Yonsei Medical Journal
Vol. 31, No. 1, 1990

# Influence of Nutritional Status on CAPD Peritonitis

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*To investigate the effect of nutritional status of continuous ambulatory peritoneal dialysis (CAPD) patients on the development of peritonitis, a cross-sectional sutdy of the nutritional status of 79 CAPD patients and a retrospective study on the incidence of peritonitis in these patients were done. The incidences of peritonitis were compared according to the nutritional status of these patients on CAPD. Protein-caloric malnutrition assessed by a score system based on triceps skinfold thickness, mid-arm circumference, serum albumin level and relative body weight was demonstrated in 27 patients (34%) among 79 total CAPD patients. The incidence of peritonitis was significantly higher in poor nutritional status patients, with 1.09±0.86/patient-year, than that in normal nutritional status patients with 0.64±0.72/patient-year ($p<0.05$). In patients with the same nutritional status, patients using Dianeal solution had a trend of a lower incidence of peritonitis than those using Peritosol solution. In conclusion, the nutritional status and possibly the type of CAPD solution may influence CAPD peritonitis as risk factors.*

**Key Words:** Nutritional status, CAPD, protein-caloric malnutrition, peritonits

Unfortunately, peritonitis continues to be the major complication of continuous ambulatory peritoneal dialysis (CAPD). The incidence of peritonitis has been reduced markedly nowadays, especially with improvements in connecting devices of the transfer system of CAPD, for example, Y-set and O-set (Mariorca *et al.* 1983; Cantaluppi *et al.* 1986; Lempert *et al.* 1986).

As the external contamination during the exchange of CAPD solution decreased with those devices, endogenous defense mechanisms including local intraperitoneal defensive factors were being studied recently for the further reduction of peritonitis in patients on CAPD (Rubin *et al.* 1983; Verbrugh *et al.* 1983; Goldstein *et al.* 1984; Lamperi and Carozzi, 1986). We also experienced many cases who developed peritonitis without a definite history of external contamination and some had to give up CAPD due to recurrent peritonitis.

Received December 6, 1989
Accepted January 15, 1990
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We performed a cross-sectional study of the nutritional status of CAPD patients and compared the retrospective incidences of peritonitis of these patients according to the nutritional status and the type of CAPD solution being used to define the importance of nutritional status and type of CAPD solution as risk factors of peritonitis in patients on CAPD.

## MATERIAL AND METHODS

### Patients

Among 187 patients on CAPD in November 1989 at the dialysis center in Yonsei Medical Center, seventy-nine patients who agreed to do this study and who met this study criteria, and 130 normal healthy control subjects were studied.

Exclusion criteria in patients on CAPD were malignant disease, steroid treatment in the recent 3 months, diabetes mellitus, terminal lung or heart disease, and chronic inflammatory bowel disease. We included only those patients who cooperated for the measurements of all kinds of nutritional parameters throughout this study and those only on CAPD for more than the past 6 months.

All patients used 4 bags of CAPD solution daily, mostly 3 bags of 1.5% and 1 bag of 4.25% dextrose

solution. Forty-six patients used Dianeal solution (Baxter, USA) and 33 patients used Peritosol solution (Green Gross Med. Corp., Korea) for CAPD. The nutritional parameters were measured in 130 normal control subjects, consisting of kidney donors for renal transplantation, medical students, nurses, and doctors, to obtain the reference values of the nutritional status at similar age and sex with the study group. Blood chemistry including serum albumin was measured monthly in all patients.

We measured height, body weight, mid-arm circumference (MAC) with an ordinary tape measure, and triceps skin-fold thickness (TSF) by Range fat caliper.

Relative body weight (RBW) was calculated from the formula RBW = 100% × observed weight/reference weight. Reference weights were the values measured from normal control subjects. MAC and TSF were expressed as percentile of normal control values.

### Nutritional Score System

The nutritional status was classified as poor nutritional status and normal nutritional status according to the score system obtained from the nutritional parameters of RBW, TSF, MAC and serum albumin levels. A value of 0, 1, or 2 was given for each parameter (Table 1). Addition of scores yielded a total score for each patient varying from 0 to 8. A total score of 0-2 indicated normal nutritional status and that above 3, poor nutritional status.

### Statistical analysis

The number of peritonitis episodes was calculated for each patient during the period of CAPD and expressed per patient-year of exposure.

Independent t-test and chi-square test were performed using 5% significance level.

**Table 1. Nutritional score system**

| Scores / Parameters | 0 | 1 | 2 |
|---|---|---|---|
| RBW (%) | >90 | 80 - 90 | <80 |
| TSF (percentile) | >90 | 60 - 90 | <60 |
| MAC (percentile) | >90 | 60 - 90 | <60 |
| Albumin (g/dl) | >3.5 | 3.0 - 3.5 | <3.0 |

Abbreviations: RBW; relative body weight, TSF; triceps skin fold thickness, MAC; mid arm circumference

## RESULTS

### Patient Characteristics

There were no statistically significant differences in sex ratio and mean age between normal and poor nutritional groups. The durations of CAPD in normal and poor nutritional groups were 26.2±19.5 months and 19.4±13.9 months respectively without significant difference (Table 2).

### Nutritional Score

The total score was within the normal range, meaning normal nutritional status with a score less than 2, in 52 patients (66%) out of the total 79 CAPD patients, and 27 patients (34%) showed poor nutritional status with a total score of more than 3 (Table 2).

The respective score distribution of each nutritional parameter showed a balanced distribution between 0 and 2 in TSF and MAC, but RBW and albumin levels revealed normal values in almost all patients (Table 3).

### Peritonitis According to the Nutritional Status

The incidence of peritonitis was significantly higher in the poor nutritional group (n=27) with 1.09±0.86/patient-year than in the normal nutritional group (n=52) with 0.64±0.72/patient-year (Tabel 4).

**Tabel 2. Patient characteristics**

| Nutritional status / Patient characteristics | Normal | Poor |
|---|---|---|
| Number | 52 | 27 |
| Male : Female | 1.5 : 1 | 2.1 : 1 |
| Age (year) | 45.5±11.6* | 43.7± 9.7 |
| Duration of dialysis (Mo) | 26.2±19.5 | 19.4±13.9 |

* Results are expressed as Mean±S.D.

**Table 3. Distribution of nutritional scores**

| Score / Parameters | 0 | 1 | 2 |
|---|---|---|---|
| RBW (%) | 74* | 5 | 0 |
| TSF (percentile) | 34 | 7 | 38 |
| MAC (percentile) | 41 | 8 | 30 |
| Albumin (g/dl) | 72 | 6 | 1 |

* Number of patients
Abbr. are same as in Table 1.

### Peritonitis According to the Dialysate

The patients using Dianeal solution (n=46) as a dialysate showed a lower incidence of peritonitis, with 0.48±0.56/patient-year, than that of patients using Peritosol (n=33) with 1.05±0.99/patient-year (Table 5).

In 52 patients showing normal nutritional status, the peritonitis incidence of the Peritosol group (n=14) was also relatively higher, with 0.99±1.12/patient-year, than that of the Dianeal group (n=38) with 0.51±0.49/patient-year and the total nutritional scores were 1.00±1.01 and 0.56±0.79 respectively (Table 6).

In 27 patients with poor nutritional status, the incidence of peritonitis was also quite different according to the type of dialysate, with 0.41±1.21/patient-year in the Dianeal group (n=8) and 1.38±1.01/patient-year in the Peritosol group (n=19). And their total nutritional scores revealed 3.75±0.46 in the Dianeal group and 3.84±0.50 in the Peritosol group respectively (Table 6).

Among the patients using Peritosol as a dialysate, the incidence of peritonitis in the poor nutritional group (n=19) was higher, with 1.38±1.01/patient-year, than that of the normal nutritional group (n=14) with 0.99±1.12/patient-year (Table 7). In contrast to those, the patients using Dianeal solution showed similar incidences of peritonitis in normal (n=38) and poor (n=8) nutritional groups with 0.51±0.49/patient-year and 0.41±1.21/patient-year respectively (Table 8).

**Table 4. Peritonitis according to the nutritional status**

| Nutritional status | Number of patients | Incidence of peritonitis (episodes/patient-year) |
|---|---|---|
| Normal | 52 | 0.64±0.72*# |
| Poor | 27 | 1.09±0.86 |

* Reslts are expressed as Mean ± S.D.
# $p<0.05$ normal vs poor nutritional group

**Table 5. Peritonitis according to the dialysate**

| Dialysate | No. of patients | Incidence of peritonitis (episodes/paient-year) |
|---|---|---|
| Dianeal | 46 | 0.48±0.56*# |
| Peritosol | 33 | 1.05±0.99 |

* $p<0.01$, Dianeal vs Peritosol
# Reults are expressed as Mean ± S.D.

**Table 7. Peritonitis in patients using Peritosol solution**

| Nutritional status | Number of patients | Incidence of peritonitis (episodes/patient-year) |
|---|---|---|
| Normal | 14 | 0.99±1.12* |
| Poor | 19 | 1.38±1.01 |

* Results are expressed as Mean ± S.D.

**Table 8. Peritonitis in patients using Dianeal solution**

| Nutritional status | Number of patients | Incidence of peritonitis (episodes/patient-year) |
|---|---|---|
| Normal | 38 | 0.51±0.49* |
| Poor | 8 | 0.41±1.21 |

* Results are expressed as Mean ± S.D.

**Table 6. Peritonitis according to the nutritional status of patients and the dialysate**

| Nutritional status | Dialysate | No. of patients | Score | Incidence of peritonitis (episodes/patient-year) |
|---|---|---|---|---|
| Normal | Dianeal | 38 | 0.56±0.79* | 0.51±0.49 |
| | Peritosol | 14 | 1.00±1.01 | 0.99±1.12 |
| | Subtotal | 52 | 0.68±0.81 | 0.64±0.72** |
| Poor | Dianeal | 8 | 3.75±0.46 | 0.41±1.21 |
| | Peritosol | 19 | 3.84±0.50 | 1.38±1.01 |
| | Subtotal | 27 | 3.81±0.51 | 1.09±0.86** |

* Results are expressed as Mean ± S.D.
** $p<0.05$ normal vs poor nutritional group

## DISCUSSION

Infectious complication has been the major obstacle in maintaining continuous ambulatory peritoneal dialysis (CAPD) in patients suffering from end-stage renal disease (ESRD), even though CAPD has proven to be a good alternative to hemodialysis (HD) as a method of maintenance dialysis (Moncrief 1979; Blagg and Scribner 1980). Above all, peritonitis remains the single most important complication of CAPD. The combined financial burden and the considerable patient morbidity and mortality associated with peritonitis have limited the appeal of this dialytic modality in ESRD patients (Rubin *et al.* 1980).

Several studies suggest that malnutrition is an important factor for morbidity and mortality in dialytic patients (Degoulet *et al.* 1982; Acchiardo *et al.* 1983; Schoenfeld *et al.* 1983). Substantial loss of protein into the dialysate is another drawback with peritoneal dialysis. In CAPD, the reported average loss of protein into the dialysate varies between 5 and 15gm per day in different studies (Katirtzoglou *et al.* 1980; Blumenkrantz *et al.* 1981; Dulaney and Hatch 1984) and the protein loss may increase considerably, usually by 50-100% during peritonitis and may remain elevated for several weeks (Blumenkrantz *et al.* 1981; Bannister *et al.* 1987). CAPD patients can be confronted with a situation leading to malnutrition, especially in patients with recurrent peritonitis due to this protein loss in addition to the protein-caloric malnutrition associated with chronic renal failure.

With the method of nutritional evaluation (Table 1) modified from that of Marckmann (1988), individual nutritional scores revealed that triceps skin fold thickness (TSF) and mid-arm circumference (MAC) showed even distribution between patients with normal and poor nutrition, but relative body weight (RBW) and serum albumin level showed that patients with a normal nutritional pattern are predominant even though these are the same patients (Table 3). Further studies on the relative significance of these parameters are needed to evaluate the nutritional status completely in CAPD patients.

In a cross-sectional study, Marckmann (1988) reported that protein-energy malnutrition, assessed from a score system based on triceps skin fold, mid-arm muscle circumference, serum transferrin and relative body weight, was recorded in 56% of CAPD patients (9/16 patients) and in 53% of HD patients (17/32 patients). But in our study, poor nutrition was noted in 34% of CAPD patients out of 79 patients (Table 2).

The incidence of peritonitis and length of hospital stay have also been found to be greater in CAPD patients with malnutrition in another study (Young *et al.* 1986). Our results showed that peritonitis developed more frequently in patients with poor nutrition than in those with normal nutrition (Table 4). It cannot be ruled out that in some patients, recurrent peritonitis is the primary event, and malnutrition is a secondary event. But in our patients using Dianeal solution as a dialysate, no difference was noted in the incidence of peritonitis between normal and poor nutritional groups, suggesting that malnutrition may not result from recurrent peritonitis in our cases (Table 8).

In this country, two kinds of CAPD solution, which are Peritosol (Green Gross Med. Crop., Korea) and Dianeal (Baxter, USA), are available. We noted a higher incidence of peritonitis in patients using Peritosol solution compared to those using Dianeal solution in a previous study (Kim *et al.* 1989). Because those differences could have resulted from many different factors unrelated to the soltuion itself, such as differences in socioeconomic conditions, we compared the incidences of peritonitis between each solution group with similar nutritional status. The patients with Peritosol solution showed also a higher rate of peritonitis than those with Dianeal solution with the incidences of 1.05±0.99 and 0.48±0.56/patient-year respectively (Table 5). When we looked at the peritonitis rates according to the nutritional status in each type of CAPD solution, the Peritosol group also showed higher rates of peritonitis in both normal and poor nutritional status compared to those using Dianeal solution (Table 6).

Marichal *et al.* (1986) also reported different rates of peritonitis according to the brand of CAPD solution, suggesting the composition of the solution used played a role in the risk of developing peritionitis.

The role of the buffer in CAPD solution against peritonitis has been discussed. Richardson and Borchardt (1969) suggested that acetate solution may provide greater protection from peritonitis than lactate solution but Binswanger *et al.* (1981) demonstrated in an in vitro study that the use of acetate or lactate does not modify the replication of bacteria or the phagocytosis by normal human leukocytes. However, both types of CAPD solution used by us are made of the same buffer, lactate.

It is well-known that low pH and high osmolality of the solution decrease the efficiency of phagocytosis in the peritoneal cavity (Duwe *et al.* 1981; Harvey *et al.* 1987; McGregor *et al.* 1987) but these are also very similar in both of our solutions.

From a different point of view, unfitness, in-

complete sealing of connection sites or decreased elasticity of the spike system of the CAPD transfer sets could be other factors of external contamination leading to peritonitis, especially in patients with poor nutrition where even a minor contamination could result in severe peritonitis. As a possible evidence for this suggestion, the patients using Peritosol solution developed a higher rate of peritonitis in the poor nutrition group than in the normal nutrition group, but in patients with Dianeal solution, no difference in the peritonitis rate was noted between normal and poor nutrition groups (Tabel 6).

Even though peritonitis has been reduced remarkably nowadays thanks to major advances in the technology of CAPD, further reduction of the peritonitis rate is necessary to choose CAPD without hesitation in patients with ESRD.

If improved nutritional status could improve host defenses in uremic patients, this might contribute to a greater reduction of peritonitis. Further study will be needed to determine whether immunologic dysfunction is related to the nutritional status in patients on maintenance dialysis.

It can be suggested that several factors may be responsible for the different rates of peritonitis in patients using different brands of CAPD solution. These factors require an additional randomized investigation through a cooperative study to reduce the incidence of peritonitis to the acceptable level and expand the CAPD population, because of the relative shortage of the number of hemodialysis machines compared to the rapidly increasing ESRD population in this country.

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