal dysplasia (3), Alport's syndrome (3), reflux nephropathy (2), and chronic glomerulonephritis (2) (Table 1).

Table 1. Patients on continuous ambulatory peritoneal dialysis in the Department of Paediatrics, Queen Mary Hospital, from 1983 to 1993

Patient no.	Sex/age (yr)	Diagnosis	Date started	Duration (mth)	Outcome
1	F/15.8	Renal agenesis dysplasia	Nov 1983	36	To chronic HD* (*Candida* spp. peritonitis)
2	F/4.3	IgA nephropathy	Dec 1985	58	Live-related Tx†
3	F/16.3	Reflux nephropathy	Feb 1988	40	CAPD (adult clinic)
4	M/11.1	Chronic glomerulonephropathy (SBE)	May 1988	44	Died (heart failure)
5	M/6.7	Obstruction, dysplasia	Feb 1990	34	Cadaveric Tx
6	M/14.8	Renal dysplasia	May 1990	15	Cadaveric Tx
7	M/15.3	Alport's syndrome	Feb 1991	24	Cadaveric Tx
8	M/14.7	Alport's syndrome	Oct 1992	5	Cadaveric Tx
9	M/15.9	Reflux nephropathy	Aug 1993	8	CAPD
10	M/15.4	Alport's syndrome	Sept 1993	7	CAPD

* HD haemodialysis

† Tx transplant

Table 2. Pre-dialysis and post-dialysis status of continuous ambulatory peritoneal dialysis patients

Parameters	Pre-dialysis	Post-dialysis	p value
Ht-SDS*	-2.37 ± 2.18	-2.78 ± 2.48	ns†
Hb (g/L)	71 ± 18	81 ± 13	ns
Urea (mmol/L)	73.4 ± 23.9	21.4 ± 3.3	< 0.0001
Creatinine (μmol/L)	1313.5 ± 342.2	835.6 ± 176.1	< 0.0025
Albumin (g/L)	38.6 ± 0.5	34.1 ± 4.5	ns
Globulin (g/L)	25.7 ± 4.5	23.6 ± 4.9	ns
Na (mmol/L)	132.7 ± 8.2	140.0 ± 3.5	< 0.05
K (mmol/L)	4.7 ± 1.1	4.0 ± 0.8	ns
Ca (mmol/L)	2.1 ± 0.6	2.3 ± 0.2	ns
PO_4 (mmol/L)	2.7 ± 1.2	1.5 ± 0.2	< 0.01
Cl (mmol/L)	92.9 ± 10.4	100.0 ± 3.6	ns
CO_2 (mmol/L)	19.8 ± 9.5	27.3 ± 4.0	< 0.05
Alkaline phosphatase (U/L)	196.2 ± 63.6	218.5 ± 189	ns

* Ht-SDS height standard deviation score based on local growth standards (interpolated to exact years)

† ns not significant by Student's paired t-test

Table 2 shows the biochemical status of our patients before and during CAPD. There was definite improvement in the biochemical control of uraemia and a significant reduction in the serum urea and creatinine concentrations. A rise in serum sodium concentration, a fall in serum phosphate concentration, and a rise of plasma bicarbonate level also occurred. There were no significant changes in haemoglobin and serum albumin levels. The height standard deviation score before and after CAPD showed a decreasing trend, although the difference was not statistically significant. All the children were leading an active life and attending normal school.

The commonest dialysis-related complication in our patients was peritonitis (Table 3). On average, this occurred once every 10 patient-months. However, most episodes were concentrated in a few patients, especially in the earlier cases (patients 1 and 2 had eight episodes of peritonitis each). Table 4 shows that *Staphylococcus aureus* and *Staphylococcus epidermidis* were the organisms most commonly causing peritonitis, followed by *Acinetobacter* and *Enterobacter* spp. Fungal peritonitis occurred in two patients, and both required removal of the catheter and transfer to haemodialysis.

The second most common problem was outflow obstruction of the catheters, which occurred in six catheters in five patients. This usually happened in the early post-operative period and invariably required replacement of the catheter. Other complications encountered were inguinal hernia and skin erosion of the subcutaneous tunnel in one boy, and two instances of accidental cutting of the catheter and the transfer set.

The median catheter survival was approximately 30 months (Fig 1). There was a wide 95% confidence interval because of the small sample size involved. The survival probability at 19 months was 0.50 (95% CI 0.19 - 0.81), and at 32 months was 0.40 (95% CI 0.10 - 0.70). The early losses within the first four months were due to mechanical blockage, while the late losses were due to fungal or refractory peritonitis. Overall, the technique survival was 100% up to 36 months.

There were only two technique failures due to fungal peritonitis, at 36 and 44 months of dialysis. Patient survival was 100% up to 44 months. The only death was with patient 4, who also had cor pulmonale with tricuspid regurgitation and progressive heart failure. He developed *Penicillium* spp. peritonitis and had to transfer to haemodialysis. However, his heart failure

progressively decompensated and he died after two weeks of haemodialysis. His death was due primarily to heart failure, although the change to chronic haemodialysis may have aggravated the haemodynamic decompensation.

The earlier patients remained on CAPD for a longer duration (Table 1). Patients 1 to 4 were dialysed for more than three years (range 36 to 58 months) under our care. Of these four patients, only patient 2 received a renal transplant from her mother and has discontinued dialysis. Patients 1 and 3 continued their lives on dialysis and were transferred to the adult unit. The outcome of the last six patients was much more encouraging. Patients 5 to 8 received cadaveric renal transplants following CAPD for five to 34 months. They have now discontinued CAPD.

Discussion

In a survey of childhood chronic renal failure from 1985 to 1992 in Hong Kong, the annual incidence of ESRF in children below 15 years of age was estimated to be four per million childhood population. Over the same period, 61 children with chronic renal failure—among whom 39 were in ESRF—were diagnosed in public hospitals in Hong Kong.[9] At present, these patients are managed separately in various paediatric or adult units. However, collectively, they present an important patient group for the health care system.

Our report describes the care these children received in the paediatric unit of a major hospital. It supports the idea that nowadays no child should die from renal failure. It is possible that children with ESRF can be maintained on long term dialysis with reasonable quality of life and satisfactory symptomatic and biochemical control of their uraemia. The only death in our series could be directly attributed to cor pulmonale and heart failure. The youngest patient was 4.3 years old at the time of commencing CAPD. However, in many renal centres, much younger children have also been treated by dialysis and renal transplantation. In a recent series reported by Rizzoni and colleagues, 8.9% of children on RRT were less than two years old, and these patients have a three-year survival rate of 78%.[10] However, our report shows that this group of children still have significant morbidity and long term problems. Morbidity is chiefly related to the infective and mechanical complications of CAPD, and the long term problem is the availability of kidney transplantation.

Table 3. Complications of continuous ambulatory peritoneal dialysis encountered by each patient

Patient no.	Duration of CAPD (mth)	Peritonitis (episodes)	Exit site infection (episodes)	Blockage of catheters (episodes)	Other complications	Catheter replacement (reason)
1	36	8	0	1	Break of transfer set	2 (blockage, *Candida* spp.)
2	58	8	0	0	–	–
3	40	2	0	0	–	–
4	44	4	1	0	–	–
5	34	2	1	1	Erosion of subcutaneous tunnel	2 (blockage, eroded tunnel)
6	15	0	0	1	–	1 (blockage)
7	24	2	0	2	–	2 (blockage)
8	5	0	0	0	–	–
9	7	1	1	1	Catheter cut	3 (cut, blockage, colonised)
10	7	0	0	0	–	–
Total	270	27	3	6		10

Table 4. Organisms causing peritonitis in children on continuous ambulatory peritoneal dialysis

Organisms	No. of episodes
Staphylococcus aureus	5
Acinetobacter spp.	4
Staphylococcus epidermidis	4
Enterobacter spp.	3
Escherichia coli	1
Pseudomonas aeruginosa	1
Flavobacterium meningosepticum	1
Candida albicans	1
Pencillium spp.	1
Organism not identified	6
Total	27

The reported incidence of peritonitis complicating CAPD varied from one episode every three months to 46 months.[11] Our peritonitis rate was comparable to the early experience of one peritonitis episode per 10.7 patient months reported in a Canadian study.[12] The mechanical blockage of catheters usually necessitates their replacement. The actuarial survival of 50 Tenckhoff catheters in 27 children has been reported as 58% at 12 months and 37% at 24 months.[13] Our catheter survival of 60% at 12 months and 50% at 24 months was encouraging. Various measures have been adopted to reduce the peritonitis rates in CAPD patients, including strict adherence to hand washing, use of various disconnect techniques such as the Y-set, ultraviolet irradiation devices,[14] adherence to strict protocols to deal with accidental contaminations, and removal of *S aureus* carriers by rifampicin prophylaxis.[15] Obstruction of catheters can also be avoided by using proper surgical techniques and the newer coiled or swan-neck catheters.[15]

It is evident that to optimise the care of these patients, we need a stable team of paediatric surgeons, nephrologists, renal nurses, and dietitians who can devote their time and expertise to properly place the catheter, prescribe the dialysis regime, treat any complications early, and give explicit instructions to parents and children about CAPD procedures and the diet to be followed at home. As in all paediatric units, our patients were managed by paediatricians with a special interest in nephrology, without the support of full-time renal nurses and dietitians. There is a great need to pool our resources and expertise to establish a paediatric renal centre and to introduce better CAPD techniques. In this way, the morbidity of children with ESRF will be reduced.

Equally important is the long term prognosis of these children. How long can CAPD last? Although there are minimal morphological alterations in the peritoneal membrane after five years of CAPD in the absence of peritonitis, even transient breakdown of the mesothelial barrier during infection will cause a high glucose concentration in peritoneal interstitium and glycosylation of capillary basement membrane proteins similar to those seen in diabetiform changes.[16] A medium long term study of CAPD adults followed for five to 11 years has demonstrated a reduction in the mass transfer coefficient ratio of urea to creatinine and a decrease of ultrafiltration capacity with time. The changes were positively correlated to the occurrence of peritonitis.[17] In a group of 68 children on CAPD for three to 70 months, the overall incidence of peritoneal membrane failure was 16.2% with a failure risk of 12%, 28%, 35%, and 48% at two, three, four, and five years, respectively.[18] At present, CAPD can best be considered a temporary treatment modality while patients wait for renal transplantation.

The availability of kidney donors is still a problem. In 1992, only 56 renal transplants were performed with 22 being from living-related donors, while a total of 1520 adult patients were on the waiting list for renal transplants.[19] Our earliest transplant in children was done in 1985. With efforts to promote renal transplantation, a child (patient 2) was given a live-related donor transplant from her mother in 1990. It is also encouraging to see that four of our patients have received cadaveric transplants in the past two years.

It is feasible for children with ESRF in Hong Kong to be treated with CAPD and to have a reasonable quality of life. However, we should strive to improve the care of these patients by optimising their dialysis prescriptions and reducing their complications. The establishment of a paediatric renal centre with a full complement of paediatric nephrologists, renal nurses, dietitians, and social workers can best achieve this aim. The long term well-being of these children still depends on the availability of renal transplantation in Hong Kong.

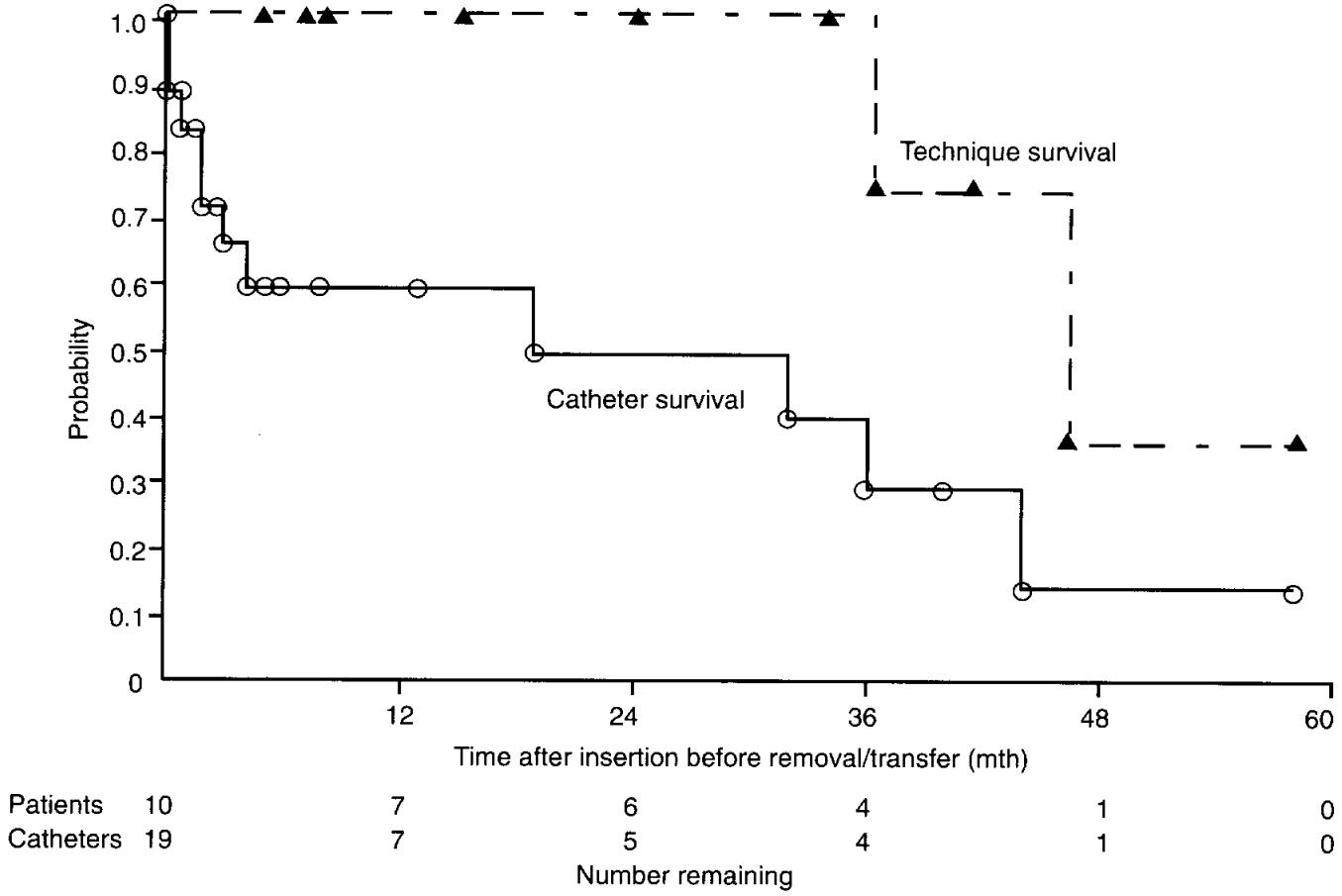

Fig 1. Actuarial survival curves for catheters (n=19) and for technique (n=10) in continuous ambulatory peritoneal dialysis paediatric patients, Queen Mary Hospital, from 1983 to 1993

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