CLINICAL EXPERIENCE WITH CONTINUOUS AMBULATORY PERITONEAL DIALYSIS

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SINCE its introduction, peritoneal dialysis has been used more frequently in Canada than in the United States, Europe or Japan. In Toronto, during 1979, 413 patients were maintained on dialysis in 5 teaching hospitals; of these, 232 (56 per cent) were on peritoneal dialysis. This figure reflects the superiority of peritoneal dialysis as a home treatment — either as intermittent peritoneal dialysis (IPD) or, recently, as continuous ambulatory peritoneal dialysis (CAPD), over hemodialysis.

A recent study ¹ of patients admitted to the continuous ambulatory peritoneal dialysis program in Ontario during the last 2 years has demonstrated that negative selection still operates among those admitted for chronic peritoneal dialysis compared with those admitted for home hemodialysis. Thus CAPD is the treatment of choice for diabetics, for those older than 55 or 60 years, for those with hypertension and severe cardiovascular complications, and of course for those who, for various reasons, are unable to continue on hemodialysis. For new patients, an important factor in deciding the mode of dialysis is their preference, especially if they belong to that group of patients who can be treated as effectively with one form as the other.

This paper will present the clinical experience with patients on CAPD in the Toronto Western Hospital program.

PATIENTS AND TECHNIQUES

Between September 1977 and June 1980, 115 patients (60 females and 55 males) were admitted to our program. They ranged in age from 6 to 78 years, with an average of 49.7. Their time on CAPD varied from 1 to 30 months (average 11.4 months). It is interesting to note that 7.8 per cent had polycystic kidneys and 8.7 per cent were diabetic.

All were dialyzed using the Toronto Western Hospital technique for CAPD ². The major modifications of the original technique were as follows: (1) The connection tubing was changed every four weeks in hospital by the nurses
instead of once a week by the patients at home; (2) the dressings were changed every two days and in some patients once a week instead of once a day; (3) the Luer end of the tubing was connected directly to the permanent catheter, to prevent separation, and since January 1980 we have used the titanium connector and tubing manufactured by Baxter Travenol Laboratories 3.

RESULTS AND DISCUSSION:

During their monthly visits the patients completed a questionnaire which was subsequently analysed. Fifty-one per cent complained of tiredness at six months, and the percentage increased to 69 at eighteen months. The mechanism underlying this complication is not clear; it may represent a combination of factors such as depression, postural hypotension, anemia, chronic illness, etc. The patients feel tired even though their biochemical and hematological control is as good as, if not better than, that of those on hemodialysis or chronic intermittent peritoneal dialysis. The possibility that this tiredness may be a manifestation of a depletion syndrome should be explored in studies that would include a measurement of trace metal concentration.

Between 26 per cent and 31 percent of these patients complained of mild to moderate pruritus and 6 per cent to 11 per cent of severe pruritus. Many patients suffered cramps, involving chiefly the legs and the abdominal muscles, symptoms that probably reflect dehydration.

The table shows the biochemical control achieved with CAPD and the effect that decreasing the dialysis volume from 8 to 6 litres a day has on the biochemical values of 15 patients. The changes were significant only for BUN and serum creatinine. Continuous ambulatory peritoneal dialysis is an excellent means of controlling serum potassium, even with 6 litres of dialysate a day. CO₂ levels were maintained in a slightly acidotic range because the concentration of lactate in the dialysate was relatively low, 35 mEq/l; perhaps the concentration should be higher (40 mEq/l).

Continuous ambulatory peritoneal dialysis with small doses of antacids (2-4 g/day) provides satisfactory control of serum phosphorus. The control of serum calcium is also satisfactory. However, a higher concentration of calcium may be desirable, because we have observed that hyperparathyroidism persists in most patients on CAPD when dialysed with a dialysate that has a calcium concentration of 6 mg/dl.

During the first 3 months on CAPD the hemoglobin, hematocrit and red blood cell count increase, but level off thereafter. It is interesting to note, however, that there is a slight decline at the later stages for some reason that is not clear (Figure 1).
Despite the removal of immunoglobulins by CAPD, the plasma immunoglobulin levels remain within normal ranges.

Serum cholesterol concentration increased slightly, from an initial value of 205 mg/dl to around 280 mg/dl, but declined after the 18th month. Similarly, serum triglycerides initially are slightly increased, but increase further to between 400 and 500 mg/dl after 6 months on CAPD. As the high standard errors indicate, a few patients have triglyceride levels about 1000 mg/dl. This hypertriglyceridemia, which may predispose to accelerated atherosclerosis, may be related to the continuous absorption of dextrose from the dialysate. If dextrose is indeed responsible, we should consider the use of other osmotic agents, e.g. mixed amino-acid solutions, as we suggested in the past. The potential advantages of an amino-acid-containing dialysate are the elimination of the side effects of dextrose, and the enhancement of protein synthesis and improvement of hypoproteinemia. Our experience with humans and with animals indicates that an amino-acid-containing dialysate is as effective as a dextrose dialysate in producing ultrafiltration and removing urea and creatinine.

**CALCIUM AND BONE STATUS OF PATIENTS ON CAPD.**

A dialysate with a calcium concentration of 6 mg% keeps the patient in a negative peritoneal calcium balance ranging between 30 and 50 mg a day. Radiological investigations have shown that subperiosteal resorption continues in most of them, and the hyperparathyroid bone disease persists or progresses in these patients despite the good control of serum phosphorus. In contrast to osteitis fibrosa, osteomalacia seems to respond to treatment with CAPD. Two
of our patients who had osteomalacia, histologically confirmed, and multiple rib fractures that did not respond to treatment with 1,25 dihydroxyvitamin D or DHT achieved healing of their fractures while on CAPD.

Vascular calcifications do not progress in patients on CAPD, probably because their calcium x phosphorus product is maintained within the normal range.

**NUTRITIONAL STATUS OF PATIENTS ON CAPD**

There is a gradual increase in mean body weight which probably reflects the increase in appetite which develops after the institution of CAPD and the absorption of dextrose. Nitrogen balance studies, done over short periods, indicate that these patients are in a positive nitrogen balance 6, 7.

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**PERITONITIS AND OTHER COMPLICATIONS**

Figure 2 shows the incidence of peritonitis in our unit expressed in episodes per patient year for each quarter since we started CAPD in September 1977. During the first 15 months, the infection rate remained grossly unchanged and ranged between 1.3 and 1.5 episodes per patient per year. However, it has since improved steadily and during the first quarter of 1980 declined to 0.41 episodes per patient year or one episode every 28 patient months. The total experience (in patient months) during each quarter is large enough to suggest that this is a real trend. This improvement may be due to such factors as changing of the tubing
by staff every month, the introduction of the Travenol Titanium adapter, and the decrease in the number of exchanges. Whatever the reason(s), we seem to be reaching the point where peritonitis will cease to be the major complication of CAPD; for example, we have maintained 22 of our patients on CAPD for one year and 3 of them for 2 years without a single episode of peritonitis.

MECHANICAL OR DIALYSIS-RELATED COMPLICATIONS

Catheter-tubing separations were encountered until we introduced the technique of connecting the Luer end of the tubing with the permanent catheter. Recently, we adopted the Travenol Titanium Luer lock connector, which has eliminated this problem. Skin exit site infection is still a serious problem and it may require catheter replacement or may lead to peritonitis. Bloody effluent may be related to menstruation. Early or late dialysate leak through the exit site may be prevented by the introduction of the modified Toronto Western Hospital catheter, which has a Dacron disc at the base of the peritoneal cuff to seal the peritoneal hole. (Fig 3).

MEDICAL COMPLICATIONS OF CAPD

Although most of the cardiovascular complications were observed in our older patients, it is still possible that these may be related to lipid abnormalities. They included symptomatic hypotension (33), arrhythmia (8), pericarditis (5), myocardial infarction (5), unstable angina (5) and reduced circulation to legs (4). Our research into symptomatic hypotension suggests that in most of these patients it is related to volume depletion.

Blood flow in the legs may decrease in patients who have obstructive lesions in their femoral arteries. Our ultrasound studies of blood flow show that the presence of 2 litres of dialysate leads to a further decrease in flow rate in patients with a large-vessel lesion. In 2 such patients this complication lead to gangrene. Whenever necessary, reconstructive vascular surgery should be carried out in these circumstances.

Gastrointestinal complications are the most frequent, and are probably related to the continuous presence in the abdomen of 2 litres of dialysate and the
associated increase in the intra-abdominal pressure. They included nausea/vomiting (17), diarrhoea (15), deterioration of hiatus hernia (3), deterioration of haemorrhoids (3), pancreatitis (1), hernias (11), colonic perforation (3), constipation (very frequent).

Severe back pain, which occurred in 3 patients, is probably related to the lordotic position imposed on these patients. This complication may become serious in those with pre-existing lumbar disc disease.

OUTCOME OF CAPD

At the time of writing, of the 115 patients who entered our CAPD program, 60 are on CAPD and 26 have received a cadaveric kidney transplant after being on CAPD for an average of 12 months. CAPD had to be interrupted in 20 patients and they were transferred to hemodialysis or to intermittent peritoneal dialysis. Eleven patients died. The actuarial success rate for the first year was 57 per cent; the remaining 43 per cent represented those who were transferred from CAPD to hemodialysis or intermittent peritoneal dialysis, and those who died. The success rate for 2 years, 39 per cent, indicates that failures continue at almost the same rate during the second year. Table V shows the reasons for interruption of CAPD among the 20 patients transferred to intermittent peritoneal dialysis or to hemodialysis. A significant number of the complications are clearly preventable, suggesting that the success rate for CAPD can be improved in the future.

**TABLE—Comparison of the blood biochemical values on 3-bags and 4-bags days.**

|                      | 4 bag day | 3 bag day | p    |
|----------------------|-----------|-----------|------|
| **No.**              | **Mean Std Dev.** | **No.** | **Mean Std Dev.** | p  |
| Blood urea nitrogen (mg%) | 75 | 54.1 ± 16.6 | 75 | 68.7 ± 19.18 | .001 |
| Serum determinations: | | | | |
| Creatinine (mg%)     | 77 | 11.5 ± 1.5 | 75 | 12.8 ± 1.4 | .001 |
| Calcium (mg%)        | 77 | 9.3 ± 0.64 | 75 | 9.2 ± 0.57 | N.S. |
| Phosphorus (mg%)     | 77 | 4.2 ± 0.75 | 75 | 4.8 ± 0.84 | .001 |
| Uric acid            | 77 | 6.9 ± 1.03 | 75 | 7.2 ± 0.83 | N.S. |
| Total protein        | 77 | 6.3 ± 0.93 | 75 | 6.4 ± 0.5 | N.S. |
| Albumin              | 69 | 3.2 ± 0.44 | 68 | 3.4 ± 0.49 | .01 |
| Potassium            | 77 | 4.0 ± 0.59 | 75 | 4.2 ± 0.58 | N.S. |
| Cholesterol          | 22 | 237.2 ± 80.7 | 27 | 217.9 ± 51.4 | N.S. |
| Triglycerides        | 22 | 299.3 ± 134.2 | 27 | 273.5 ± 133.7 | N.S. |
| Mean blood pressure (lying) | 76 | 88.93 ± 15.2 | 75 | 94.1 ± 19.6 | N.S. |
| Mean blood pressure (standing) | 77 | 83.8 ± 18.9 | 75 | 92.4 ± 17.5 | .005 |
| Body weight          | 75 | 67.8 ± 14.92 | 75 | 69.3 ± 13.59 | N.S. |
| Hemoglobin           | 78 | 9.3 ± 1.9 | 75 | 8.9 ± 2.2 | N.S. |
| Platelets (x 100/mm³) | 33 | 501.3 ± 106.41 | 34 | 438.76 ± 106.5 | .05 |
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