International Urology and Nephrology 12 (3), pp. 229–240 (1980)

Satellite Peritoneal Dialysis

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(Received December 11, 1978)

In 29 cases of chronic renal failure 1325 peritoneal dialyses were performed between January 1, 1976 and April 31, 1978. The technique of peritoneal dialysis, the general lines of supervision and follow-up, the results and shortcomings of the procedure are discussed.

Peritoneal dialysis is regarded as an alternative to haemodialysis in chronic renal failure. On ground of the favourable observations, organization of satellite PD services on a large scale, parallel with the expansion of other services (haemodialysis, renal transplantation), is advocated.

In the last two decades chronic intermittent haemodialysis and renal transplantation have brought decisive changes in the management of chronic renal failure. Yet the two methods have their limitations experienced to a greater or lesser degree all over the world. In the case of dialysis it is a disproportion between demand and supply, in that of transplantation the lack of adequately matched kidneys which pose the main problems.

According to the latest statistical figures issued by the European Dialysis and Transplantation Association [7], the number of patients being on a long-term dialysis program on our Continent has attained 31,842 by the end of 1977, and the number of renal transplantations performed between 1954 (the year of the first successful intervention of this kind) and 1977 is as high as 17,243. This progress is comparable in scope and significance only to pacemaker therapy.

Despite the prodigious advances, the facilities are not in proportion to the demands. According to statistical figures for Europe dating from 1977, the rate of dialysed patients was 58.8, and of patients with functioning renal grafts 13.6 per one million population. On the other hand, the number of recently diagnosed cases of chronic renal failure has been between 19 and 125 per one million population [1, 21, 28, 33, 35].

On the evidence of a pilot study carried out in five regional counties (Somogy, Tolna, Vas, Veszprém, Zala) of 1.5 million population assigned to the Haemodialysis Unit, University Medical School, Pécs, the number of patients with renal failure requiring dialysis or renal transplantation was 33 in one million population, between 15 and 55 years of age [17]. On the other hand, the Haemodialysis Unit

is unable, even at full capacity, to handle more than 23 to 25 patients. Under the given circumstances chronic peritoneal dialysis (PD) offers the only way of increasing dialysis capacity.

The satellite dialysis program, controlled by an advisory center, was prompted by the disproportion between the large number of patients requiring dialysis and the limited facilities, on the one hand, and by difficulties of access to the Dialysis Unit by patients from distant rural areas, on the other [5, 25].

In conformity with this plan, chronic PD was started by insertion of the Tenckhoff catheter [8, 14, 23] at the Haemodialysis Unit, University Medical School, Pécs, and the patients were kept there for a brief period of observation. When the first PD had been uneventful, the patient was returned to the unit from which he had been referred to us, but we remained in contact with the medical staff in charge of the case.

The aim of the present study has been to promote the organization of a PD network, which is now under way in this country.

Material

Between January 1 and April 31, 1978, 29 patients with chronic renal failure were treated in the framework of a centrally controlled satellite PD program. The total number of PD was 1325.

The patients were between 16 and 63 years of age (average 42 years). The male-to-female ratio was 17 : 12. The primary disease was chronic glomerulonephritis in 20, chronic pyelonephritis in 6 cases, glomerulonephritis of rapid progress, Goodpasture's syndrome and Wegener's granulomatosis in one case each.

The institutions participating in the PD program, the number of patients and treatment, as well as the time since the start of PD per patient are summed up in Table 1.

In the interest of consistent lines of treatment the medical and nursing staff of the units engaged in PD attended a consultation of a few, maximum 7, days at the Dialysis Unit of the University Medical School, Pécs.

Technique of PD

After premedication with Seduxen (diazepam) the Tenckhoff catheter was passed 4 cm below the umbilicus or in the middle between the spina iliaca anterior and the umbilicus through a subcutaneous channel, a 30 to 40 mm long incision having been made in local anaesthesia. The dacron ring of the abdominal side was fixed subfascially, the external ring in the subcutaneous portion of the canal by closure of the wound in layers.

Table 1

Institutes taking part in the peritoneal dialysis program

Institute	No. of patients	No. of PD	Time since start of PD (months)
University Medical School, Pécs, Department of Urology	11	795	96
University Medical School, Pécs, II. Department of Medicine	12	369	51
University Medical School, Pécs, I. Department of Medicine	2	13	4
County Council Hospital, Bonyhád, Department of Medicine	1	55	10
County Hospital, Kaposvár, Intensive-care Unit	1	39	6
County Council Hospital, Veszprém, Department of Urology	1	22	5
County Council Hospital, Celldömölk, Department of Medicine	1	32	4
Total	29	1325	176

PD was started immediately after insertion of the catheter and continued, if possible, for 24 hours. In case of necessity for changing the catheter, the new catheter was inserted and fixed at the side of the previous one, unless subcutaneous inflammation had developed.

For PD the intermittent infusion technique of Maxwell [19] was used, the time of retention being 20 to 30 min, and the amount of dialysing fluid 1000 ml per cycle. The dialysing fluid was Perisol, types ID, I DK, 2 D and 2 SK, made by the Institute for Vaccine Production and Research, Human, Gödöllő. In individual cases a fluid of type 1 DK, with lactate instead of acetate (prepared in the dispensary of the University Medical School, Pécs), was used.

Prior to the start of PD the temperature of the solution was brought to 38 °C and 0.1 ml heparin was added per 1000 ml for the prevention of obstruction of the catheter by fibrin or blood clots, 50 mg Oxacillin or Ampicillin for the prevention of abdominal infection, and in case of need, 3 to 5 ml of 2 per cent Lidocain for the attenuation of abdominal pain.

At the end of PD, 500 ml Peridisol, 1 ampoule Ampicillin or Oxacillin and 0.5 ml heparin were left in the peritoneal cavity.

General lines of supervision and follow-up

The time of dialysis averaged 16 to 20 hours twice a week, the amount of dialysis fluid 30 to 50 litres per dialysis, depending on the clinical condition, residual renal function and diuresis. It was sought to perform the dialyses at fasting serum BUN and creatinine levels not higher than 120 to 130 mg/100 ml and 12 to 14 mg/100 ml, respectively. In case of an increase in the values, or of clinical deterioration, or of some hypermetabolic complication since the last PD, the amount of dialysing fluid per week was increased and the time of dialysis prolonged.

Patients who had been hypertensive also earlier received Peridosol 2 D (mOsm/l: 680) or Peridosol with a 10 per cent mannite solution (1 : 1), so as to attain gradual evacuation of the retained fluid, normalization of blood pressure and to maintain body weight at the optimal level.

In patients who had been brought into equilibrium by PD the laboratory tests were performed at the morning of dialysis (so as to avoid blood loss). Blood counts, serum carbamide-N, creatinine, electrolytes, uric acid were examined weekly, serum total proteins and electrophoresis every two weeks, liver function and HB_sAG at monthly intervals. Protein loss with the dialysis fluid was measured by the biuret method.

PD was performed under strictly aseptic conditions. In the interest of early detection of possible abdominal infections a sample for bacterial culture was taken from the dialysing fluid emptying from the Tenckhoff catheter on its opening prior to each treatment. If the dialysing fluid left in the peritoneal cavity had been absorbed in the meantime, the sample for bacteriologic study was taken from the effluent before adding the antibiotic to the dialysing fluid.

The patients were started simultaneously with PD on a diet of varied composition with 1 g protein per kg body weight, prevalently of full biological value. The dietary restrictions were directed at fluid intake, depending on diuresis, at salt intake in case of hypertension and, in individual cases, at the consumption of fruits and vegetables. A parenteral or peroral high-protein substitution was provided at serum albumin levels below 2.8 g per 100 ml by infusions of 15 per cent albumin, 5 per cent plasma protein, less frequently by essential amino acids in the form of infusions or capsules.

Results and discussion

The policy of PD, or rather its selection as an alternative to haemodialysis, had been made necessary by the prevailing situation (Table 2). The chronic shortage of haemodialysis capacity had been one of the main causes of our decision.

In 10 of the present cases PD was undertaken for the preparation of chronic intermittent haemodialysis. The majority of these patients came under observation in an advanced, often even terminal, stage of uraemia and were kept on PD for an

Table 2

Indications for chronic peritoneal dialysis

Indication	No. of patients	Age (years)	Peritoneal dialysis		
			total number	average number	time (months)
1. Preparation for haemodialysis	10	28 (16–42)	115	11.5 (3–35)	1.5 (0.5–3.5)
2. Haemodialysis practicable	2	44	366	183 (104–262)	23.5
3. Complications during haemodialysis	1	46	19	19	2
4. Patients unsuited for a transplantation program	16	49 (34–63)	825	51.5 (8–147)	7 (1–17)

average period of 6 weeks until the shunt was set up. Two of them had all clinical and radiological signs of pericarditis when started on PD. Administration of steroids and PD were of no benefit despite a considerable fall in certain laboratory parameters of renal failure (serum carbamide-N < 80 mg/100 ml, serum creatinine < 8 mg/100 ml). One patient died after the fourth, another after the sixth PD, 24 hours after pericardiectomy. The other eight patients of this group were assigned to a chronic haemodialysis program.

In two patients PD had been made necessary by our failure of setting up a shunt for haemodialysis. Owing to slenderness of the blood vessels, repeated attempts had been made in both cases to construct a Scribner shunt or an arteriovenous fistula. An autologous saphena loop was applied to the forearm, but only a few haemodialysis treatments had been possible because of thrombosis. Both patients improved on PD, to the degree of being able to attend to their household chores. Both have been now on PD as outpatients for 20 and 27 months, respectively.

In one of the patients thrombosis of the fistula ensued 18 months after the start of haemodialysis and she was placed on transitory PD until a new shunt was set up.

In view of our present possibilities 16 patients unsuited for a transplantation program were placed on PD. The causes of this decision included advanced age, diabetes, heart failure and systemic disease. On completion of the present study the 16 patients had a total of 825 PD. The time of treatment averaged 7 months, the number of PD per patient 51.5.

The results in those patients in whom only PD could be considered owing to failure of the shunt (S. A., aged 46 and G. I., aged 42) or to unsuitability for transplantation, are presented in Fig. 1. In regard of rehabilitation as a result of PD the patients were classified into three groups, i.e. "capable of work", "ambulant but disabled" and, in consequence of some complication associated with uraemia, "hospitalization required". In the last-mentioned three cases it was not the state of health but the distance from their homes to the unit being in charge of PD, which had made hospitalization necessary.

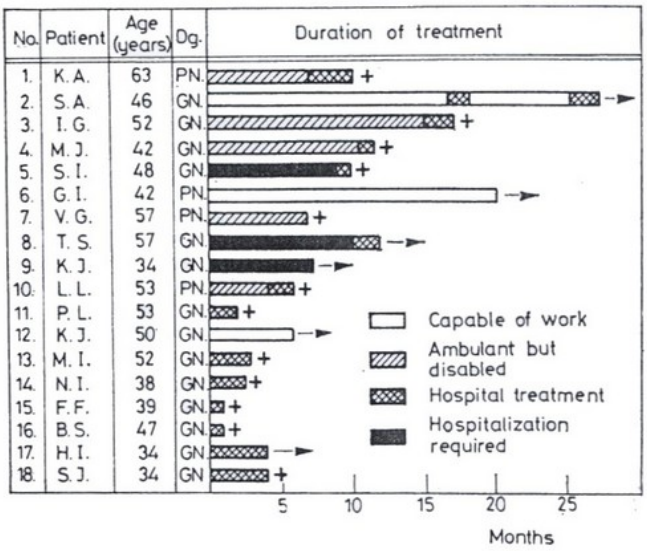

Fig. 1. Results of PD started because of failure of the shunt or contraindications to renal transplantation

Laboratory findings under the effect of PD

The basic factors deciding the success of PD are the duration of treatment and the amount of exchanged dialysis fluid, in other words, the cycle time (time of inflow + time of retention + time of outflow). If the decrease of the small-molecular substances (serum carbamide-N, creatinine per time unit) is considered, PD is inferior to haemodialysis in efficiency. In 16 patients exchange of 25 l Peridisol in 17.6 $\pm$ 2.6 hours produced a percentage decrease of 36.5 $\pm$ 11.05 for serum carbamide-N, and 26 $\pm$ 7.2 for serum creatinine. The respective figures in case of a 7-hour dialysis with a capillary dialyser (CDAK) of 1.3 sq.m surface were 61.3 and 46.3 per cent, respectively [16].

In our experience, even in the presence of high serum carbamide-N, appetite, general well-being and strength improved more rapidly in the PD group than in the haemodialysis group. In fact, the small-molecular substances are rough indicators

of the severity of the uraemic state and their increased levels are still compatible with a relative equilibrium.

The observation that despite the high blood levels of small-molecular substances the incidence of polyneuropathy and pericarditis is lower in case of PD [30, 32] than of haemodialysis, has brought the "middle-molecular" theory [2] into existence, which, in its original formulation, claims that PD provides for the elimination of middle-molecular substances (Mw 300 – 5000 D) of polypeptide character from the fluid spaces, these very substances being held responsible for the symptoms of uraemic toxicosis [3]. Though the part played by middle-molecular substances has remained uncertain to the present day, published evidence suggests that owing to the selectivity of the peritoneum it is the toxic fraction X_1 (Mw $\simeq$ 1500) which will be eliminated in the first place in this molecular range [12, 13, 15, 29].

In a number of patients the serum carbamide-N and creatinine values measured at the morning of PD were found higher than expected (serum carbamide-N 120 – 130 mg/100 ml, creatinine 12 – 14 mg/100 ml) (Fig. 2). This was due to occasional difficulties (delay in the dialysate supplies, shortage of staff, etc.).

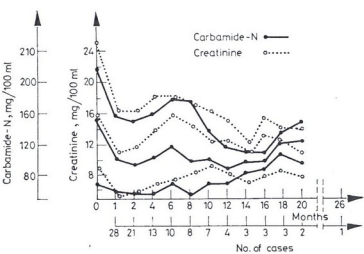

Fig. 2. Mean and outside values of serum carbamide-N and creatinine

It is to be noted that short daily PD [10] or continuous PD with prolonged retention of the dialysis fluid for 4 to 5 hours [23] may produce a considerable and sustained decrease in the levels of small- and middle-molecular substances.

In the present cases the average serum total protein and serum albumin values showed a gradual decline despite administration of human albumin and plasma protein (Fig. 3). The most favourable values were found after the 14th month in those three patients who had been on PD for the longest time. The general condition too had been better in these three cases at the very outset than in the

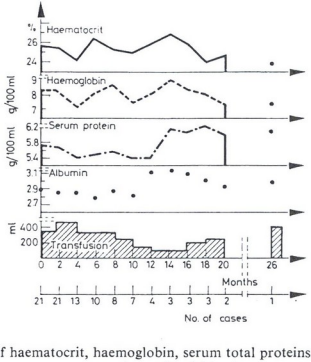

Fig. 3. Mean values of haematocrit, haemoglobin, serum total proteins and monthly requirements of transfused blood

others. Blood requirement per patient varied between 100 and 500 ml, haematocrit values were between 24 and 26 per cent and haemoglobin values between 7.3 and 9.0 mg/100 ml.

Complications of PD

The relatively uncommon complications of PD, which can be prevented by close supervision of the patient (disorders of electrolyte and acid–base metabolism, hyperglycaemia, pulmonary congestion), are amply documented in the literature [4, 20, 22].

Under the present technical conditions the potential obstacles to chronic intermittent PD comprise the direct complications related to the Tenckhoff catheter, abdominal infections and protein depletion. Complications of this kind observed in the present cases will be discussed below in more detail.

In the course of 1325 dialyses, in 29 cases of chronic renal insufficiency 46 insertions of Tenckhoff catheters into the abdominal cavity were performed (Fig. 4). On completion of the present study 8 catheters were in operation, 6 had been removed intentionally, in 16 cases the catheters had been in operation until death and in 16 cases they had to be changed. Insertion of a new catheter had been made necessary by fibrin deposition in 2, by omental adhesions in 7 and by peritonitis in 7 cases. One of the patients had to be placed on haemodialysis earlier than planned because of peritonitis and consecutive peritoneal adhesions.

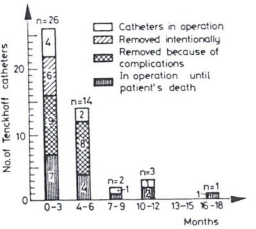

Fig. 4. Duration of the function of Tenckhoff catheters

Infections of the abdominal cavity consecutive to PD, though of major severity, are usually responsive to therapeutic measures. Their incidence, related to the number of dialyses, has been estimated at 0.1 to 3.2 per cent [6, 9, 24, 26]. The infection spreads from the skin surface, as a result of an inflammation of the subcutaneous channel, through the catheter to the peritoneal cavity, or it may be due to a bacterial invasion from the intestinal lumen.

In the present study 117 cultures in association with 1325 PD (i.e. 13.3 per cent) yielded bacterial growths without any sign of peritonitis. Manifest peritonitis was found in 15 cases (1.1 per cent). The pathogens were *Pseudomonas aeruginosa* in 5, *Klebsiella* in 3, *E. coli* in 3, *Proteus* and *Staph. aureus haem.* in one case each. The effluents of two patients yielded *Candida albicans* cultures. The intraabdominal infection was brought under control in all of the 15 cases.

The general lines of conduct in peritonitis were the following:

1. In case of prolongation of the cycle time, the Tenckhoff catheter was changed.

2. Instead of the two PD of 16 to 20 hours per week, 4 to 5 PD per week, each of 8 hours, were applied. The retention time for Peridosol was reduced to zero and the weekly fluid exchange was increased to 60 – 70 l.

3. If an abdominal bacteriological finding was available, specific antibiotic therapy was applied on the ground of the sensitivity tests, otherwise Ampicillin, Oxacillin or Keflin and Gentamycin were administered parenterally or applied locally. For parenteral administration Ampicillin and Keflin were used in half the usual doses, Oxacillin in full doses, adding 100 mg Keflin, 50 mg Ampicillin and Oxacillin per litre of Peridisol. Gentamycin was administered 2 to 3 times a week in doses of 80 mg, and locally, of 8 mg/l, consideration being given to the peritoneal excretion. In peritonitis caused by *Candida albicans* 5 mg fluorocytosin per litre was given.

4. This reinforced PD was continued until three successive bacterial cultures had proved negative.

5. Administration of antibiotics, in accordance with the sensitivity of the causative pathogens, was continued for six weeks after control of peritonitis, in order to prevent recurrences or the development of some encapsulated intraabdominal process.

Prevention of abdominal infections consecutive to PD may be expected, strictly aseptic conditions being taken for granted, from the use of closed system automatic devices [18, 20, 35] and from the development of abdominal catheters of new types.

Protein loss resulting from PD is related to the duration of treatment and to the amount and osmolarity of the exchanged dialysis fluid. In the present cases protein loss for each 25 l Peridisol 1 DK varied between 6.3 and 37.2 l [27]. It is to be noted that the protein fraction washed out with the first fifth of the dialysing fluid was as high as 30 to 50 per cent of the protein loss.

The planned daily dietary intake of 1 g protein per kg body weight proved illusory in some cases. The consequence was a fall in serum albumin. Administration of 15 per cent albumin and 5 per cent plasma protein was of little benefit. On the evidence of published data, administration of ketoanalogues of essential amino acids [34] and addition of essential amino acids to the dialysing fluid [11] seem promising.

Review of the death figures set out in Table 3 comprises only those cases in which PD was the last treatment. The direct cause of death was not connected with complications of PD in any of the cases. In Group 2, two patients died of haemorrhagic pericarditis.

Table 3

The causes of death by primary disease

Cause of death	Primary disease					
	PN	GN	rGN	Nephro. scl.	Other	Total
1. Heart and circulatory failure	2	5	1	1	—	9
2. Pericarditis	—	2	—	—	—	2
3. Cerebral haemorrhage	1	—	—	—	1	2
4. Pneumonia	—	—	—	1	—	1
Total	3	7	1	2	1	14

PN = chronic pyelonephritis
GN = chronic glomerulonephritis
rGN = Glomerulonephritis of rapid progress
Nephro. scl. = Nephrosclerosis

PD may thus be summed up as an alternative to haemodialysis for the management of chronic renal failure in the following cases:

1. shortage of haemodialysis capacity;
2. preparation for "live"-donor transplantation if the time between the start of PD and the planned transplantation is short enough;
3. preparation for haemodialysis, until construction of the arterio-venous shunt;
4. complications consecutive to haemodialysis (thrombosis of fistula, pericarditis, subdural haematoma, etc.);
5. uncertainty at the given date whether the patient's advanced uraemic state will be compatible with a transplantation program at some later time;
6. patients unsuited for a transplantation program (cardiac failure, diabetes, systemic diseases, advanced age);
7. children younger than 3 or 4 years.

From the review of the present cases PD has emerged as a valuable alternative to haemodialysis or renal transplantation for the management of chronic renal failure. Organization of a decentralized satellite system of PD would be welcome in the interest of rehabilitation of the patients. It would be desirable that the services for PD should be at a short distance from the patients' homes.

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