

## The Relationship Between Peritoneal Leukocyte Count, Fluid Cultures, and Clinical Results in Peritonitis Among Peritoneal Dialysis Patients: Is There a Geographic or Ethnic Difference?

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*We investigated peritoneal leukocyte count (PLC) and culture results for correlations with inflammation, nutrition, microbiologic parameters, and the effects of peritonitis on peritoneal equilibration tests (PETs) and clinical outcomes in peritoneal dialysis (PD) patients. The study group consisted of patients who had experienced peritonitis for the first time and who had been on PD for at least 6 months, with a PET performed both before and after the peritonitis episode. Only patients with an increased PLC were analyzed.*

*In the 70 patients analyzed (35 men; mean age:  $45.1 \pm 13.5$  years), 7 (10.0%) underwent PD catheter removal, 60 (85.7%) responded well to treatment, and 3 (4.3%) died. Cultures of peritoneal fluid were positive in 25 patients (35.7%), and these patients had a significantly higher PLC than did the culture-negative patients. After the peritonitis episode, C-reactive protein (CRP) increased significantly in affected patients. Residual urine declined after peritonitis. We observed no significant difference in PET results.*

*Clearly, more micro-organisms are present in the peritoneal fluid in patients with a positive culture than in those with a negative culture, meaning that they have severe peritonitis, which responds poorly to treatment. Beyond a consideration of possibly inappropriate culturing*

*techniques, the variations in effluent culture results might reflect geographic or ethnic differences.*

*Positive culture results and a high PLC should be considered risk factors for catheter loss and mortality in PD. Moreover, culture results might show geographic and ethnic differences. In peritonitis follow-up, CRP may be a better marker than erythrocyte sedimentation rate is.*

### Key words

Peritonitis, mortality, culture results, outcome, peritoneal leukocyte count

### Introduction

Among the therapies for end-stage renal disease, peritoneal dialysis (PD) is the treatment modality in which the patient's contribution is highest. Peritonitis is an important complication of PD treatment because it increases the risk of hospitalization and technique failure. Moreover, peritonitis is responsible for 1% – 6% of deaths in PD patients (1). Obtaining positive peritoneal fluid culture results is extremely important in the course of peritonitis treatment, because many patients are started on empiric antibiotic treatment as suggested by the International Society for Peritoneal Dialysis (ISPD) guidelines (2). If no clinical or laboratory response is obtained with appropriate therapy, then the peritoneal catheter should be removed to avoid further damage to the peritoneal membrane and to prevent morbidity and mortality.

The risk factors leading to peritonitis are a nonsterile catheter exit site; altered host defense mechanisms; depressed viability of polymorphonuclear leukocytes,

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monocytes, peritoneal macrophages, and mesothelial cells of the peritoneum; and depletion in macrophages and opsonin during exchanges (3). Patients have a worse prognosis when infected with *Staphylococcus aureus*, *Pseudomonas* and other enteric gram-negative organisms, fungi, and mycobacteria, or when they have a polymicrobial infection (4,5). When a culture of the peritoneal fluid grows no organisms, the patient's condition is called culture-negative peritonitis (CNP). The outcome of CNP remains controversial.

Some studies have investigated peritoneal leukocyte count (PLC) and its effect on morbidity and mortality from peritonitis (6–8). Although the initial PLC does not seem to be reliable for predicting the outcome of peritonitis treatment, some data suggest that it shows geographic and ethnic differences in outcomes between PD populations.

In the present study, our primary objective was to investigate culture results and PLC for correlations with inflammation, nutrition, microbiologic parameters, and clinical outcome in PD patients. We also investigated the common demographic characteristics of patients with peritonitis and the effects of peritonitis on the peritoneal equilibration test (PET).

### Material and methods

We retrospectively analyzed the outpatient charts of the 290 patients who were followed between 1998 and 2008 by two reference-hospital PD units. The study group consisted of the patients who had experienced peritonitis for the first time and who had been on PD for at least 6 months, with a PET performed both before and after the peritonitis episode. Aiming for clear conclusions, we excluded patients with polymicrobial peritonitis and with sterile peritonitis related to icodextrin use. Any use of an antibiotic during dialysate sampling was also an exclusion criterion. Patients who experienced catheter loss or who died during the peritonitis episode were included in the study regardless of the absence of a post-peritonitis PET. We analyzed only those patients whose peritonitis was accompanied by an increased PLC and who were diagnosed when an effluent white blood cell count above 100/mL, with at least 50% polymorphonuclear neutrophil cells, was accompanied by one of the following criteria:

- Presence of clinical symptoms (abdominal tenderness, fever, cloudy dialysate)
- Positive effluent culture

For effluent cultures, two blood-culture bottles (which include antibiotic-binding resin) were directly injected with 10 mL effluent immediately after drainage in the clinic. Following the ISPD guidelines for diagnostic criteria and management of PD peritonitis (2), the initial antibiotic regimen given was a first-generation cephalosporin combined with aminoglycosides intraperitoneally, or ciprofloxacin orally if the patient had a urine output greater than 100 mL daily. This empiric regimen was changed to a suitable agent according to the antibiogram test results. Vancomycin was added to the treatment of peritonitis that did not respond to the foregoing treatment. In the case of treatment-refractory peritonitis, the PD catheter was removed, and the patient was initiated onto hemodialysis. The patients with fever, severe abdominal pain, and insufficient oral intake were hospitalized.

In a chart prepared for this study, we recorded demographic characteristics (age, PD duration, primary renal disease), laboratory parameters [biochemical tests, C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), significant PET parameters, number of cells in the effluent, effluent culture results], response to treatment, response time, and removal of the PD catheter. In addition, we obtained pre- and post-peritonitis levels of CRP, ESR, serum cholesterol, triglycerides, and albumin recorded during routine outpatient follow-up and also recorded those values in the study chart.

All biochemical analyses were carried out using a Roche P-Module instrument (Roche Diagnostics, Basel, Switzerland) and the Abbott Architect 1600 clinical chemistry analyzer (Abbott Diagnostics, Abbott Park, IL, U.S.A.). Serum creatinine specimens were analyzed kinetically by the Jaffe method, and serum albumin was measured using the bromocresol green method. Blood urea was measured by the urease method.

The PETs were performed by instilling 2 L PD solution (2.27% or 2.30% glucose) into the peritoneal cavity after a routine overnight exchange. To provide the appropriate fluid distribution, the patient was requested to turn from side to side after instillation of each 400 mL fluid. The dialysate samples of a 4-hour dwell were analyzed for urea, creatinine, glucose, and sodium concentrations at 0, 2, and 4 hours. Serum samples were taken at hour 2, and the drain volume was measured at 4 hours. Dialysate-to-plasma (D/P)

ratios were calculated for urea and creatinine at 0, 2, and 4 hours. The ratio of glucose at drain time to the initial glucose concentration was also calculated. The PET results were then assessed using the RenalSoft software (version 2.0: Baxter Healthcare Corporation, Deerfield, IL, U.S.A.).

Statistical analyses were performed using the SPSS for Windows software package (version 13.0: SPSS, Chicago, IL, U.S.A.). Numeric data are expressed as mean  $\pm$  standard deviation. The Student *t*-test for matched pairs and the Mann–Whitney *U*-test were used for comparing groups, if necessary. Test for nonnumeric data (if available), a Yates correction chi-square test, and a Fisher exact test were used for 2 $\times$ 2 probability tables. The correlation analysis for numeric parameters was performed using a Spearman rho correlation test. The Student *t*-test, or single or multiple analysis of variance was used if necessary. Kruskal–Wallis *H*-variance analysis was used in comparisons of more than two groups in the presence of abnormalities in distribution. The Tukey HSD (“honestly significant differences”) was used in *post hoc* comparisons. We accepted  $p < 0.05$  as significant.

## Results

We analyzed 70 patients (35 men, 35 women; mean age:  $45.1 \pm 13.5$  years; mean PD duration:  $20.7 \pm 6.2$  months). Of these 70 patients, 59 (84.2%) were treated with continuous ambulatory PD; 6 (8.5%), with continuous cycling PD; and 5 (7.1%), with nocturnal intermittent PD. The primary diagnoses of the patients were primary glomerulonephritis [ $n = 21$  (30%)], renal cystic disease [ $n = 9$  (12.9%)], nephrosclerosis [ $n = 8$  (11.4%)], and diabetic nephropathy [ $n = 6$  (8.6%)]. In 13 patients (18.6%), the cause of renal failure was unknown. Just over one third of the patients [ $n = 25$  (35.7%)] had previously undergone hemodialysis or renal transplantation.

### Peritoneal leukocyte counts

The mean initial PLCs in the study patients when peritonitis was first diagnosed was  $3269 \pm 4428/\text{mm}^3$  (range: 100 – 19,800/ $\text{mm}^3$ ). The PLC declined to less than 100/ $\text{mm}^3$  in  $9.2 \pm 5.3$  days in 60 patients. The PD modality was altered after peritonitis in 8 patients.

### Culture results

Culture of the peritoneal effluent was positive in 25 patients (35.7%). The distribution of micro-organisms

showed gram-negative enteric bacteria [ $n = 10$  (40%)], *Staphylococcus* [*epidermidis* and *aureus*;  $n = 9$  (36%)], *Streptococcus* [ $n = 5$  (20%)], and fungi [*Candida albicans*;  $n = 1$  (4%)]. The PLC was greater in patients with a positive culture than in those with a negative culture (Figure 1).

### Treatment outcome

We recorded catheter removal in 7 patients (10.0%) and good response to treatment in 60 patients (85.7%). Three patients (4.3%) died during the peritonitis episode. Table I and Figure 2 show the relationship between the micro-organisms cultured, with overall culture results, and response to treatment. As the table shows, the ratio of catheter removal and of patient death were both higher in patients whose cultures showed gram-negative micro-organisms, although neither ratio reached statistical significance. In 2 patients with documented *P. aeruginosa* peritonitis, treatment produced no response, and the PD catheters were removed in those patients.

Though not reaching statistical significance, the initial PLCs of patients who died during treatment were higher ( $7833 \pm 9290/\text{mm}^3$ ) than those seen in patients who fully recovered or who lost the PD catheter despite treatment ( $3025 \pm 4200/\text{mm}^3$  and  $3397 \pm 3503/\text{mm}^3$  respectively,  $p = 0.414$ , Figure 3). The primary renal disease showed no statistical relationship with treatment outcome or initial PLC. Additionally, we investigated the correlation between initial PLC and culture result. The initial PLCs in patients with

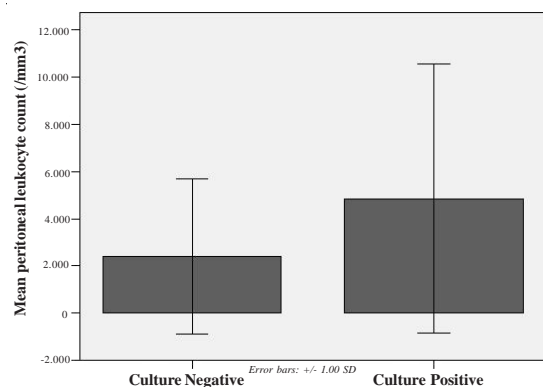


FIGURE 1 The initial peritoneal leukocyte count (mean  $\pm$  standard deviation) in the culture-positive ( $4855 \pm 5699/\text{mm}^3$ ) and culture-negative ( $2387 \pm 3288/\text{mm}^3$ ) peritonitis groups.

TABLE I The association between micro-organisms and response to treatment

Treatment result	Micro-organism cultured [n (%)]				TOTAL
	Gram-negative	Staphylococcus	Streptococcus	Other	
Improved	6	7	4	0	17 (68)
Catheter loss	2	1	1	1	5 (20)
Death	2	1	0	0	3 (12)
TOTAL	10 (40)	9 (36)	5 (20)	1 (4)	25

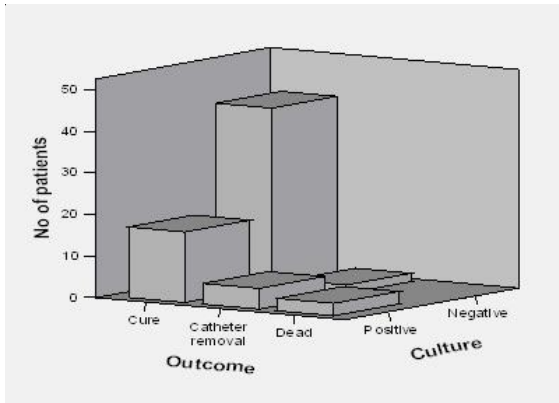


FIGURE 2 The relationship between response to treatment and results of peritoneal fluid cultures.

positive cultures were significantly higher than those in patients with no culture growth ( $4855 \pm 5699/\text{mm}^3$  and  $2387 \pm 3288/\text{mm}^3$  respectively,  $p = 0.025$ , Figure 1).

The peritonitis episode led to immediate hospitalization in 10 patients (14.2%); 2 of these patients subsequently died. In 2 other patients, the PD catheter was removed; the rest of the patients completely recovered. Catheter loss and mortality were significantly higher among the hospitalized patients (Table II). Additionally, the initial PLCs in the hospitalized patients were higher than those in the non hospitalized patients; however, that difference was not statistically significant ( $4662 \pm 5520/\text{mm}^3$  and  $3036 \pm 4231/\text{mm}^3$  respectively).

#### Biochemical analyses

Table III presents values for serum albumin, cholesterol, CRP, ESR, dialysate dose, and PET results at the beginning of PD and before and after peritonitis. The mean level of serum albumin at the month before

peritonitis was significantly higher in the treatment-responsive patients than in the treatment-failure patients (those who died or underwent catheter removal:  $3.76 \pm 0.54\text{g/dL}$  and  $3.33 \pm 0.50\text{g/dL}$  respectively;  $p = 0.032$ ). Cholesterol levels increased compared with baseline levels; however, no significant change before and after peritonitis was observed. Similarly, ESR increased after the basal assessment, but it remained stable, presenting no significant difference from before to after peritonitis. Levels of CRP were significantly higher after the peritonitis episode, but in the subsequent months it returned to the initial value before peritonitis. Residual urine output, total Kt/V urea, total creatinine clearance, and dialysate creatinine clearance declined insignificantly after peritonitis. The post-peritonitis daily dialysis solution volume therefore had to be increased, but again, not with statistical significance. The D/P ratio of urea measured at hours 2 and 4 of the PET showed no significant difference from before to after peritonitis. Mean daily antihypertensive medications per patient was found to be the same before and after peritonitis ( $1.4 \pm 0.5$  medications).

In the correlation analyses, a positive culture result and initial PLC showed correlations with response to treatment ( $r = 0.27$ ,  $p = 0.024$  and  $r = 0.384$ ,  $p = 0.01$  respectively; Figures 2 and 3). On the other hand, no correlation was found between PLC and patient age, PD duration, serum albumin and cholesterol levels, ESR, and CRP level before and after peritonitis. We observed no relationship between patient age and sex, response time to therapy, and time of PLC decline to less than  $100/\text{mm}^3$ .

#### Discussion

During the study period, the micro-organisms grown in effluent cultures generally matched the pathogens most frequently encountered in PD (36% *Staphylococcus*, 20% *Streptococcus*, 40% gram-negative enteric bacteria, 4% fungi) (9).

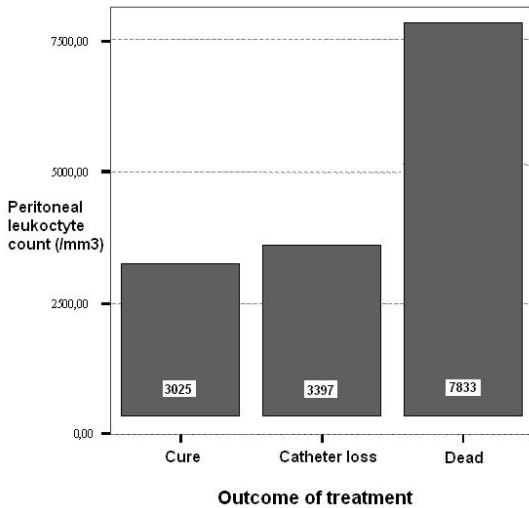


FIGURE 3 The correlation between response to treatment and peritoneal leukocyte count.

TABLE II Treatment results for hospitalized and non-hospitalized patients

Outcome	Hospitalized [n (%)]		TOTAL [n (%)]
	Yes <sup>a</sup>	No	
Improved	6 (60)	54 (90.0)	60 (85.7)
Catheter loss	2 (20)	5 (8.3)	7 (10.0)
Death	2 (20)	1 (1.7)	3 (4.3)
TOTAL	10 (14.3)	60 (85.7)	70 (100)

<sup>a</sup> Rates of catheter loss and mortality were found to be significantly higher among hospitalized patients ( $p = 0.012$ ).

Various alterations are observed in the peritoneal defense system in PD patients. Macrophages and opsonins are discharged with the dialysis effluent. Thus, inoculation with small amounts of bacteria can easily lead to peritonitis, because bacteria are typically cleared by means of opsonization, chemotaxis, phagocytosis, and intracellular elimination. Lymphatic absorption of the bacteria can also play a role; blood cultures are rarely positive in bacterial peritonitis because the lymph nodes remove bacteria very efficiently (10). The incidence of peritonitis depends on the balance between the inoculated bacteria count and the power of peritoneal defense to eradicate those bacteria. Bacterial contamination does not result in peritonitis every time (11,12). Thus,

the micro-organism count in the effluent has great importance for any growth in the effluent culture. Clearly, more micro-organisms are present in the peritoneal fluid of patients with a positive culture than of those with a negative culture, meaning that the patients with a positive culture have severe peritonitis, which responds poorly to treatment. Supporting this idea, we found that the mean PLC in patients with a positive culture was higher than that in patients with a negative culture (Figure 1).

The most striking outcome of our study was that, as compared with patients with CNP, the patients with culture-positive disease had a higher initial PLC and worse catheter and patient outcomes. Catheter removal and patient loss were both higher in the culture-positive group than in the culture-negative group (Figure 2). In a study conducted by Chow *et al.* (6), initial PLC was not associated with the outcome of peritonitis, and a PLC cutoff of more than  $1090/\text{mm}^3$  on day 3 carried increased odds (by a factor of 9) of treatment failure. Likewise, Krishnan *et al.* (7) reported that a PLC above  $100/\text{mm}^3$  lasting more than 5 days was independently associated with worse outcomes. Martikainen *et al.* (8) reported poorer outcome in patients with high CRP and leukocytes on day 4. Yang *et al.* (13) also showed that initial PLC was not a predictor of outcome in their study.

Our study did not research PLC on any particular day; instead, we researched the time for PLC decline to less than  $100/\text{mm}^3$ . We observed no relationship between patient age, sex, and response time to therapy with time of PLC decline to less than  $100/\text{mm}^3$ . Initial PLC was not correlated with the time of decline in PLC to less than  $100/\text{mm}^3$ . On the other hand, an important result of our study was that the initial PLC of the patients who died during treatment was higher ( $7833 \pm 9290/\text{mm}^3$ ) than that of the fully recovered patients and the ones that lost the PD catheter despite treatment ( $3025 \pm 4200/\text{mm}^3$  and  $3397 \pm 3503/\text{mm}^3$  respectively, Figure 3). However, these differences did not reach statistical significance, probably because of the small number of patients who died and the high standard deviation in PLCs ( $p = 0.414$ ).

Several studies show results similar to ours with regard to prognosis of CNP (13–15). In a recent study by Yang *et al.* (13), in which the CNP rate was 26% (151 of 579 patients), the catheter removal rate was notably lower among patients with CNP (7%). But

TABLE III Demographic data and biochemistry analyses, dialysate dose, and peritoneal equilibration test (PET) results

Parameter		Value
CRP (mg/L)		
Baseline		10.83±14.82
Before peritonitis	6th month	11.06±13.84
	3rd month	6.55±8.33
	Previous month	5.81±5.79
After peritonitis	1st month	31.15±66.79
	3rd month	6.80±7.07
	6th month	7.62±7.39
ESR (mm/hour)		
Baseline		43.85±29.65
Before peritonitis	6th month	70.94±35.74
	3rd month	68.12±32.30
	Previous month	61.86±32.69
After peritonitis	1st month	65.48±36.11
	3rd month	59.88±30.88
	6th month	59.77±31.36
	12th month	60.84±31.72
Serum albumin (g/dL)		
Baseline		3.76±0.60
Before peritonitis	6th month	3.77±0.39
	3rd month	3.71±0.46
	Previous month	3.70±0.55
After peritonitis	1st month	3.68±0.51
	12th month	3.84±0.43
Total cholesterol (mg/dL)		
Baseline		182.50±54.63
Before peritonitis	6th month	193.55±39.26
	3rd month	204.43±59.10
	Previous month	191.16±54.93
After peritonitis	6th month	190.37±40.94
	12th month	204.12±39.88
Urine volume (mL/day)		
Before peritonitis		746±1029
After peritonitis		512±706
Dialysis dose (L/day)		
Before peritonitis		9.31±1.87
After peritonitis	1st month	9.45±1.93
	6th month	9.94±1.73
Weekly creatinine clearance (L)		
Before peritonitis	Total	66.98±27.07
	Dialysate	50.09±11.35
After peritonitis	Total	64.39±20.50
	Dialysate	47.39±7.98
Weekly Kt/V urea		
Baseline	Total	2.37±0.71
	Dialysate	1.82±0.38
Before peritonitis	Total	2.33±0.58
	Dialysate	1.76±0.42
After peritonitis	Total	2.26±0.52
	Dialysate	1.59±0.30
PET (D/P creatinine)		
Baseline	2nd hour	0.45±0.12
	4th hour	1.47±6.92
Before peritonitis	2nd hour	0.42±0.13
	4th hour	0.58±0.16
After peritonitis	2nd hour	0.43±0.13
	4th hour	0.59±0.17

CRP = C-reactive protein; ESR = erythrocyte sedimentation rate; D/P = dialysate/plasma ratio.

some studies demonstrate unfavorable outcomes with CNP. Szeto *et al.* (16) showed that patients with CNP had poor outcomes: The complete cure rate was 37.7%, and the authors recommended removal of the catheter in these patients. In another study, endotoxin was negative in effluent from CNP, illustrating the absence of gram-negative organisms, which are known to be associated with a bad prognosis (17). That finding may explain why CNP shows a better treatment outcome, as in our study.

As is known, whenever peritonitis is suspected, samples of dialysate effluent should be cultured, and the empiric antibiotic treatment used in the PD unit should be initiated without waiting for culture results. If the rate of sterile or aseptic peritonitis in a PD unit is greater than 20%, then culture methods should be reviewed and improved (14). It is reported that, occasionally (2% – 20%), cultures may be negative for a variety of technical or clinical reasons (2). Follow-up with available techniques can provide positive culture results in approximately 90% of peritonitis episodes (18). In our study, however, the culture-negative rate was 64.2% higher than the rate proposed in the ISPD guideline (2).

Beyond a discussion of possibly inappropriate culturing techniques, the variation in results might reflect geographic or ethnic differences in effluent cultures. The literature contains some data concerning this issue. In other studies from various centers in our country, similar high rates of CNP have been reported. Aksu *et al.* (19) reported 93 CNP in 147 peritonitis episodes (63.2%), and CNP represented 69 of 134 episodes (51%) reported by Dervisoglu *et al.* (20). Al Wakeel *et al.* (21) from Saudi Arabia also reported a 60% rate of CNP, which is akin to our results.

Similar high CNP rates have been presented in other studies (22). In a Korean study, CNP was about 37%, and that rate has remained almost constant for 25 years (23). These varying rates of CNP have not only occurred between countries, but also within the same country. For example, in a multicenter national study in Scotland, CNP comprised 11% – 29% of all peritonitis (15). Racial differences in PD outcome have also been noted in some studies (24). Mehrotra *et al.* (25) successfully reduced peritonitis rates in a PD program serving indigent ethnic minorities. Evidence also suggests that seasonal and geographic variations may affect the peritonitis rate, a result that was attributed to temperature and, particularly,

humidity (26–28). From this perspective, the spectrum of micro-organisms and culture-positive peritonitis rates may also differ with geographic conditions.

It has been shown that CRP level may be a predictor both of short-term and of long-term peritonitis outcomes (29,30). In our study, CRP remained high along the study patients and continued high (as expected) in the month following a peritonitis episode (Table III); however, during the same period, the ESR showed no significant difference before and after peritonitis. Therefore, we conclude that, compared with ESR, CRP is a better parameter of inflammatory response in the diagnosis and follow-up of peritonitis.

Although low serum albumin levels are known to be associated with mortality and morbidity in the hemodialysis population, results in PD patients are conflicting (31,32). In some studies, serum albumin was not a predictor of peritonitis in multivariate analyses (33–35). Conversely, in a randomized retrospective study of continuous ambulatory PD patients, Chow *et al.* (36) showed that low serum albumin at the initiation of CAPD was an important indicator of future peritonitis. A decrease of 10 g/L in serum albumin increased the peritonitis risk with a hazard ratio of 1.67 (95% confidence interval: 1.08 – 2.60). In addition, Sirivongs *et al.* (37) showed that a 1 g/dL increase in basal albumin level and a 1% increase in hematocrit can reduce the risk of peritonitis by 27% and 3% respectively. Some studies show serum albumin to be a predictor of catheter loss during peritonitis episodes (13,38,39). A correlation was found between peritonitis outcome and serum albumin level in our study, too. Although serum albumin remained nearly constant through the entire study (Table III), the mean serum albumin level in the month before peritonitis was significantly higher in the treatment-responsive patients than in the treatment-failure patients (those who died or underwent catheter removal). Although albumin is being used as a parameter of nutrition, it may also be related to inflammation or higher comorbidity, and consequently, to worse outcome.

Serum cholesterol is another parameter of nutrition. In PD patients who continuously use solutions containing glucose, abnormalities in lipid profile are expected as a metabolic complication (40,41). Serum cholesterol levels in study patients rise above baseline assessments, and they remained high in the following months (Table III). The lack of changes in levels of serum albumin and cholesterol show that

our patient population did not have obvious malnutrition. Therefore, it can be concluded that there was no relationship between peritonitis episodes and parameters of nutrition in our study patients.

Peritonitis is known to affect the peritoneum, being associated with ultrafiltration failure in the long term (42,43). On the other hand, some studies failed to show any relationship between peritonitis and change in peritoneal function (44–46). In the present study, PET results (small-solute transport and ultrafiltration characteristics) did not show a significant change. An excellent study conducted by Ates *et al.* (47) showed that a single peritonitis episode did not affect the peritoneal transport of low, middle, and high molecular weight solutes in repeated PETs after peritonitis. Davies *et al.* (43) also stated that a single episode of peritonitis did not affect PET results. Our study, which included only first peritonitis episodes, also accords with those conclusions. However, because of a decline in residual urine volume, the prescribed dose of dialysate needed to be increased in the post-peritonitis period.

Our study has some limitations. First, no control group was used. Also, antibiotics could not be reported in detail, and PLC determinations were not given longitudinally.

## Conclusions

Our study data suggest that positive culture results, high PLC, and hospitalization at the beginning of any peritonitis episode should be considered risk factors for catheter loss and mortality in PD. A more cautious choice of antibiotic, and perhaps more aggressive dosing, must be considered for those patients. Moreover, results of cultures during peritonitis may show geographic and ethnic differences. In the follow-up of peritonitis treatment, CRP may be a better marker than ESR is. Furthermore, a first peritonitis episode has no significant effect on standard characteristics of the peritoneal membrane as measured by a PET.

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