PART IV

DIALYSIS 3

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COMPARISON OF INTERMITTENT WITH CONTINUOUS PERITONEAL DIALYSIS

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Summary

Our experience with 41 patients on CAPD is presented (127 patient months). Thirty-three patients were previously on intermittent peritoneal dialysis. We used 4 exchanges of 2 L each per 24 hours (8, 6, 6 and 4 hours dwell times). There was a dramatic fall in serum creatinine of 27%, BUN fell 22%, total CO₂ rose 15%. Haemoglobin rose 10% and serum albumin fell by 5%.

The incidence of peritonitis was one episode per 7.1 patient months.

All patients noted an increase in well being. There were almost no dietary restrictions and patients gained real body weight. In most instances, their anti-hypertensive medication could be discontinued.

This technique is superior to all the other forms of peritoneal dialysis.

Introduction

In the past, chronic dialysis has meant that the patient has to be attached to a machine from 15 to 40 hrs a week. The wide fluctuations in biochemistry which occur on machine dialysis, the considerable fatigue and washed-out feeling which follow the dialysis and the psychological dependency which the patients experience towards their machines, all combine to make machine dialysis a necessary evil which the patient has to endure if he wishes to live. This is reflected in a high suicide rate in both haemodialysis and peritoneal dialysis programmes [1].

The ideal method of dialysis should not require a machine so that the patient is free at all times to go about his daily activities. It should be continuous so that wide fluctuations in BUN, creatinine, and fluid removal do not occur. It should remove both small and middle molecules effectively so that the patient need not have any dietary restrictions. It should be inexpensive and above all, it must be safe. Until recently, such a concept of perfect dialysis has been only a dream; however the report of Dr Popovich and his colleagues on continuous ambulatory peritoneal dialysis (CAPD) [2] has
brought this concept a step nearer to reality. Their concept is the continuous presence of 2 L of dialysate in the peritoneal cavity with 5 exchanges per 24 hours. They showed that this method produced biochemical results which were better than those previously described for peritoneal dialysis.

In the concept of CAPD, despite low clearances of small molecules (urea clearance of 8 ml/min), the weekly removal of small molecules is superior to conventional peritoneal dialysis since the dialysis is continuous. Furthermore, it is far more efficient than intermittent peritoneal dialysis (IPD) and haemodialysis in the clearance of middle molecules.

In the original technique, the patient used the continuous presence (24 hr a day, 7 days a week) of peritoneal dialysis solution in the peritoneal cavity except for periods of exchange of fresh solution five times a day. After each drainage, the patient disconnected himself from the 2 L bottle and capped the peritoneal catheter so that he was free to participate in his usual daily activities. The preliminary report which described 9 patients treated by this technique showed that in terms of solute removal, it was extremely effective. However, there was a high incidence of peritonitis of one every 10 patient weeks, and this was due to the many connections and disconnections necessitated by the use of 2 L glass containers.

The widespread availability of 2 L plastic bags in Canada has enabled us to reduce the incidence of peritonitis and simplify the technique [3]. Furthermore, the presence of a large number of patients on IPD, both in hospital and at home, has provided us with a unique opportunity for studying the effects of CAPD on a highly trained patient population and of comparing this new method of treatment with standard methods of IPD.

Patients

Forty-one patients, 16 men and 25 women, ages 21–74 years, were trained. Their residual kidney function as measured by creatinine clearance varied from 0 to 5 ml per minute with an average of 1.1 ml per minute and daily urine volume varied from 0 to 1,800 ml with an average of 360 ml. Thirty-three had been on IPD for periods ranging from 7 to 45 months (average 23) before CAPD was started. The remaining eight were new patients. All patients used 2 L plastic bags and followed our technique as previously described [2]. After filling the abdomen with 2 L of fluid, the plastic bag, still connected to the abdominal catheter, was folded into a cloth pocket suspended around the patient's waist. To drain, the patient suspended the empty bag on a special portable stand* and allowed it to drain by gravity. The majority of patients exchanged 2 L of dialysate 4 times a day 6 days a week, and 1 day a week they came off dialysis for a rest. Three patients achieved adequate control of weight removal and biochemistry by exchanging only 3 times a day. The training of most of these patients who had been on home IPD before took only one or two days. Training of new patients took between 8 and 15 dialysis days with an average of 10. On four occasions, we had to train a relative.

*Manufactured by Accurate Surgical Instruments, Toronto, Canada
of the patient either because the patient was elderly or could not understand English.

Diet

The patients were advised to take a high protein diet of between 80–100 g a day without fluid, sodium, or potassium restriction and to avoid foods high in phosphorus.

Results

Figure 1 shows the mean percentage fall of serum creatinine, BUN, uric acid, and CO₂ values of the patients who were converted from IPD to CAPD during the three months before and after. A dramatic decrease was observed for the first three substances during the first week of CAPD. Creatinine decreased by an average of 27%, BUN 22%, and uric acid 16% of the pre-CAPD values. In contrast, serum CO₂ showed an increase from an average of 19 mEq/L to normal levels of 22.5 mEq/L.
Figure 2

Figure 3
Figure 2 shows the percentage change in serum albumin and haemoglobin before and after CAPD. There was a rise of 10% in the haemoglobin and a fall of 5% in the serum albumin.

Figure 3 shows the percentage changes in calcium and phosphorus. There was no significant change in the calcium but there was a 15% fall in the phosphorus.

Fluid Removal

On average, patients used two 1.5 g/100 ml and two 4.25 g/100 ml dextrose solutions and on this regimen they removed 1,700 ml/day enabling them to drink a generous amount of fluid. By varying the number of 4.25 g/100 ml dextrose solutions, patients were able to remove up to 2.4 L of fluid a day in special circumstances.

Complications

Postural hypotension This was an extremely common problem and was observed in many patients, usually 2 or 3 weeks after they had started on CAPD. Since sodium and fluid removal were so efficient and since the patients all had an increase in appetite and gained real body weight, attempts to dialyse them down to their previous ideal weight resulted in postural hypotension. The majority of patients who were taking antihypertensive medication were able to discontinue this medication and we are now routinely raising the ‘ideal weight’ of patients when they start the programme of CAPD in order to avoid this complication.

Peritonitis A total of 18 episodes of peritonitis in 15 patients occurred during the 7 months period of study (128 patient months). This corresponds with an incidence of 36% among the patients or one episode per 7.1 patient months. The majority of infections were staphylococcal — S. aureus in 5 and S. epidermidis in 9, streptococcus viridans — 1, enterococcus — 1, acinobacter — 1, and proteus morgani — 1. Two patients had aseptic peritonitis.

Further experience with this technique has shown that peritonitis occurs only when the patient has a gross break in the sterile technique. We therefore emphasise that home visits once a month by the nursing staff are necessary in order to re-inforce the finer points of sterile technique. When the patient has an attack of peritonitis, he is usually brought back into the home unit for a period of re-training.

Although peritonitis has been a problem, we have elected to treat the last six patients without varying the technique by merely adding antibiotics to a 2 L bag and allowing it to remain in the abdomen for six hours. Three patients who were not ill but merely had a cloudy fluid and slight abdominal pain were treated at home this way. All patients had antibiotics in the peritoneal fluid for an arbitrary time of 10 days and in all cases we noted rapid clearing of the abdominal fluid and negative cultures. It seems that this method of treating
peritonitis is efficient and cheaper, both in terms of antibiotics used and of hospital beds occupied.

**Abdominal pain** Seven patients had mild to severe pain during the day when they came off dialysis. The pain was abdominal and radiated to one or both of the shoulders. We found that by leaving 300 ml of fluid in the abdomen, the pain would be partly relieved. By leaving 600 ml in, the pain was completely relieved. However, by the next morning all of this fluid had been reabsorbed into the circulation.

**Disconnections** Several patients had tubing disconnections at the permanent catheter site while on CAPD. All patients were instructed to carry, at all times, a sterile red cap and in the event of a disconnection to replace the cap and return to the home unit. We are presently designing new tubing which will make accidental disconnection impossible.

**Protein losses** These have been severe and have reached up to 15 g of protein a day [2]. The majority of patients who are well and have been able to tolerate a high protein diet have done well on this regimen and have had nearly normal serum proteins. A small number of patients who are unable to take the high protein diets have had hypoalbuminaemia, but to date this has not resulted in any serious problems. Mean serum albumin of all patients prior to CAPD was 3.3 g/100 ml ± 0.3, and after two months of CAPD was 3.4 g/100 ml ± 0.4.

Two patients showed a deterioration in their biochemical values during the first weeks of CAPD. We found out that they were dialysing only 3 times a day and both improved after they adhered to the proper technique.

A number of patients have found it difficult to tolerate 2 L inside the abdomen on the first day and we have had to build up to 2 L gradually by daily increasing the amount of fluid which is being allowed to remain inside the abdomen. Up until now, apart from one patient who can only tolerate 1700 ml, all patients have been able to tolerate the 2 L.

**Outcome**

Five patients returned to IPD; two because they preferred it and one because CAPD resulted in accentuation of her lumbar disc problem. Two patients were confused and unable to learn the technique; in one of these, CAPD unmasked diabetes and she required daily injections of insulin. Two patients received a cadaveric kidney transplant. Seven other patients interrupted CAPD temporarily; six because of peritonitis and one because of deterioration in clinical and biochemical conditions. At present, 34 patients are continuing on CAPD.

**Discussion**

About half the patients when first started on CAPD complained of abdominal distension and fullness and numerous complaints related to the new technique.
These complaints lasted, on average, one week to ten days. By ten days, all patients preferred this technique. All were unanimous in expressing a feeling of well being and were able to tolerate a level of activity that they had never experienced before on machine dialysis. Patients were especially appreciative of the fact that they were free of a machine for the first time in years. They reported that they were able to think more clearly, they had a greater zest for life, and a number of patients immediately made plans for a vacation, the first vacation they had had since starting dialysis. A normal diet was appreciated by everybody. In some cases, it was exceedingly difficult to persuade patients who had for years been on restricted protein diets to eat enough protein and drink more fluid, and this is the reason for the high incidence of postural hypotension. Another interesting result was that the patient felt less thirsty and this is probably due to the lack of fluctuation in their serum sodium and in fluid removal. A common reaction among the patients was immediately to telephone the renal unit and beg them to remove the peritoneal dialysis machine which they had been using for years. It amazed us to see how much patients hated the machine and how glad they were to be treated without it.

An impressive advantage of CAPD is a marked decrease in running costs which are cut to almost one-third of those on IPD. Thus, in Canada, the yearly expenses of a patient on IPD using an automatic cycler are in the neighbourhood of 15,000 dollars per patient per year. Those on CAPD are around 5,000 dollars per year. Its simplicity, ease of training and low cost should make it an ideal method of home dialysis.

As experience grows with this technique, our main clinical impression is the absence of the dialysis uraemic picture. Patients no longer look ill and on continuous dialysis treatment, depression, long periods of enforced inactivity and chronic fatigue following machine dialysis, have been replaced by a return of energy, well being, increase in appetite and real body weight. It is as though the patients were experiencing efficient dialysis for the first time.

Despite the relatively high incidence of peritonitis of 1 per 7.1 patient months, in contrast to our average of 1 per 18 patient months on IPD [4], we believe that this method is far superior to conventional peritoneal dialysis. Further developments in the connecting technique are necessary in order to reduce even further the incidence of peritonitis. When this has been achieved, this technique will become the mainstay of home dialysis treatment and we confidently expect that in the future it will attract a high proportion of haemodialysis and peritoneal dialysis patients, both in hospital and from the home, who will prefer life without a machine.

References

1 Abram, HS, Moore, GI and Westervelt, FB Jr (1971) Amer. J. Psychiat., 127, 1199
Open Discussion

SHALDON (Montpellier) Could you explain why your patients only use this technique six days a week as opposed to seven days a week in Texas?

ROBSON They think that the Sabbath is a day of rest! No, but seriously for psychological reasons we gave them the day off. At the moment we are dialysing half of our patients six days a week and half seven days a week. Elderly and blind patients, who have been unable to learn to change their tubing come into hospital once a week for a tubing change, taking half an hour. These patients dialyse seven days a week. We are gradually going over to seven days a week like Dr Popovich.

BLUMENKRANTZ (Los Angeles) I would like to question your last conclusion that this is more acceptable than intermittent peritoneal dialysis overnight at home. Also I would like to question your mathematics. If your patients are indeed ingesting 100 g of protein per day, have residual renal function one ml/minute, exchange 60 L of dialysate per week (allowing for 2 L/day of ultrafiltration), and lose an average of 10 g of protein/day in the effluent dialysate, my rough calculations indicate that the average BUN concentration in your patients should be approximately 120 to 130 mg/dl. Since their actual BUN levels were half of this, I suspect that on the average the patients actually ingested only 50 g of protein/day. This quantity of protein may not be sufficient for their long-term nutritional needs.

I would like to see long term psychological and social evaluation of the patients as well as nutritional.

ROBSON All these patients were on four times a week nightly dialysis using a machine, beforehand. Now for the first two weeks we usually have a lot of complaints regarding this new technique. After about two weeks all of the patients, apart from two, preferred the technique because they just did not like the machine.