CONTINUOUS AMBULATORY PERITONEAL DIALYSIS WITHOUT WEARING A BAG: COMPLETE FREEDOM OF PATIENT AND SIGNIFICANT REDUCTION OF PERITONITIS

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Summary

Despite the great impact of continuous ambulatory peritoneal dialysis (CAPD) as an effective modality of treatment for uraemic patients, two limiting factors remain: the high incidence of peritonitis and the need for patients continuously to carry a bag. We have designed a new closed system with two bags connected to the permanent Tenckhoff catheter. Two clamps alternately allow outflow and inflow of peritoneal dialysate. When the exchange manoeuvre is finished the patient frees the whole system from the needle and discards it. Since December 1978, 24 patients have been treated with this technique. The results are similar to the Toronto series with a marked reduction in the incidence of peritonitis (22.5 pt/months).

Introduction

Continuous peritoneal dialysis appears to be a simple and effective method for treating uraemic patients [1, 2]. Contamination of peritoneal fluid still remains the major problem during the connection-disconnection manoeuvre. In order to overcome this problem, we have designed a new double-bag system [3, 4].

Methods

Patients

Twenty-four patients (18 males and 6 females) have entered our CAPD programme using the double-bag system since December 1978 and have continued with this therapy for at least one month. All were trained in our technique by an assigned nurse under the supervision of a nephrologist for a minimum of one week.

Among these patients, 14 received CAPD as their first type of dialysis, 5 were previously treated on HD, 3 came from conventional CAPD and 2 from IPD. The mean age was 50.9 years range 25—70 years; creatinine clearance varied from 2 to
7ml/min, with a daily urine volume ranging from 0 to 620ml. Underlying renal pathology included: chronic glomerulonephritis (11), interstitial nephritis (8), diabetes mellitus (2), polycystic kidneys (2), and nephrosclerosis (1).

All patients on CAPD with our system were dialysed through a permanent peritoneal catheter (Tenckhoff). Allowed a free diet, they were advised to maintain a high protein intake and to avoid foods with a high phosphorus content.

Figure 1. New double-bag system for CAPD
Materials

Double-bag system This system includes two strictly related parts:

1. Two-bag system*
2. Peritoneal catheter adapter*

Two-bag system The system consists of two bags connected by a Y-shaped set with a capped needle at its end; one bag contains the sterile peritoneal dialysis solution (2L), the other (4L approximate capacity) is empty. Two clamps prevent any possible flow between the bags during the exchange manoeuvre (Figure 1). The dialysate** compositions differ with respect to glucose content and in sodium and potassium concentration (Table I).

<table>
<thead>
<tr>
<th>Type of solution</th>
<th>Glucose 2%</th>
<th></th>
<th>Glucose 4%</th>
<th></th>
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<tr>
<td></td>
<td>DP 016</td>
<td>DP M₁</td>
<td>DP 017</td>
<td>DP M₂</td>
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<tr>
<td>Na⁺ mEq/L</td>
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<td>137</td>
<td>135</td>
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<td>K⁺ mEq/L</td>
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<td>Cl⁻ mEq/L</td>
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<tr>
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<tr>
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<tr>
<td>Acetate mEq/L</td>
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<td>–</td>
<td>38.5</td>
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</tr>
<tr>
<td>Lactate mEq/L</td>
<td>–</td>
<td>38.5</td>
<td>–</td>
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<tr>
<td>Osmolarity mOsm/L</td>
<td>375</td>
<td>375</td>
<td>472</td>
<td>472</td>
</tr>
</tbody>
</table>

Peritoneal catheter adapter The Y-shaped adapter is placed between the Tenckhoff catheter and the drainage-infusion set. The adapter is closed by a para-rubber material allowing multiple punctures (Figure 2).

A variant of this connector provides an antiseptic chamber to prevent the entry of micro-organisms during needle insertion.

Bag exchange technique

Approximately four hours after the previous fluid load, the patient prepares using general antiseptic procedures. He cleans his hands with antiseptic liquid and removes the entire dressing from the adapter which he cleans with gauze soaked in an iodine solution.

The patient then takes the bag system, frees the needle from the cap and connects it by piercing the rubber closure of the adapter. Drainage of the dialysate present in the peritoneal cavity into the empty bag begins by gravitational flow

* Manufactured by Bieffe SpA, Hospital Supplies Industry, Grosotto (SO), Italy
** Supplied by Bieffe SpA, Hospital Supplies Industry, Grosotto (SO), Italy
after its clamp has been opened. When the empty bag is filled, the clamp is shut.

The dialysate solution contained in the new bag, hung on a stand, is allowed to run into the peritoneal cavity immediately afterwards. This is effected by opening the clamp of the solution bag.

When the infusion is completed, the entire system is disconnected and discarded by the patient. He is now free of the bag until the next solution exchange, unlike the conventional CAPD technique.

The average time for a complete exchange (drainage and refill) is about 30–40 minutes. This procedure is usually performed five times a day six days per week, with a usual daily schedule of 2 litres hypertonic glucose solution (4%) for three exchanges at intervals of five, five and three hours; 2 litres of moderately hypertonic solution (2%) for one exchange after three hours and 1 litre of the same solution for the eight hour overnight period.

This schedule is occasionally changed according to the needs of the patients and to their specific laboratory data.
Results

Figure 3 illustrates the changes in BUN, creatinine and phosphorus in the 24 patients on our programme treated with the double-bag system CAPD. An impressive reduction of all these parameters as compared to those pretreatment was noted and constant values during the period of treatment were also observed. During

![Graphs of BUN, creatinine, and phosphorus over months.]

Figure 3. BUN, creatinine and phosphorus: mean values (X ± SE) of patients on CAPD with double-bag system

this period, serum phosphorus was satisfactorily controlled, resulting in a diminished requirement of antacid dose.

While haemoglobin (Figure 4) shows a progressive increase with the start of this treatment, reaching quite stable levels of about 10.5g% from the previous 8g%, serum protein did not show any significant change during the period of observation. Daily protein loss of about 15g in the peritoneal effluent fluid, may be overcome by a high protein diet. The low incidence of peritonitis may also explain such satisfactory levels of serum protein.

Figure 5 shows the behaviour of the blood pressure during CAPD using the double-bag system. In contrast with other authors, we have not observed a major decline in blood pressure with accompanying orthostatic hypotension. Since the
Figure 4. Haemoglobin and serum protein: mean values ($\bar{X} \pm SE$) of patients on CAPD with double-bag system

Figure 5. Blood pressure, triglycerides and body weight: mean values ($\bar{X} \pm SE$) of patients on CAPD with double-bag system
beginning of this therapeutic procedure, mean blood pressure has shown a progressive reduction — from 122mmHg to 105mmHg over a ten month period. Thereafter, a slight but constant increase was noted. The absence of orthostatic hypotension may be related to the high concentration of sodium in the dialysate.

Triglycerides appeared to increase universally, as is also reported by other authors involved in CAPD programmes [5]. Similarly, body weight increased progressively during this type of CAPD. The use of hypertonic glucose solutions with an absorption rate of about 45g per exchange may be a significant factor.

Complications

A total of ten episodes of peritonitis (two septic and eight chemical) were observed during our 19 month CAPD experience; this corresponds to an incidence of 22.5 patient/months in a total 225 month period.

The micro-organisms responsible for the septic episodes were Enterobacter cloacae and Staphylococcus aureus. In both cases, recurrent episodes significantly reduced the peritoneal clearance, thus inducing us to switch the patients to extracorporeal haemodialysis even though the peritonitis eventually yielded to antibiotic treatment.

In eight episodes of peritonitis we failed to isolate any bacterial micro-organism and in these cases we classified the peritonitis as chemical (aseptic).

In order to prevent outbreaks of frank peritonitis, we train each patient to test routinely the dialysate effluent with a strip sensitive to leucocyte concentrations. This test is fast and easy to perform and detects an increase in leucocytes of more than 25 cells per μL by means of a colour reaction [6]. When the result is positive, peritonitis is suspected and an immediate culture is performed.

Other complications observed during the CAPD programme include: back pain (12 patients), ankle oedema (3), hypertensive crisis (2), constipation (2), muscle cramps (2), lumbar pain (2) and hypotension (1).

The appearance of hypertensive crises in two patients may have been due to a high dialysate sodium concentration. These episodes responded to antihypertensive medication, and by modifying dry body weight, without necessitating any changes in diet or in dialysate sodium concentration.

Only one diabetic patient showed occasional hypotensive crises, most likely related to an impaired autonomic nervous system.

Outcome

The outcome for the 24 patients who originally entered this programme is as follows: 16 still remain on CAPD; 5 have returned to haemodialysis for various reasons — recurrent peritonitis (2), poor acceptance (2) and intestinal cancer (1); 3 have expired — 2 due to cerebral haemorrhage and 1 to myocardial infarction.

Discussion

The results obtained with our newly designed CAPD technique to date are very encouraging, considering the low rate of peritonitis and the great satisfaction on
the part of the patients, thanks to their freedom from the usual bag. The laboratory data also appeared satisfactory. Mean serum protein, despite a daily loss ranging from 10 to 15g, remained close to the normal level. These data are in keeping with those of other series of patients reported by Popovich and Oreopoulos.

The composition of the dialysis solution differs in sodium concentration from that usually employed in other centres [7]. This modification was suggested to prevent hypotension. In fact, the schedule of solution exchange provides for three bags with Na 135mEq/L and two bags with Na 137mEq/L, with a mean Na of about 136mEq/L. This sodium concentration appeared useful in preventing hypotensive crisis. Despite the increased sodium concentration, our patients did not experience increased thirst. We did, however, observe hypertensive crises in two previously hypertensive patients [8]. Excellent biochemical data and the general well-being of our patients allowed them to remain free of dietary restrictions: this led us to prefer a solution combination of six litres hypertonic (three bags) and three litres moderately hypertonic (one bag plus half a bag for the overnight period). Hypertriglyceridaemia, combined with increased body weight, is the most striking blood abnormality which often appears with the longest treatment periods. These findings seem to be related to the use of hypertonic dextrose solutions.

The high, stable level of haemoglobin associated with the well-being of our patients and with their excellent rehabilitation indicates to us that protection of the peritoneal membrane from septic or chemical damage is crucial for maintaining good clearance of uraemic toxins via the small and middle molecules. Nonetheless, our new technique frees the patient from the obsessional observance of sterile procedures, thanks to the adoption of a closed system, while also reducing the incidence of peritonitis [9]. At the same time, the absence of the bag around the patient’s waist gives him much more freedom and consistently contributes to achieving better rehabilitation. Furthermore, with the double-bag system it is possible to vary the volume of dialysate solution in relation to the anatomical and clinical condition of the patient with every exchange — especially valuable in children.

Our series includes two patients with diabetes mellitus who received intraperitoneal insulin and did not experience any episodes of peritonitis [10]. Our CAPD technique allows us to modulate the glucose load with every bag exchange, in direct relation to their specific clinical needs.

Conclusions

Contamination due to repeated connections is the major cause of peritonitis. Our new technique is aimed at solving this serious problem.

The advantages of conducting CAPD with a double-bag system are the marked reduction in the incidence of peritonitis, the elimination of the unpleasant burden of the bag around the patient’s waist, and freedom to change volume load with every bag exchange and thus also the glucose load; a feature of particular interest in the management of two diabetic patients.

We routinely use a catheter adapter which requires substitution twice a month.
This safe and simple technique implies a short and easy training period. Our type of CAPD encountered complete acceptance amongst the patients, owing to the simplicity of the technique, the reduction of major complications, and their freedom, due to the disposability of the entire system immediately after use. This resulted in better rehabilitation and improved psychological condition of the patients. A small increase of the cost of CAPD has to be considered, due to the empty bag, but this is irrelevant in the light of its many benefits.

References

6. Chan LK, Oliver DO. Lancet 1979; ii: 1336

Open Discussion

KHANNA (Toronto) Reviewing our experience of peritonitis in 122 patients treated with CAPD in Toronto Western Hospital, in the first two months we had a steady rate of peritonitis ranging from 1.2 to 1.4 episodes per patient year. Since then, in the last one and a half years the rate has been steadily declining and at present we have a rate of 0.4 episodes per patient year. Expressed another way it comes to one episode every thirty months and this episode was recorded in 57 patients, giving a total of 125 episodes in these patients. We have over 22 patients who have had no peritonitis over one year and three patients with no peritonitis over two years.

COLOMBI (Lucerne) At what rate of time do you exchange the adaptor and how long do you leave it on?

BAZZATO I change this adaptor twice a month.

WOLF (Vienna) I am interested in the diameter of the needle used to go through the rubber cap.

BAZZATO They are 2mm internal diameter.

BROWN (Sheffield) Can you tell me the difference in cost using the two bag system as opposed to the old type using the one bag system?
BAZZATO There is a slight increase of cost.

BOEN (Chairman) What do you put as a solution in the aseptic chamber?

BAZZATO We are running a little trial as to which one is best for the patient.

BOEN But what are you using?

BAZZATO Iodine solution and an antiseptic available only in my country which is a hypochlorite solution.

BOEN Doesn’t it go into the peritoneal cavity?

BAZZATO No, because my system goes first to the drainage.

KRAMER (Göttingen) Since you are using a needle with an internal diameter of 2mm only, what is the time the patient needs for one exchange of peritoneal fluid?

BAZZATO Yes, the complete time is about 20 to 25 minutes drainage and infusion.