NINETEEN MONTHS EXPERIENCE WITH CONTINUOUS AMBULATORY PERITONEAL DIALYSIS (CAPD)

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Introduction

The technique of continuous ambulatory peritoneal dialysis (CAPD) was first described by Popovich and his colleagues [1,2], but the general response to this method was limited because of the high incidence of peritonitis (one episode every 10 patient weeks) and the cumbersoness of the technique. A new technique for CAPD was developed at the Toronto Western Hospital and first described at the 1978 meeting of the American Society for Artificial Organs [3,4]. The initial results with this technique were so encouraging that we decided to convert all our home peritoneal dialysis patients to CAPD. In addition, all new patients admitted to our peritoneal dialysis programme during the last year were trained in CAPD. In this paper we describe our experience with CAPD to date.

Patient Population and Methods

A total of 84 patients (38 men and 46 women) were trained in CAPD during a 19 months period. The duration of CAPD ranged from one to 19 months, with an average of 9.1 months. Their ages ranged from 3 to 74 years, with an average of 47 years. Four of these patients were children (3, 10 and 11 years old) and 4 were diabetics.

Initially, the patients were dialysing 6 days a week, but later all the patients were converted to the 7 days a week scheme. The majority of the patients (61) were dialysing with 4 exchanges a day (every 6, 6, 4 and 8 hours). Thirteen did 3 exchanges a day and 10 did 5. The decision with regard to the number of exchanges was based on the level of serum creatinine. Patients who had a serum creatinine below 13mg% on 4 exchanges a day were allowed to exchange 3 times a day, while those who had a serum creatinine above 17mg% on 4 exchanges a day were asked to exchange 5 bags a day.

Thirty-two patients were carrying out the entire dialysis procedure themselves, whereas 13 had a relative to perform the dialysis. In the remaining 29, a nurse
changed the tubing every 2–4 weeks, and the patients had only to change the bags and dressings.

The patients were trained by the staff of the Home Dialysis Unit. One nurse was assigned to each patient, and it took the patients an average of 10 dialysis days (2 weeks) to master the CAPD technique.

Results

Table I shows the average values of the last measurements of the various biochemical indices. It should be noted that, in contrast to other types of dialysis, CAPD is not associated with any biochemical fluctuations. Most of the patients ingested antacids to control serum phosphorus but in smaller doses than those required on intermittent peritoneal dialysis.

The hypertriglyceridaemia which is universal among patients on CAPD may be related to the continuous absorption of carbohydrate (dextrose) from the dialysate.

Outcome

At the time of this report, of the 87 patients, 3 interrupted their training, 9 received a cadaveric transplant, 7 returned to in-centre peritoneal dialysis, 5 to in-centre haemodialysis, 5 died and 54 are still on dialysis.

CAPD was interrupted for the following reasons: four patients because of recurrent peritonitis, two because of back pain, two because of bowel perforation (unrelated to dialysis) one because of loss of ultrafiltration capacity, one because of depression, one, with systemic sclerosis, because of persistent vomiting and one because of confusion and hypercalcaemia.

Of the five patients who died, one died suddenly, one died after gangrene of the lower extremities, one of peritonitis and severe pneumonia, and two after a prolonged, complicated course characterised by pneumonia, brain damage and wasting.

| TABLE I. Average of the Last Biochemical Values in 66 Patients Maintained on CAPD (x + SD) |
|---------------------------------|-----------------|-----------------|-----------------|
| Serum Creatinine                | (mg%)           | 11.50 ± 3.21    |                 |
| BUN                             | (mg%)           | 60.45 ± 22.05   |                 |
| Serum Calcium                   | (mg%)           | 9.30 ± 0.90     |                 |
| Serum Phosphorus                | (mg%)           | 4.78 ± 1.21     |                 |
| Serum Potassium                 | (mEq/L)         | 4.19 ± 0.79     |                 |
| Total Proteins                  | (gm%)           | 6.44 ± 0.56     |                 |
| Albumin                         | (gm%)           | 3.50 ± 0.52     |                 |
| Haemoglobin                     | (gm%)           | 9.06 ± 1.94     |                 |
| Cholesterol                     | (mg%)           | 233.27 ± 84.84  |                 |
| Triglycerides                   | (mg%)           | 304.51 ± 348.87 |                 |
Complications

Cardiovascular  Hypotension was frequent, occurring in 40 patients. Nineteen had postural dizziness. Oedema was common in 18; in 7 it was associated with hypoproteinaemia, but in the rest it was related to our efforts to control hypotension. Atrial fibrillation was present in 2, and pericarditis developed in two patients while on CAPD. Five patients showed evidence of impaired blood supply to the lower extremities, and 2 of them developed gangrene.

Gastrointestinal  Eighteen patients complained of nausea and vomiting. Six had a transient decrease in appetite, but this improved later on. Four had aggravation of haemorrhoids which required surgical intervention in 2. Two had rectal prolapse, 1 developed inguinal hernia, 1 diaphragmatic hernia both of whom required surgical repairs, and 7 complained of constipation, which probably was related to antacids.

Musculoskeletal  Eighteen patients had arthritis involving the shoulders and other joints. This symptom usually responded to anti-inflammatory medications. Fifteen patients complained of back pain, but only in 2 was it severe enough to necessitate discontinuation of CAPD. Fourteen patients complained of cramps involving the abdominal muscles and legs, mainly after irrigation with hypertonic solutions.

Cutaneous  Eighteen patients had infections at skin exit sites. Thirteen complained of pruritus; 7 developed dermatitis (4 from the ‘air-strip’ bandage, and 3 had a dialysate leak around the catheter).

Miscellaneous  Thirteen patients complained of an unexplained malaise even though the haemoglobin concentration was close to 10Gm% and the levels of BUN and creatinine were adequately controlled. One patient developed dialysis dementia after she had been for two years on IPD followed by one year on CAPD.

Complications related to dialysis  Nineteen patients were forming fibrin clots but these could be prevented by continuous use of heparin in the dialysate. In 12 the tubing separated from the catheter, and in seven of them this led to peritonitis. Thirteen developed abdominal pain related to the use of hypertonic solutions, and 3 (especially in the initial stage of CAPD) absorbed fluids from the peritoneal cavity while using a dialysate of 1.5%. Three patients completely lost their capacity for ultrafiltration after an episode of peritonitis. Finally, 44 patients developed 89 episodes of peritonitis.

Peritonitis  The incidence of this complication in our patients was 54%, or one episode every 8.9 patient months. Most of the episodes (67%) were due to gram-positive organisms (Staph aureus and Staph epidermidis). Twenty-seven percent were due to gram-negative organisms, 3% were due to fungi and 3% were aseptic.
No differences were noted between the incidence of peritonitis in men and women.

Among 64 cases of peritonitis in whom we looked for a cause we found that in 38 of them it was due to a poor technique detected when the patients performed their dialysis under the supervision of a nurse after the episode of peritonitis. In 7, peritonitis was preceded by the separation of the tubing from the permanent catheter. Seven other cases had a skin-exit infection, and peritonitis was due to the same organisms that were present on the skin. Finally, 4 episodes of peritonitis developed while the patients were in hospital and being dialysed by the nurses.

Although peritonitis rarely led to catheter obstruction, it was necessary to remove the permanent peritoneal catheter on 16 occasions. In 13 cases the catheter was replaced by another catheter; because of persistent skin exit infection that might have led to peritonitis in 5; because of persistent peritonitis (contaminated catheters) in 2, because of dialysate leak in 3, and because of loss of ultrafiltration capacity in 3 patients. The catheter was removed from the remaining 3 patients and they were transferred to haemodialysis because of bowel perforation, loss of ultrafiltration capacity, and rupture of an internal iliac aneurysm following the removal of a transplant kidney, respectively.

*Protein losses* The protein losses, calculated from our own observations, are shown in Table II.

TABLE II. Calculated Average Daily Protein Losses in Patients on CAPD

<table>
<thead>
<tr>
<th>CAPD - Scheme</th>
<th>Patients Without Peritonitis</th>
<th>Patients With Peritonitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 bags/day (3x8 hours)</td>
<td>5.37</td>
<td>6.18</td>
</tr>
<tr>
<td>4 bags/day (1x4, 2x6, 1x8)</td>
<td>5.69</td>
<td>9.70</td>
</tr>
<tr>
<td>5 bags/day (4x4, 1x8)</td>
<td>6.99</td>
<td>11.50</td>
</tr>
</tbody>
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**Discussion**

The results of CAPD to date are very encouraging. The patients had excellent biochemical control, a fact which is even more impressive because the biochemical values do not fluctuate.

The mean serum protein and albumin levels remain close to the normal range, which supports our observation that daily protein losses are not as high as those Popovich et al described in their original paper [2].

Because of the excellent biochemical control, no dietary restrictions (fluid, potassium and sodium) are necessary, and the patient is required only to restrict his phosphorus intake.

The most serious of the various complications of CAPD seem to be hypo-
tension, hypertriglyceridaemia and back pain. Although we have not interrupted CAPD because of hypotension, it remains a significant problem and we are studying its pathogenesis. This complication seems to be due to multiple factors such as increased fluid and salt removal, an increase in the total body dry weight and the removal by CAPD of components of the renin angiotensin system [5].

If the patient has a pre-existing lumbar disc lesion, back pain is a contra-indication to CAPD.

Hypertriglyceridaemia combined with low levels of high density lipoproteins (as we observed in 6 of our patients) are potentially serious complications of CAPD over long periods. It is probably due to the continuous absorption of glucose by the dialysate. Probably for the same reason some of our patients show a continuous increase in their body weight, since there is an obligatory intake of 500–800 calories a day depending on the dextrose content of the dialysate used. One should consider the use of osmotic agents other than dextrose to avoid these complications. Such an agent may be a mixture of aminoacids. Preliminary data in our laboratory indicate that a solution of aminoacids (Travenol-Baxter) of 2% with electrolytes has an osmotic pressure of 460mosm/L similar to that of a 4.25% Dextrose-Dianeal solution. Figure 1 shows the changes in osmotic pressure of a 4.25% Dianeal solution and a 2% aminoacid solution left in a uraemic rabbit for 6 hours. One can notice that there is an early decline in both solutions whereas

![Graph showing osmolality changes after Aminoacid and Dextrose dialysate solution were left in the peritoneal cavity of a uraemic rabbit for 6 hours](image)

Figure 1. Osmolality changes after Aminoacid (●) and Dextrose (○) dialysate solution were left in the peritoneal cavity of a uraemic rabbit for 6 hours
there is a similar equilibration of creatinine in both. Potential advantages of using dialysate with aminoacids instead of dextrose include a) absence of the side effect of the dextrose i.e. hypertriglyceridaemia and obesity, b) improvement of the aminoacid abnormalities in blood and c) enhancement of protein synthesis which may effectively replace the amount of proteins lost. Possible disadvantages include increased urea production if instead of protein synthesis they are catabolised, and increased cost. We are presently studying all these aspects.

Recent observations that a regular exercise programme may decrease the levels of triglyceride and increase those of high density lipoprotein in patients on chronic haemodialysis may be of some value for patients on CAPD.

The most serious problem encountered in patients on continuous ambulatory peritoneal dialysis is still peritonitis. Although the Toronto Western Hospital technique has significantly decreased its incidence (from one episode every 10 patient weeks to one episode every 36 patient weeks), further improvements are needed if CAPD is to be established as a safe treatment for patients with terminal renal failure. That 9 patients in our unit were on CAPD for more than one year (average 15 months) without peritonitis indicate CAPD without peritonitis is a goal that can be achieved in the future. The most important cause of peritonitis seems to be a break in sterile technique, and in the future the technology should be directed to the development of simpler connections whose safety will not depend on the patient’s obsessional observance of sterile technique.

Continuous ambulatory peritoneal dialysis seems to be especially useful in children. Free dietary intake, more freedom and increased activity are advantages which may allow normal growth in these children.

Acknowledgments

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References

4 Robson, M and Oreopoulos, DG (1978) Dialysis & Transplant, 7, 999