Various aspects of peritoneal water transport

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Free water transport in fast transport status: a comparison between CAPD peritonitis and long-term PD

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Abstract

Background: Ultrafiltration failure (UFF) in CAPD is a transient phenomenon during acute peritonitis and a permanent complication in long-term peritoneal dialysis (PD). The high solute transport rates during acute peritonitis are probably caused by an increased number of perfused peritoneal capillaries. Long-term PD is associated with an increased number of peritoneal microvessels, leading to an enlargement of the anatomic vascular surface area. This leads to high mass transfer area coefficients (MTAC) and to UFF. Impaired conductance to glucose, leading to a reduction in free water transport, may be a contributing factor to UFF in long-term PD. We hypothesized that UFF during acute peritonitis is, in the absence of permanent structural changes, only caused by an increased vascular surface area, while that in long-term patients is often the result of an increased surface area in combination with an impaired conductance to glucose. Therefore the peritoneal transport parameters of patients with acute peritonitis were compared to those in long-term PD patients.

Methods: A standard peritoneal permeability analysis (SPA) was done in 10 PD patients during the first 48 hours after the diagnosis of peritonitis. The results were compared to those obtained in 10 long-term PD patients matched for the MTAC creatinine. Besides, the results of 8 peritonitis patients were compared with SPA results of 8 recently started PD patients, matched for MTAC creatinine.

Results: Peritonitis patients had a deeper maximal dip in D/P sodium, corrected for diffusion, than long-term patients (0.058 vs. 0.039, p<0.05). Most parameters of peritoneal fluid transport were not different, except that t50, i.e. the time to reach 50% of the maximum transepithelial ultrafiltration, was reached earlier during the dwell in peritonitis than in long-term PD: 128 vs. 175 minutes, p<0.05. This confirmed the difference in the shape of the intraperitoneal volume vs. time curve, which was blunted in the long-term patients. No differences were found for the parameters of solute transport between peritonitis patients and recently started patients.

Conclusions: In contrast to patients with long-term PD, the osmotic conductance to glucose is unaffected in peritonitis, despite the lower net ultrafiltration caused by high solute transport. This implies that impaired free water transport in chronic PD must be regarded as a contributing factor to UFF.
Introduction

Impaired ultrafiltration with CAPD is a transient phenomenon during acute peritonitis [1] and a permanent complication in more than 30% of long-term peritoneal dialysis patients [2,3]. The higher solute transport rates during acute peritonitis, compared to the stable situation, lead to a rapid dissipation of the osmotic gradient caused by augmented absorption of glucose from the peritoneal cavity [1-6]. The infection induced hyperpermeability is probably caused by increased secretion of vasoactive substances such as prostaglandins and cytokines [7,8] and an up-regulation of NO-synthase activity [6,9-11]. These mediators are likely to increase the number of perfused peritoneal capillaries, leading to a functional increment of the vascular peritoneal surface area. This explains why the transcapillary ultrafiltration rate (TCUFR) in the first phase of a dwell during peritonitis is higher than after recovery [6]. Usually transport characteristics return to the baseline level after cure of the peritonitis.

Long-term peritoneal dialysis is associated with an increased number of peritoneal microvessels [12-15], causing an enlargement of the anatomic vascular surface area. Similar to peritonitis this leads to high mass transfer area coefficients (MTAC) of low molecular weight solutes and impaired ultrafiltration due to the fast absorption of glucose from the peritoneal cavity. The presence of a high or fast transport status is however unlikely to be the only cause of ultrafiltration failure in long-term peritoneal dialysis. Monquill et al. analysed peritoneal solute and fluid kinetics in a selected group of long-term PD patients with ultrafiltration failure of unknown cause [16]. The only consistent abnormality in these patients was the absence of the sieving of sodium, i.e. no decrease in the dialysate/plasma Na⁺ ratio occurred during a 4 hours exchange with a 3.86% glucose solution. Also the intraperitoneal volume versus time curves were blunted, quite dissimilar to previous observations during acute peritonitis. Instead, these curves were very similar to those obtained by computer simulations based on the combination of increased peritoneal glucose transport with a decreased osmotic conductance to glucose [17]. Impaired free water transport is one of the theoretical causes of a decreased osmotic conductance to glucose. We have argued previously that free water transport can be assessed by the sieving of sodium, especially after the correction for sodium diffusion [18]. Using a cut-off point for diffusion corrected sodium sieving of 0.045, we found the combination with a high MTAC creatinine to be present in 11 out of 20 PD patients with ultrafiltration failure, treated for more than 4 years (unpublished data).

We therefore hypothesised that ultrafiltration failure during acute peritonitis, when no permanent structural peritoneal changes are present, is only caused by an increased vascular
surface area, while that in long-term patients is often the result of an increased surface area in combination with an impaired osmotic conductance to glucose. The aim of the present case-control study was to compare peritoneal transport in patients with acute peritonitis to that in long-term PD patients matched for the MTAC creatinine. Because a first analysis showed a greater osmotic conductance to glucose during peritonitis than in long-term patients, the peritonitis patients were also matched with recently started PD patients with similar MTACs of creatinine, to elucidate whether the osmotic conductance to glucose is decreased in long-term PD, or increased during peritonitis.

Methods

A Standard Peritoneal permeability Analysis (SPA) with a 3.86% glucose solution was performed in 10 patients within the first 48 hours of acute CAPD peritonitis. Antibiotic treatment was given according to our protocol. The Committee on Medical Ethics of the Academic Medical Center, Amsterdam approved the protocol, and written informed consent was obtained from all patients, after an explanation of the purpose and methods of the study.

Patients

Peritonitis patients were excluded from the study when they had clinical signs of ultrafiltration failure previous to the diagnosis, or had been on PD for more than 4 years.

The peritonitis patients had a mean age of 52 years (range 25 to 79 years). The duration of CAPD therapy ranged from 1 to 46 months, mean 17 months. In only 5 peritonitis patients, SPA results within 12 months prior to the peritonitis episode were available. In this way these patients could serve as their own control. For each of the 10 peritonitis patients a match in a group of stable long-term patients (arbitrarily defined as duration of PD of more than 4 years) was selected from our database, with regard to the MTAC creatinine. The matched long-term patients had a similar age (47 years, range 28-74), but were treated with PD for a longer period (90 months, range 48-144). These patients had no peritonitis at time of the SPA or in the previous 4 weeks. Because usually MTAC values of 18.0 and higher are uncommon in recently started PD patients, only eight MTAC matched patients were available in our database. The median duration of PD in this group was 3 months (range 1-4 months) and age was similar to the peritonitis group. These patients had never suffered any peritonitis episode.
Procedure

The SPA was performed during a four hours dwell period, as described previously [19], with 3.86% glucose. It was preceded and followed by a rinsing procedure to avoid the possible effects of the residual volume before the test, and to calculate the residual volume after the test. Dialysate samples were taken before instillation and at multiple time points during the test (10, 20, 30, 60, 120, 180 and 240 minutes). Blood samples were taken at the beginning and at the end of the test-period. A volume-marker, dextran 70 1 g/L (Hyskon, Medisan Pharmaceuticals AB, Uppsala, Sweden), was used to calculate fluid kinetics. To prevent a possible anaphylactic reaction to dextran 70, dextran 1 (Promiten, NPBI, Emmercompascuum, the Netherlands) was injected intravenously before instillation of the test bag [20].

Measurements

Total dextran was determined by means of high performance liquid chromatography [21]. Creatinine and urate were measured by enzymatic methods (Boehringer Mannheim, Mannheim, Germany). All electrolytes were determined using ion selective electrodes. Glucose was measured by the glucose oxidase-peroxidase method, using an autoanalyzer (SMA-II, Technicon, Terrytown, USA).

Calculations

All calculations were performed as previously described [19]. Briefly, the changes in intraperitoneal volume are the result of transepidermal ultrafiltration and lymphatic absorption. Both parameters were assessed with the intraperitoneally administered volume marker dextran 70. Transepidermal ultrafiltration (TCUF) was calculated from the dilution of the volume marker, by subtracting the initial intraperitoneal volume (IPV) from the theoretical IPV (when both lymphatic absorption and sampling would not have been present) at any time point. Because transepidermal ultrafiltration has its maximum value during the initial phase of a dwell, transepidermal ultrafiltration rate in the first minute (TCUF₁₀) was calculated, using the Lineweaver-Burke plot. That is, the linear regression between the reciprocal values of the transepidermal ultrafiltration obtained during the SPA and the reciprocal of time [22]. This enabled us to calculate the TCUFmax and t₅₀, that is, the time it takes to reach 50% of the maximal transepidermal ultrafiltration. The effective lymphatic absorption rate (ELAR) was calculated as the peritoneal dextran clearance. It therefore included all pathways of uptake into the lymphatic system, both subdiaphragmatic and interstitial. The net ultrafiltration is the difference between the transepidermal ultrafiltration and the effective lymphatic absorption. Net ultrafiltration rate
(NUFR) was calculated by dividing the difference in IPV\textsubscript{240} by the dwell time. Peritoneal handling of low molecular weight solutes was expressed as mass transfer area coefficients (MTAC). The MTAC represents the maximal theoretical diffusive clearance of a solute at \( t=0 \), before transport has actually started. In this study we used the Waniewski model [23], where the solute concentration was expressed per volume of plasma water [24]:

\[
MTAC (mL/min) = \frac{V_m}{t} \ln \frac{V_{10}^{1-F} (P - D_{10})}{V_i^{1-F} (P - D_i)}
\]

\( F \) is a correction factor (0.5) for convective transport, \( V_m \) is the intraperitoneal volume and \( D_{10} \) the dialysate concentration at \( t=10 \) min. \( V_i \) and \( D_i \) are these parameters at \( t=240 \) min. \( V_m \) is the mean intraperitoneal volume. \( P \) is the mean plasma concentration of the solute.

D/P sodium was calculated as the dialysate sodium concentration divided by the plasma sodium concentration. Delta D/P sodium is the difference between the initial D/P sodium and the lowest D/P sodium (usually after 1-2 hours). A correction for Na\textsuperscript{+} diffusion from the circulation to the dialysate, known to cause blunting of the decrease in D/P Na\textsuperscript{+}, was applied as described previously [18], using the mass transfer area coefficient of urate. This enabled us to calculate the sodium concentration in the dialysate due to diffusion. This value was subtracted from the measured concentration at any time point, resulting in the actual Na\textsuperscript{+} sieving.

**Statistical analysis**

Results are presented as median values and ranges, because most data were asymmetrically distributed. The Mann-Whitney-U test was employed to compare the peritonitis patients with the long-term group and with the patients who were on PD for 4 months or less. In 5 of the patients, studied during peritonitis, a previous SPA done within one year was available. The paired samples \( t \)-test was used to compare the SPA results of this sub-group. A p-value of less than 0.05 was considered as statistically significant.

**Results**

All SPAs were performed within 48 hours after the diagnosis CAPD peritonitis; half of the patients were investigated within 24 hours. The causative pathogens were *Staphylococcus aureus* (1), *Staphylococcus epidermidis* (3), *Pseudomonas aeruginosa* (2), *Streptococci* (3) and *Corynebacterium xerosis* (1). Dialysate cell counts ranged from 330 to 85.000/mm\(^3\), but no correlation was found between cell
count and transport characteristics. The initial antibiotic treatment was cefalotin intraperitoneally in all patients. Three of the patients also received gentamicin i.p.

**Solute transport**

The peritoneal solute kinetics are summarized in Table 1. Although it was not possible to find a complete match in MTAC creatinine for one peritonitis patient, because of the high value of 23.0 mL/min, values for mass transfer area coefficients of creatinine and urate were similar for both groups. Also, peritoneal glucose absorption was not different.

**Table 1.** Small solute transport in 10 patients with acute CAPD peritonitis and 10 long-term PD patients matched for small solute transport with MTAC creatinine

<table>
<thead>
<tr>
<th></th>
<th>Peritonitis patients</th>
<th>Long-term PD patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTAC (mL/min/1.73 m²)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>creatinine</td>
<td>14.5 (10.9 – 23.0)</td>
<td>15.6 (12.2 – 18.4)</td>
</tr>
<tr>
<td>urate</td>
<td>12.9 (9.2 – 20.1)</td>
<td>12.7 (9.1 – 16.4)</td>
</tr>
<tr>
<td>Glucose absorption (%)</td>
<td>65 (45 – 70)</td>
<td>72 (59 – 96)</td>
</tr>
</tbody>
</table>

**Fluid kinetics**

The results of the comparison between the peritonitis and long-term patients are given in Table 2 and Figure 1. Median net ultrafiltration, transcapillary ultrafiltration rate and TCUF₉₀ were similar for both groups, but TCUF₉₀ was higher and t₅₀ was reached significantly earlier in the peritonitis patients. Also, peritonitis patients had significantly higher values for the maximum dip in D/P sodium, compared to the patients with long-term peritoneal dialysis. The values in the peritonitis patients were within the normal range, suggesting unaffected osmotic conductance to glucose. This is shown in Figure 2. The effective lymphatic absorption rate was not different for both groups.

**Comparison with previous SPAs**

From 5 of the 10 peritonitis patients results of a previous SPA performed in the preceding 12 months in the absence of peritonitis were available. Peritoneal fluid and solute transport data are compared in Table 3. As expected, the net UF and TCUFR were lower and solute transport was higher during peritonitis. However, no significant difference was observed in free water transport between peritonitis and in the preceding year.
Figure 1.
Intraperitoneal fluid profiles during the 4 hours dwell. Transcapillary ultrafiltration (open circles), effective lymphatic absorption (closed squares) and the result of both, the net ultrafiltration (closed circles). In the left panel the profiles for the peritonitis patients, in the right panel those of the long-term PD patients. Asterisks mark the values that were significantly different for long-term patients compared to peritonitis patients.

Table 2. Fluid kinetics in 10 patients with acute CAPD peritonitis and 10 long-term patients matched for MTAC creatinine

<table>
<thead>
<tr>
<th></th>
<th>peritonitis patients</th>
<th>long-term patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUF (mL)</td>
<td>381 (32 – 1092)</td>
<td>248 (-111 – 558)</td>
</tr>
<tr>
<td>TCUFR (mL/min)</td>
<td>3.6 (0.2 – 6.0)</td>
<td>3.2 (0.8 – 4.6)</td>
</tr>
<tr>
<td>TCUF max (mL)</td>
<td>1226 (51 – 2604)</td>
<td>1086 (408 – 1585)</td>
</tr>
<tr>
<td>t50 (min)</td>
<td>128 (12 – 211)</td>
<td>175 (74 – 274) *</td>
</tr>
<tr>
<td>TCUF0.1 max (mL/min)</td>
<td>11.2 (2.3 – 15.7)</td>
<td>6.1 (1.9 – 14.8) *</td>
</tr>
<tr>
<td>ELAR (mL/min)</td>
<td>1.43 (0.78 – 2.81)</td>
<td>1.68 (0.43 – 3.66)</td>
</tr>
<tr>
<td>max delta D/P Na⁺</td>
<td>0.058 (0.02 – 0.12)</td>
<td>0.039 (0.01 – 0.06)</td>
</tr>
</tbody>
</table>

* p<0.05

NUF: net ultrafiltration, TCUFR: transcapillary ultrafiltration rate, TCUF max: maximal theoretical intraperitoneal ultrafiltration, t50: time point were 50% of TCUF max would have been reached, TCUF0.1 max is TCUFR in the first minute of the dwell, ELAR: effective lymphatic absorption rate, max delta D/P Na⁺: maximal dip in dialysate/plasma ratio of sodium after correction for sodium diffusion from the circulation using the MTAC of urate.
Comparison with patients within the first 4 months of PD treatment

For 8 out of 10 patients a matched control was found in a group of patients without peritonitis, investigated in the first 4 months of PD treatment. No differences were found for the transport parameters between the patients with peritonitis and the recently started ones, as shown in Table 4.

![D/P sodium](image)

**Figure 2.**
D/P sodium corrected for diffusion, during the 4 hours dwell. The decrease in D/P sodium is the result of dilution of dialysate sodium, caused by free water transport. Peritonitis patients show a deeper dip (open circles), than those with long-term PD (closed circles). Asterisks mark the significant difference for long-term patients compared to peritonitis patients (p<0.05)

**Discussion**

The comparison, made in the present study between patients with a similar increment of the effective peritoneal surface area, either due to acute peritonitis or to long-term peritoneal dialysis, supports our hypothesis that an impaired conductance to glucose contributes to ultrafiltration failure in long-term peritoneal dialysis. In peritonitis, inflammation-induced vasodilation and an increased number of perfused capillaries lead to an increment of the vascular surface area, resulting in a rapid dissipation of the osmotic gradient caused by enhanced glucose absorption. In peritonitis no permanent structural changes are present and the changes in peritoneal small solute transport are reversible. This was supported by the results of experiments in which peritoneal
blood flow was assessed in peritonitis patients during the infection and after recovery [6]. Consequently, no impairment of the conductance to glucose is expected.

### Table 3. Results of previous SPAs in 5 peritonitis patients.

<table>
<thead>
<tr>
<th></th>
<th>Previous to peritonitis</th>
<th>During peritonitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUF (mL)</td>
<td>768 (411 - 860)</td>
<td>523 (127 - 621)</td>
</tr>
<tr>
<td>TCUFR (mL/min)</td>
<td>4.40 (2.42 - 4.62)</td>
<td>3.41 (0.18 - 4.12)</td>
</tr>
<tr>
<td>TCUF&lt;sub&gt;max&lt;/sub&gt; (mL)</td>
<td>1226 (51 - 2604)</td>
<td>1086 (51 - 2439)</td>
</tr>
<tr>
<td>T&lt;sub&gt;50&lt;/sub&gt; (min)</td>
<td>135 (122 - 354)</td>
<td>89 (12 - 211)</td>
</tr>
<tr>
<td>TCUF&lt;sub&gt;0.1&lt;/sub&gt; (mL/min)</td>
<td>8.1 (5.7 - 10.9)</td>
<td>10.3 (6.0 - 15.7)</td>
</tr>
<tr>
<td>ELAR (mL/min)</td>
<td>1.14 (0.75 - 1.29)</td>
<td>1.22 (0.0 - 2.58)</td>
</tr>
<tr>
<td>max delta D/P Na&lt;sup&gt;-&lt;/sup&gt;</td>
<td>0.10 (0.07 - 0.14)</td>
<td>0.06 (0.04 - 0.09)</td>
</tr>
<tr>
<td>MTACcreat (mL/min)</td>
<td>8.4 (6.0 - 12.6)</td>
<td>14.6 (12.3 - 23.1)</td>
</tr>
</tbody>
</table>

* p<0.05

NUF: net ultrafiltration, TCUFR: transcapillary ultrafiltration rate, TCUF<sub>max</sub>: maximal theoretical intraperitoneal ultrafiltration rate, T<sub>50</sub>: time point where 50% of TCUF<sub>max</sub> would have been reached, TCUF<sub>0.1</sub> is TCUF in the first minute of the dwell, ELAR: effective lymphatic absorption rate, max delta D/P Na<sup>-</sup>: maximal dip in dialysate/plasma ratio of sodium after correction for sodium diffusion from the circulation using the MTAC of urate, MTACcreat is MTAC of creatinine

In long-term peritoneal dialysis an anatomical enlargement of the vascular surface area is the cause of rapid glucose absorption. Consequently low ultrafiltration occurs. Several studies have shown an increased number of vessels in the peritoneal membrane of long-term PD-patients with clinical signs of ultrafiltration failure and in patients with peritoneal sclerosis [12,15]. Other anatomical changes that were observed in long-term patients are increased thickness of the submesothelial collagenous zone of the parietal peritoneum and sometimes loss of mesothelial surface [15,25]. Although an enlarged vascular surface is by far the most frequent cause of ultrafiltration failure in long-term PD, other causes could contribute to the phenomenon [26], such as a high lymphatic absorption rate or a decreased osmotic conductance to glucose. The latter is the product of the peritoneal ultrafiltration coefficient (I<sub>p</sub> S) and the reflection coefficient of glucose (σ) [17]. A reduced I<sub>p</sub> S x σ product will lead to a decrease in peritoneal free water transport, and therefore to less sodium sieving. Reduced peritoneal free water transport estimated either by the sieving of sodium or by the difference in net ultrafiltration obtained with a 3.86% and a 1.36% glucose solution [27], is present in long-term patients [16,26] and in patients with peritoneal sclerosis [28]. I<sub>p</sub> S is the product of liquid permeability (I<sub>pl</sub>) and the peritoneal surface area (S). As S is increased in long-term PD, a marked reduction of I<sub>p</sub> would have to be present to explain the decreased osmotic conductance to glucose by a decreased I<sub>p</sub> S. I<sub>p</sub> is unlikely to be 120
low, as transport rates of low molecular weight solutes are high in long-term PD with ultrafiltration failure [29]. It is therefore more likely that a reduced G explains the decreased free water transport. G is to a large extent dependent on the function of peritoneal aquaporins, as these water channels are permeable to water and not to glucose. As they are also not permeable to sodium, the reduced peritoneal free water transport is likely to be caused by an impaired function of peritoneal aquaporin-1. This is unlikely to be caused by a reduced number of water channels, because the expression of aquaporin-1 has been found normal in ultrafiltration failure [30]. Thus, the decreased water transport can most likely be attributed to a functional impairment of the water channels, although the nature of the defect is yet unrevealed.

Table 4. Comparison of 8 peritonitis patients with 8 patients who recently started PD treatment, matched for MTAC creatinine.

<table>
<thead>
<tr>
<th></th>
<th>Peritonitis patients n=8</th>
<th>Patients in first 4 months n=8</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUF (mL)</td>
<td>381 (32 – 1092)</td>
<td>379 (265 – 911)</td>
</tr>
<tr>
<td>TCUFR (mL/min)</td>
<td>3.6 (1.7 - 5.97)</td>
<td>3.6 (2.5 – 5.4)</td>
</tr>
<tr>
<td>TCUFmax (mL)</td>
<td>1365 (461 – 2604)</td>
<td>1436 (530 – 2752)</td>
</tr>
<tr>
<td>T50 (min)</td>
<td>128 (12 – 180)</td>
<td>130 (30 – 345)</td>
</tr>
<tr>
<td>TCUF₁ min (mL)</td>
<td>11.0 (5.3 – 15.7)</td>
<td>13.5 (5.1 – 24.6)</td>
</tr>
<tr>
<td>ELAR (mL/min)</td>
<td>1.7 (0.8 – 2.8)</td>
<td>1.9 (0.8 – 2.8)</td>
</tr>
<tr>
<td>Max dip D/ P</td>
<td>0.065 (0.02 – 0.12)</td>
<td>0.080 (0.05 – 0.11)</td>
</tr>
<tr>
<td>MTAC creatine (mL/min)</td>
<td>14.1 (10.9 – 19.1)</td>
<td>14.5 (10.9 – 17.6)</td>
</tr>
</tbody>
</table>

NUF: net ultrafiltration, TCUFR: transcapillary ultrafiltration rate, TCUF max: maximal theoretical intraperitoneal ultrafiltration, t50: time point were 50% of TCUF max would have been reached, TCUF₁ min is TCUFR in the first minute of the dwell, ELAR: effective lymphatic absorption rate, max delta D/P Na⁺: maximal dip in dialysate/plasma ratio of sodium after correction for sodium diffusion from the circulation using the MTAC of urate, MTACcreat is MTAC of creatinine

Based on our previous observations that a reduced sodium sieving was especially present in long-term PD patients, we assumed that impaired aquaporin-1 function would result from continuous exposure to bioincompatible PD solutions. If so, it should not be present in acute peritonitis. Therefore we performed the present study, in which patients with acute peritonitis were matched with stable long-term patients on the basis of their MTAC creatinine, reflecting the vascular surface area. The criteria for the analysis of the free water transport consisted of the sieving of sodium after correction for diffusion and the profile of the intraperitoneal volume
during the 4 hours dwell using a 3.86% glucose dialysate. Since net ultrafiltration and lymphatic absorption were not different in both groups, the two curves should have been identical, if the large vascular surface area would have been the only causative factor of impaired net ultrafiltration in long-term peritoneal dialysis. The shape of the transcapillary ultrafiltration versus time curves, however, was markedly different. In peritonitis a sharp rise in intraperitoneal volume was found, followed by a decrease. The initial rise in the long-term patients was much less steep. The resulting flattened ultrafiltration profile points to a reduced osmotic effect of the hyperosmolar glucose solution. This hypothesis is also supported by the data shown in Figure 2, where the difference in the dip of D/P sodium is obvious. Both curves show a remarkable resemblance with the computer models of Rippe et al., in which a reduced osmotic conductance to glucose was simulated [17,31]. The t50, which was significantly earlier in peritonitis than in MTAC-matched long-term patients, also points to a defect in free water transport in chronic PD. The assumption that indeed osmotic conductance to glucose is impaired in long-term PD, and not augmented in peritonitis, is supported by the results of the comparison of 8 patients during peritonitis with the MTAC-matched, recently started controls. This group showed similar transport parameters compared to the peritonitis patients, implying that free water transport in peritonitis is unaffected, whereas it is significantly lower in the long-term patients. In addition, the results of the 5 patients who were investigated within one year previous to the peritonitis episode also suggest that osmotic conductance to glucose was unchanged during peritonitis. This indicates that the impaired osmotic conductance is likely to be the result of chronic exposure to peritoneal dialysis. In the present study, no control SPA was performed after the peritonitis episode, in order to confirm that the changes in peritoneal transport were reversible. However, previous studies on this subject showed complete recovery of transport parameters after recovery from peritonitis [8]. Since no long-term data on peritoneal water transport are available, longitudinal studies in large patient groups on the changes in the osmotic conductance to glucose are required.

In contrast with our findings, Combet et al. found impaired sodium sieving in rats with acute peritonitis [10]. The difference is most likely explained by the correction for sodium diffusion made in the present study. High diffusion rates during acute peritonitis otherwise would have caused blunting of the D/P sodium ratio due to rapid transport of sodium from the circulation to the dialysate, also in our patients with peritonitis.

It can be concluded that the peritoneal free water transport is within the normal range during acute peritonitis, whereas it is a contributing factor to ultrafiltration failure in long-term PD. The
reason for this impaired osmotic conductance to glucose is probably the long-term treatment with bioincompatible dialysis fluids, but further studies are required to determine the precise pathogenesis.

References:


