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12th Congress of the International
Society for Peritoneal Dialysis

June 21-24, 2008, Istanbul, Turkey



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1. Basic and Clinical Research

Effects of Tamoxifen on Epithelial-to-Mesenchymal Transition (EMT) of Mesothelial Cells: EMT as Key in Type I Membrane Failure in PD

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Peritoneal sclerosing syndrome (PES) associated with peritoneal dialysis (PD) has no specific treatment. Tamoxifen is a synthetic estrogen with antifibrotic [anti-transforming growth factor β (TGF β)] and antimetastatic [anti-vascular endothelial growth factor (VEGF)] effects. We explored the effect of Tamoxifen on PES, neo-vascularization, and epithelial-to-mesenchymal transition (EMT) of mesothelial cells.

Methods: Human peritoneal mesothelial cells (HPMCs) were cultured to confluence. To induce EMT, HPMC were stimulated with r-TGF β (1 ng/mL) and co-treated with Tamoxifen to inhibit EMT or its deleterious effects. As EMT markers, we determined E-cadherin and Snail. As markers of extracellular matrix (ECM), we determined collagen I and fibronectin, α smooth muscle actin (α SMA), tissue plasminogen activator [tPA (a powerful fibrinolytic)], tubulin, and VEGF. We also analyzed mesothelial cells proliferation and cell cycle. Experiments of vessel formation and wound healing were also performed and analyzed at 6, 24, 48 hours and 7 days.

Results: Tamoxifen inhibited EMT of HPMC when we used collagen-coated plates. Tamoxifen also inhibited the deleterious effects of EMT (decreased ECM) and increased tPA production in HPMC and in fibroblast-like mesothelial cells from PD effluent. Tamoxifen did not affect cell proliferation or wound healing. Experiments in a mouse model of PD (4 weeks) are progressing.

We also analyzed survival and incidence of abdominal complications in 2 groups of PD patients with type I membrane failure from our units: 14 treated with daily oral Tamoxifen 20–40 mg, and 14 untreated matched for age, sex, and biochemical parameters. We found an important reduction in both endpoints as soon as 6 months in the group receiving Tamoxifen.

Conclusions: Tamoxifen showed an important and specific inhibitory effect on EMT and fibrosis without affecting the cell cycle. In PD patients with type I membrane failure, tamoxifen reduced abdominal complications and mortality.

Troglitazone Inhibits Synthesis of Transforming Growth Factor β 1 and Reduces Matrix Production in Human Peritoneal Mesothelial Cells

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Background: Inhibition of transforming growth factor β 1 (TGF β 1) expression in human peritoneal mesothelial cells (HPMCs) may provide a potential treatment for peritoneal fibrosis. Peroxisome proliferator-activated receptor γ (PPARG) agonists are increasingly used in patients with diabetes, but their effects on extracellular matrix (ECM) turnover are unknown. The aims of the present study were to investigate the effects of the PPARG agonist troglitazone on TGF β 1 expression and matrix production in HPMCs.

Methods: We cultured HPMCs from human omentum by an enzyme digestion method and grew them in medium containing 30 mmol/L D-glucose. Matrix production and turnover and expression of TGF β 1 were measured in HPMCs in the presence and absence of 15 μ mol/L troglitazone. The mRNA expression of TGF β 1, collagen I (Col I), and fibronectin were determined by semi-quantitative RT-PCR. Protein

of TGF β 1 was determined by ELISA and proteins of Col I and fibronectin were determined by Western blot analysis.

Results: As compared to a control group in F12 medium, HPMCs stimulated with 30 mmol/L D-glucose showed significantly increased mRNA expression and protein of TGF β 1, Col I, fibronectin ($p < 0.01$), which was reversed in the presence of troglitazone (15 μ mol/L). A clear decrease in TGF β 1 was found in troglitazone-treated groups as compared with groups stimulated with D-glucose ($p < 0.05$). Exposure of HPMCs to troglitazone reduced Col I and fibronectin secretion (both $p < 0.05$).

Conclusions: Troglitazone reduced the expression of TGF β 1 in HPMCs stimulated by 30 mmol/L D-glucose, and reduced ECM production. These studies suggest that the PPARG agonists may have a specific role in ameliorating the course of progressive peritoneal fibrosis under long-term peritoneal dialysis.

Dietary Salt Intake Induces Peritoneal Transforming Growth Factor β Production and Fast Transport Status in Rats

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Background: Dietary salt intake has been linked to enhanced cardiac and renal fibrosis by upregulation of transforming growth factor β (TGF β). In vitro, upregulation of TGF β by exposure to glucose leads to enhanced senescence of mesothelial cells. The present study evaluated the impact of salt intake on TGF β expression and small-solute transport in rats.

Methods: We randomized 12 healthy Sprague-Dawley rats to normal salt (NS) or high salt (HS). All rats received normal rat chow. NS rats had free access to tap water; HS rats, only to NaCl 2% as drinking water. After 2 weeks, animals were intraperitoneally injected with 15 mL 3.86% glucose solution at time 0. After 60 and 120 min., dialysate was sampled, and at 120 min. intraperitoneal (IP) volume was determined. Relative expression of TGF β mRNA from peritoneal tissue was then determined, with actin, glyceraldehyde-3-phosphate (GAPDH) as endogenous control for normalization. Samples were run in triplicate.

Results: TGF β mRNA was highly significantly upregulated in HS rats: 2.4 ± 1.4 times ($p=0.01$) and 1.6 ± 0.3 times ($p<0.001$) for visceral and parietal peritoneum respectively. Dialysate-to-plasma ratio (D/P) of urea was 0.54 ± 0.06 (NS) versus 0.60 ± 0.05 (HS, $p=0.08$) at 60 min., and 0.68 ± 0.05 versus 0.77 ± 0.04 ($p=0.009$) at 120 min. End dialysate-to-initial dialysate (D/D0) glucose was 0.23 ± 0.03 (NS) versus 0.21 ± 0.04 (HS, $p=0.3$) at 60 min., and 0.12 ± 0.02 versus 0.11 ± 0.03 ($p=0.6$) at 120 min. IP volume was 24.6 ± 0.6 mL (NS) versus 24.3 ± 0.7 mL (HS, $p=0.5$) after 120 min.

Conclusions: Increased dietary salt intake in normal non uremic rats induced a significant upregulation of TGF β mRNA expression, and an increase in small-solute transport, but not a change in ultrafiltration. Because salt intake also potentially leads to more use of hypertonic bags, a detrimental synergistic effect is exerted on peritoneal membrane structure, and salt restriction should be strongly advised in PD patients.

Effects of GDP-Reduced Dialysate (Balance) for PD on the Epithelial – Mesenchymal Transition (EMT) of the Mesothelial Cell In Vivo

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Ex vivo culture of peritoneal dialysis fluid (PDF)-derived mesothelial cells showed phenotype modifications related to an EMT during PD. Transdifferentiated mesothelial cells acquired a fibroblast-like phenotype, with the loss of E-cadherin expression and increased production of vascular endothelial growth factor (VEGF), fibronectin, and procollagen, which correlated with altered peritoneal function. We hypothesized that patients treated with Balance, a PDF with reduced glucose degradation products (GDPs), should demonstrate decreased expression of EMT markers in MCs taken from fresh peritoneal effluent and grown ex vivo, as compared with MCs from standard PDFs.

Methods: We followed 20 patients using standard PDF (controls) and 13 patients using Balance for 24 months, determining EMT markers in mesothelial cells released into effluent every 6 months. A hierarchy definition of EMT of mesothelial cells was based on fibroblastoid phenotype, higher production of VEGF in supernatant [cell proteins (pg/mg)], higher fibronectin content in mesothelial cells lysates by ELISA [protein (ng/mg)] and

higher procollagen content in mesothelial cells lysates by ELISA [cell protein (ng/mg)]. Expression of intracellular adhesion molecule 1 demonstrated the mesothelial nature of the cells.

Results: Fibroblastoid phenotype and VEGF, procollagen, and fibronectin measurements were significantly correlated. The fibroblastoid phenotype was significantly greater in control patients (70%–100%) than in patients using Balance (0%–27%). Supernatant VEGF was significantly lower in the Balance group (151 ± 153 and 86 ± 55 pg/mg) than in the control group (1107 ± 624 and 2052 pg/mg). Fibronectin levels in mesothelial cells lysate were nonsignificantly increased in both groups. Procollagen levels in mesothelial cells lysate declined over time with nonsignificant differences in both groups.

Conclusions: Two of the EMT markers (phenotype and VEGF) demonstrated a favorable effect when patients used Balance PDF as compared with standard PDF in the medium term. These results sustain the hypothesis that GDP-reduced PDF protects human mesothelial cells from EMT.

Is 3,4-DGE, the Most Toxic GDP, Found in the Circulation During PD Treatment?

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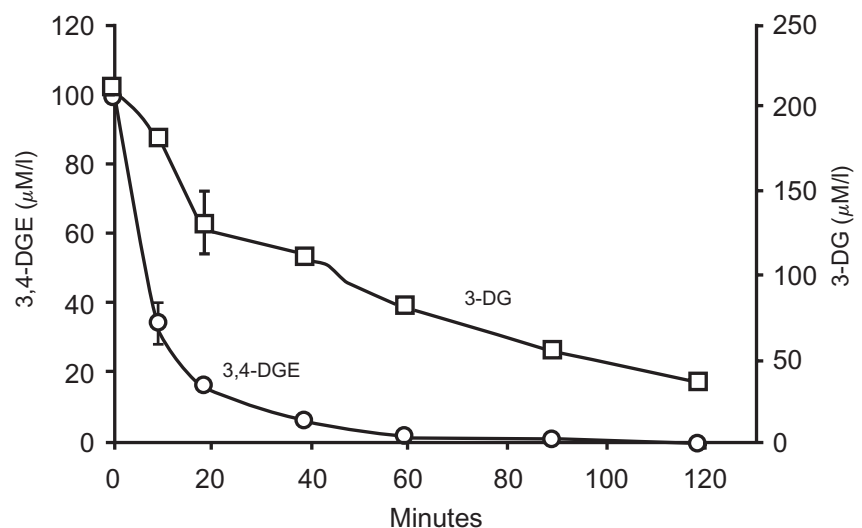
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Objectives: Glucose degradation products (GDPs) in peritoneal dialysis (PD) fluids are important for the outcome of PD treatment. 3,4-Dideoxyglucosone-3-ene (3,4-DGE) is the most cytotoxic of the GDPs and may be recruited from a large pool of 3-deoxyglucosone (3-DG). It is not known whether GDPs remain in the peritoneal cavity or reach the circulation during a PD treatment.

Design: PD patients were dialyzed with a conventional PD fluid containing 43 $\mu\text{mol/L}$ 3,4-DGE and 281 $\mu\text{mol/L}$ 3-DG. Parallel experiments were performed in rats, which were dialyzed with a PD fluid containing 100 $\mu\text{mol/L}$ 3,4-DGE and 200 $\mu\text{mol/L}$ 3-DG.

Results: The concentration of 3,4-DGE in the peritoneal cavity declined more rapidly than that of 3-DG during the dwell (Figure): During dialysis, 3-DG but not 3,4-DGE could be found in plasma of PD patients or rats.

Conclusions: During dialysis, 3,4-DGE could not be found in plasma of either PD patients or rats, probably because of a rapid reaction with tissues, cells, and proteins in the peritoneal cavity, which prevented it from entering the bloodstream. By contrast, the less reactive 3-DG can pass through the membrane and enter the blood, where 3,4-DGE might then be recruited from 3-DG pool, producing systemic effects.



Values are mean \pm SEM; n = 9

Dialysate Protein Clearance, Not Rapid Transport Status, Is Associated with Reduced Survival in a Contemporary Cohort of Peritoneal Dialysis Patients

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Background: Rapid peritoneal transport status (rPTS) may be the result of either inflammation or increased peritoneal membrane surface area, and rPTS during peritoneal dialysis (PD) has been associated with poorer outcomes (although recent studies suggest that this risk may be modifiable). Peritoneal protein clearance (PCI) as a marker of large-pore fluid flux and membrane “leakiness” may distinguish between these two risk types associated with rPTS.

Methods: We identified patients in the Stoke database who had initiated PD in January 1998 or later, and who had undergone a peritoneal equilibration test and measurement of dialysis adequacy and 24-hour dialysate protein clearance within 6 months of therapy initiation. Demographic data, validated comorbidity scores, residual urine volume, peritoneal urea clearance, plasma albumin, and initial PD modality were collected. Patients were followed until death or the end of the study. Stepwise multivariate regression was used to identify factors associated with increased PCI. A Cox proportional hazards model was used to identify factors associated with survival.

Results: On univariate analysis, of the 192 study patients (66% men; mean age: 54.3±15.3 years; 26% with diabetes), PCI correlated positively with age ($p=0.01$), dialysate-to-plasma ratio (D/P) of creatinine ($p<0.0001$), diabetes mellitus ($p=0.05$), and urine volume ($p=0.01$). On multivariate analysis, only age, D/P creatinine, and urine volume remained significant (all $p<0.01$). Predictors of mortality were age [hazard ratio (HR): 1.06; 95% confidence interval (CI): 1.045 to 1.075; $p<0.0001$], comorbidity score (HR: 1.37; 95% CI: 1.196 to 1.569; $p=0.02$), and PCI (HR: 1.009; 95% CI: 1.004 to 1.014; $p<0.05$), but not D/P creatinine (HR: 0.56; 95% CI: 0.152 to 2.073, $p=0.7$).

Conclusions: In this patient cohort, transport status no longer predicts survival, but dialysate protein clearance does, suggesting that the survival risks associated with these two aspects of membrane function are uncoupled. Increased large-pore protein loss may reflect underlying peritoneal membrane inflammation, portending a poor prognosis in these patients.

2. Clinical Practice

Comparative Analysis of Sodium Sieving During Standard Peritoneal Equilibration Tests Using 2.27% and 3.86% Dextrose Solution

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We prospectively analyzed the Na sieving profile of 90 peritoneal dialysis patients who consecutively underwent 2.27% and 3.86% dextrose peritoneal equilibration tests (PETs). We estimated the [Na] (indirect ionselective electrode) at times 0, 60, 90, 120, and 240 minutes. We searched for correlations between Na sieving with type of PET, ultrafiltration, and peritoneal transport category [dialysate-to-plasma ratio (D/P) of creatinine at 240 minutes]. Statistics used the Student t-test, analysis of variance (ANOVA), and nonparametric tests. In dialysate, [Na] was significantly lower in the 3.86% tests than in the 2.27% tests ($p < 0.001$) at any point beyond 0 minutes. The peak fall in [Na] was 11.3 mmol/l in the former and 7.3 mmol/l in the latter ($p < 0.001$). The nadir for [Na] was observed in 22% (3.86%) compared with 39% (2.27%) at 60 minutes, 56% compared with 36% at 90 minutes, in 21% compared with 22% at 120 minutes, and in 1.5% compared with 3% at 240 minutes. Ultrafiltration during PET showed a moderate correlation with peritoneal transport category (3.86%: $r = -0.26$, $p = 0.03$; 2.27%:

$r = -0.39$, $p = 0.001$). The intensity of the Na sieving phenomenon showed a clear correlation with ultrafiltration, in PETs using 3.86% ($r = 0.49$, $p < 0.001$) and 2.27% dextrose [$r = 0.43$, $p < 0.001$ (Spearman)] alike. Patients with ultrafiltration failure (< 400 mL in 3.86% PET) showed a significantly lower fall in [Na], both in the 2.27% (5.2 mmol/l vs. 8.1 mmol/l, $p = 0.006$) and the 3.86% PET (7.8 mmol/l vs. 12.4 mmol/l, $p < 0.001$). Lower ultrafiltration was also associated with an earlier [Na] nadir [3.86%: $p = 0.02$; 2.27%: $p = 0.01$ (ANOVA)]. High-average and high-transporters showed a lesser Na sieving effect, in both the 3.86% ($p = 0.005$) and the 2.27% ($p = 0.04$) PET.

Even though a PET using 3.86% dextrose is more discriminative, a PET using 2.27% dextrose is also able to yield useful information on Na sieving in peritoneal dialysis patients. The nadir for Na concentration appears later in the 3.86% PET than in the 2.27% PET, as it does in patients with a higher ultrafiltration capacity and in low or low-average transporters.

Intraperitoneal Urokinase and Oral Rifampicin for Asymptomatic Persistent Dialysate Infection by Coagulase-Negative Staphylococcus

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Background: Coagulase-negative staphylococcus (CNS) is responsible for refractory and relapsing peritonitis in peritoneal dialysis (PD) patients, probably by biofilm formation on the catheter. The ISPD recommends catheter removal in such cases. Urokinase has been used to dissolve the biofilm lining the PD catheter to allow better antibiotic penetration. Rifampicin has shown efficacy in CNS biofilm penetration.

Methods: We defined asymptomatic persistent CNS dialysate infection as a peritonitis episode with clinical improvement within 48 hours and dialysate clearing, but persistent positive dialysate cultures. We retrospectively studied such cases observed between January 1998 and December 2007, in which intraperitoneal urokinase (100 000 U) and oral rifampicin (600 mg every other day for 3 weeks) were added to intravenous vancomycin.

Results: We recorded 11 cases of asymptomatic persistent CNS dialysate infection. All were initially treated with intravenous vancomycin and oral ciprofloxacin, according to our protocol. Dialysate clearing, as defined by a white blood

cell count $<100/\mu\text{L}$, was noted at day 8 (range: day 4–17) on average. Dialysate cultures were still positive at a mean of 13.7 days (range: 5–24 days) after peritonitis onset. Intraperitoneal urokinase instillation was performed on average of 18.9 days (range: 12–30 days) after peritonitis onset. Rifampicin was given to all but one patient. Treatment success, as defined by peritonitis resolution with sterile dialysate, absence of catheter removal, and absence of peritonitis relapse within 6 weeks of treatment completion, was found in 7 of 11 cases. No side effects following intraperitoneal urokinase instillation were noted. One case of rifampicin-induced toxidermia was recorded.

Conclusions: Intraperitoneal urokinase and oral rifampicin, in addition to conventional antibiotics, resulted in a catheter salvage rate of 64% in asymptomatic persistent CNS dialysate infection. Larger studies are needed to confirm our results. In CNS peritonitis, dialysate cultures should be repeated even after clearing of the dialysate, to avoid missing asymptomatic persistent infection.

Determinants of Catheter Loss Following CAPD Peritonitis

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Background: Few patients are able to resume peritoneal dialysis therapy after an episode of peritonitis that requires catheter removal. PD catheter loss is therefore regarded as an important index of patient morbidity. The aim of the present study was to evaluate factors influencing catheter loss in patients suffering from continuous ambulatory peritoneal dialysis (CAPD) peritonitis.

Methods: We retrospectively reviewed 579 episodes of CAPD peritonitis in a tertiary-care referral hospital from 1999 to 2006. The demographic, biochemical, and microbiologic characteristics of peritonitis episodes resulting in catheter removal (n=68, 12%) were compared with those in which catheters were preserved.

Results: The incidence of catheter loss increased as the number of organisms cultured increased (p=0.001). Catheter removal was more likely to occur after peritonitis episodes in patients with a low serum albumin level (p=0.004), in those with a long duration of effluent leukocyte count remaining above 100/ μ L (p<0.001), in those

with concomitant tunnel infection (p<0.001), in those with concomitant exit-site infection (p=0.005), and in those with presence of catastrophic intra-abdominal visceral events (p<0.001). Conversely, initial PD effluent leukocyte count and serum level of C-reactive protein were not predictive of catheter loss. Microorganisms of the Enterobacteriaceae family were the major pathogens responsible for catheter loss following polymicrobial peritonitis. In the single-organism group, the microbiologic determinants of catheter loss included fungi (p<0.001), anaerobes (p=0.018), and *Pseudomonas* species (borderline significance: p=0.095).

Conclusions: Catheter loss as a consequence of peritonitis is related primarily to hypoalbuminemia, longer duration of PD effluent, leukocyte count above 100/mL, the source of the infection, and the organism causing the infection. Peritonitis associated with concomitant tunnel or exit-site infection and abdominal catastrophe were more likely to proceed to catheter loss.

Peritoneal Dialysis in Patients with Human Immunodeficiency Virus

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Patients with HIV and chronic renal failure (CRF) are thought to have a poorer outcome with peritoneal dialysis (PD) than with hemodialysis (HD), because of an increased incidence of peritonitis with unusual infecting organisms and an increased rate of systemic infections.

Methods: We analyzed our experience from November 1995 to December 2007 with 12 PD patients (10 men, 2 women; mean age: 42 ± 8 years; mean follow-up on PD: 30 ± 29 months) with HIV.

Results: Ten patients had been addicted to intravenous heroin. All were positive for hepatitis C virus and negative for hepatitis B antigen. Eight were on continuous ambulatory PD, and 4 on continuous cycling PD. Causes of chronic renal failure were 7 chronic glomerulonephritis, 2 diabetic nephropathy, 1 thrombotic microangiopathy, and 2 unknown. Six patients suffered from hypertension. HIV evolution: Viral charge lowered in all patients. CD4 levels improved in 10. All patients received long-term antiretroviral treatment. Only 1 patient developed an opportunistic

infection (Pneumocystis carinii pneumonia) with excellent evolution after cotrimoxazole. PD evolution: Four patients had 9 peritonitis episodes (3 Staphylococcus epidermidis, 1 Mycobacterium fortuitum, 1 Candida albicans, 1 Escherichia coli, 1 Klebsiella, 1 Pseudomonas). Exit-site infection was present in only 1 patient (Corynebacterium species). Eleven patients were admitted to the hospital on 23 occasions (4 for peritonitis, 7 for respiratory tract infection, 2 for hypertensive encephalopathy, and 10 other causes). All patients showed good technique compliance. Mean body-weight increase was 4 ± 2.8 kg. Five patients died (1 Pseudomonas leg abscess, 2 cardiac ischemic events, 1 cachexia, and 1 peritoneal sclerosis).

Conclusions: HIV patients can be successfully treated with PD. They do not present higher rates of peritonitis, and the infecting organisms are not more difficult to treat. We think that PD must be the therapy of choice in these patients, because PD minimizes the risk of HIV transmission.

3. Cardiovascular Issues

Comparison of Coronary Artery Calcification Score and Selected Biochemical Risk Factors of Extrasosseous Calcification by Dialysis Modality

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Several factors contribute to the increased cardiovascular pathology in patients on dialysis, including deposition of Ca and P in the vascular system. We compared the advancement of coronary artery calcification (CAC) in patients treated with peritoneal dialysis [PD: n=54; mean age: 50.6±13.7 years; median PD duration: 11.5 months (range: 1–96 months); 53% women] or with hemodialysis [HD: n=73; mean age: 49.4±11.7 years; median HD duration: 77 months (range: 12–294 months), 49% women].

Results: Median CAC by multi-row spiral CT in PD patients was 12.5 HU (range: 0–5502.8 HU), significantly lower than that in HD patients (median: 152.7 HU; range: 0–4987.0 HU; p<0.01). PD

patients had a higher body mass index (p<0.0001) and a shorter dialysis duration (p<0.0001). The two groups were comparable in terms of age and causes of end-stage renal disease. Distribution of biochemical risk factors for extra-skeletal calcification was heterogeneous (Table).

CaxP and serum HDL cholesterol, triglycerides, and TNF α seem to be more favorable in PD; the remaining parameters more favorable in HD. That the less-advanced CAC among PD patients may be entirely the result of shorter dialysis vintage cannot be excluded.

Conclusions: Our results indicate that CAC is less advanced in PD patients, but the explanation for this difference requires further study.

	PD patients	HD patients	p Value
Ca (mmol/L)	2.45±0.28	2.26±0.28	<0.001
P (mmol/L)	1.72±0.49	1.79±0.52	NS
CaxP (mmol ² /L ²)	3.44±0.98	4.04±1.24	<0.01
iPTH (pg/mL)	317 (1.22–1362)	294 (8.72–2049)	NS
Total cholesterol (mmol/L)	5.81±0.99	4.82±1.02	<0.01
HDL cholesterol (mmol/L)	1.3±0.28	0.94±0.33	<0.0001
LDL cholesterol (mmol/L)	3.5±0.9	2.72±0.85	<0.0001
Triglycerides (mmol/L)	2.22±1.16	2.52±1.43	<0.0001
CRP (mg/L)	4.8 (0.17–67.5)	0.39 (0.1–11.3)	<0.0001
Fibrinogen (g/L)	5.25±1.40	4.36±1.44	<0.001
TNF α (pg/mL)	3.9 (4.0–29.6)	8.5 (5.0–22.3)	<0.0001
IL-6 (pg/ml)	3.2 (0.5–59.2)	4.1 (0.4–37.4)	NS
Leptin (ng/mL)	22.9 (2–210)	11.4 (0.6–181.8)	<0.01

Values expressed as median and range or mean \pm standard deviation. NS = nonsignificant; iPTH = intact parathyroid hormone; HDL = high-density lipoprotein; LDL = low-density lipoprotein; CRP = C-reactive protein; TNF α = tumor necrosis factor α ; IL-6 = interleukin-6.

Relationship Between Serum N-Terminal Pro-Brain Natriuretic Peptide Density, Left Ventricular Dysfunction and Extracellular Water in CAPD Patients

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Background: An association has been reported between serum N-terminal pro-brain natriuretic peptide (NT-proBNP) and left ventricular (LV) dysfunction, extracellular water (ECW%) in congestive heart failure, and hemodialysis patients. The aim of the present study was to investigate the relationship between levels of serum NTproBNP and various indices of heart failure in continuous ambulatory peritoneal dialysis (CAPD) patients.

Methods: We conducted a prospective study with 30 CAPD patients (22 men, 8 women; mean age: 54 ± 15 years; 13 with diabetes, 17 without diabetes). Echocardiography was performed using a sonography machine that allowed M-mode, 2-dimensional measurements, and a multi-frequency bio-impedance analyzer was used in

calculating extracellular water as a percentage of total body water (ECW%), understood to be the index of volume load in CAPD patients.

Results: Mean serum NT-proBNP was 14 063 pg/mL, LV mass index was 157 mg/m², and LV ejection fraction was 51%. Mean ECW% was 36.3%. Serum NT-proBNP correlated positively with LV mass index ($r=0.637$, $p=0.01$) and with ECW% ($r=0.612$, $p=0.01$) and negatively with LV ejection fraction ($r=-0.614$, $p=0.01$).

Conclusions: Serum NT-proBNP correlated significantly with LV mass index, LV ejection fraction, and ECW%. Serum NT-proBNP level can therefore be clinical predictive marker for LV hypertrophy, LV dysfunction, and hydration status in CAPD patients.

Increased Troponin I Levels Predict All-Cause and Cardiac Mortality in PD Patients

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Cardiovascular (CV) disease is the main cause of morbidity and mortality in end-stage renal disease patients. Troponin I predicts global and cardiac mortality in healthy populations and hemodialysis patients. It is a marker of subclinical myocardial lesion [coronary ischemia, left ventricular (LV) hypertrophy, and congestive heart failure (CHF)]. Our aim was to analyze Troponin I in peritoneal dialysis patients and to evaluate its predictive value in all-cause and CV mortality and in risk of cardiac events.

Methods: We studied 88 PD patients [56 men, 32 women; mean age: 53 years; mean time on PD: 13 months; mean follow-up: 19 months; mean Charlson comorbidity index (CCI): 5.3 ± 3]. An echocardiography study was obtained in 58 patients.

Results: Previous CV pathology was present in 34% of patients. A CV event of some kind (13 peripheral vascular disease, 12 CHF, 9 ischemic cardiopathy, 7 arrhythmia, 6 cerebral vascular disease) developed in 28%. Of 15 deaths (17%), 3 were from cardiac and 5 from vascular causes. Mean Troponin I was 0.05 ± 0.1 ng/mL (range: 0.01–0.88 ng/mL). In 33%

of patients, Troponin I was elevated (>0.02 ng/mL). Troponin I correlated with LV posterior diameter and interventricular septum by echocardiography. In Cox regression analysis, predictive factors of all-cause mortality were previous CHF [hazard ratio (HR): 6.38; $p=0.00$], ischemic cardiopathy (HR: 5.41; $p=0.00$), Troponin I >0.04 (HR: 3.35; $p=0.02$), CCI (HR: 1.5; $p=0.003$), age (HR: 1.06; $p=0.006$), C-reactive protein (HR: 1.02; $p=0.02$), and time on PD (HR: 1.02; $p=0.006$). Patients with Troponin I >0.04 ($n=19$) were older (59 years vs. 52 years, $p=0.04$) and showed higher previous cardiac comorbidity (63% vs. 26%, $p=0.003$). In Kaplan–Meier survival analysis, patients with Troponin I >0.04 showed higher all-cause mortality ($p=0.018$) and CV mortality ($p=0.036$). CV events during follow-up were similar in both groups.

Conclusions: Elevated Troponin I was present in 33% of our patients. Increased Troponin I correlated with older age and cardiac comorbidity. Troponin I >0.04 is associated with higher risk of all-cause and CV mortality, but a similar rate of CV events.

Assessing Volume Status in CAPD Patients: Value of Bioimpedance Analysis and Plasma ANP

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Objectives: Determining volume status in dialysis patients is critical. The present study examined the usefulness of bioimpedance analysis (BIA) and plasma atrial natriuretic peptide (ANP) in determining the volume of continuous ambulatory peritoneal dialysis (CAPD) patients.

Methods: We measured 24-hour ambulatory blood pressure, plasma concentration of ANP and BIA in 32 stable CAPD patients (13 men, 19 women). Patients were divided into 3 groups; normal blood pressure (group A, n=11), hypertension (<130/80 mmHg) controlled with anti-hypertension medication (group B, n=9), and high blood pressure (>130/80 mmHg) with 2 more anti-hypertension medications (group C, n=12).

Results: Plasma ANP in group C (53.1 ± 13.6 pg/mL) was significantly higher than that in groups A (10.3 ± 7.2 pg/mL) and B (13.7 ± 8.1 pg/mL, $p < 0.05$). The values of normalized extracellular fluid (nECF),

extracellular/intracellular fluid (ECF/ICF), and extracellular fluid/total body water (ECF/TBW) measured by BIA was significantly higher in group C than in groups A and B. Values in groups A and B were not significantly different. The values of nECF, ECF/ICF, ECF/TBW in patients with normal kidney function were not different from values in groups A and B, but they were significantly lower than the values in group C ($p < 0.05$). Plasma ANP level correlated with nECF, ECF/ICF, and ECF/TBW ($p < 0.05$). In a simple linear regression analysis, daytime mean diastolic blood pressure correlated with plasma ANP level ($r = 0.53$, $p < 0.05$). Plasma ANP and nECF, ECF/ICF, ECF/TBW had no effect on peritoneal equilibration test results.

Conclusions: BIA and plasma ANP are both considered useful standards for predicting volume status in CAPD patients.

4. Encapsulating Peritoneal Sclerosis (EPS)

Does the Incidence of Encapsulating Peritoneal Sclerosis Increase After Renal Transplantation?

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Background: Encapsulating peritoneal sclerosis (EPS) is a rare but devastating complication of peritoneal dialysis. An increased incidence is suspected worldwide.

Methods: We retrospectively reviewed the medical charts of all PD patients who underwent transplantation (Tx) at our center from 1 January 1998 to 31 August 2006 to determine the incidence of post-Tx EPS and to identify risk factors.

Results: Among the 97 PD patients transplanted at our center, 8 (8.2%) developed EPS [mean age at Tx: 60 years (range: 52–67 years); peritoneal dialysis duration: 58 months (range: 24–114

months)] 1–4 months post-Tx, all in the last 3 years (see figure). On univariate analysis, EPS patients had a longer peritoneal dialysis duration ($p < 0.001$) and were older at Tx ($p = 0.004$) than were the non-EPS patients. By multiple regression, peritoneal dialysis duration remained significantly higher in EPS patients. No other risk factors could be identified.

Conclusions: An emerging incidence of post-Tx EPS has been observed in our center since 2004. Duration of peritoneal dialysis was significantly longer in EPS patients, but other predisposing factors could not be found.

Dialysate Cytokines Predict Progression of Peritoneal Fibrosis in Patients on PD

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Objectives: Clinically, peritoneal fibrosis manifests late as membrane failure or encapsulating peritoneal sclerosis (EPS). No clinical or biochemical tests are able to determine the rate of peritoneal fibrosis progression or the driving forces behind it.

Methods: For 1 year, we followed 106 stable peritoneal dialysis (PD) patients who were initially free from infection or recent peritonitis. Inflammatory, angiogenic, and fibrotic cytokines were measured in dialysate (value/4h) and serum at baseline and at 1 year.

Results: Dialysate and serum monocyte chemoattractant protein 1 (569.3 ± 40.55 ng/4h, 274.8 ± 12.63 pg/mL), interleukin-6 (IL-6): 103.7 ± 19.23 ng/4h, 5.1 ± 0.46 pg/mL, angiogenin (AngG): 111.9 ± 6.4 μ g/4h only, and pulmonary activation-regulated chemokine (CCL18/ PARC): 6.76 ± 0.66 μ g/4h, 126.4 ± 7.6 ng/mL correlated with membrane permeability. By one year, seven patients had developed EPS. Baseline dialysate CCL18 (11.5 ± 3.6 μ g/4h) and IL-6 (184.9 ± 64.6 ng/4h), and serum CCL18 (156.9 ± 12.8 ng/mL) were significantly higher in patients who developed EPS than in those who did not (5.6 ± 0.8

μ g/4h, $p=0.022$; 78.5 ± 10.2 ng/4h, $p=0.018$; 124.7 ± 12.2 ng/mL, $p=0.022$ respectively). In 12 patients who were transferred to hemodialysis, only dialysate and serum CCL18 ($p=0.03$) were higher.

Cytokine levels were measured in 37 of the 57 patients who remained on PD at 1 year (Table).

Serum C-reactive protein and dialysate IL-6 and CCL18 were significantly increased at 1 year, but membrane permeability, residual renal function, and ultrafiltration capacity were not different. Serum AngG fell significantly over the year.

Conclusions: A finding of high inflammatory and fibrotic cytokines may be helpful in predicting which patients are at risk of EPS. CCL18 may possibly be able to be used as a predictor of membrane changes necessitating a change to HD. The increase in IL-6 and CCL18 in dialysate at 1 year is interesting and may explain background inflammation leading to peritoneal fibrosis. The decline in serum AngG is surprising and may imply less angiogenesis and more fibrosis. These findings need to be confirmed in larger number of patients.

	Baseline	1 Year	p Value
Serum C-reactive protein (mg/dL)	4.9 ± 0.92	9.1 ± 1.5	0.01
Dialysate IL-6 (ng/4 h)	82.4 ± 16.8	182.8 ± 34.4	<0.0001
Dialysate CCL 18 (μ g/4 h)	4.47 ± 0.7	12.4 ± 1.4	<0.0001
Serum AngG (ng/mL)	957 ± 42.5	614.3 ± 31.7	<0.0001

IL-6 = interleukin 6, CCL = pulmonary activation-regulated chemokine, AngG = angiogenin

Encapsulating Peritoneal Sclerosis: Nutritional Support and Outcomes in Long-Term Survivors

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Background: There is little evidence on which to base nutritional management of patients with encapsulating peritoneal sclerosis (EPS).

Methods: We assessed changes in nutrition status and gastrointestinal (GI) symptoms related to various types of nutritional support over 12 months in long-term EPS survivors. Baseline data included nutrition status, GI symptoms (nausea, vomiting, abdominal cramps/bloating, constipation, diarrhea), and nutritional support received. Data collection was repeated every 2 months for 1 year.

Results: Of 30 EPS patients diagnosed between June 1997 and November 2006, 17 survivors (mean age: 49 years; mean peritoneal dialysis duration: 7 years; mean duration since EPS diagnosis: 17 months) were identified. At 12 months' follow-up, 4 patients had died, and data for 1 patient were

missing, leaving 12 patients for analysis (5 transferred to hemodialysis, 7 transplanted). Three patients received total parenteral nutrition (TPN), 1 received intradialytic parenteral nutrition (IDPN), 4 received oral nutritional supplements only, and 4 received no nutritional support. Mean time on TPN was 20 weeks (range: 4–52 weeks); IDPN, 36 weeks; and oral nutritional supplements, 27.5 weeks (range: 14–52 weeks) (Table).

Conclusions: Most patients with EPS became less symptomatic over time and achieved good nutrition with oral supplements alone. The most symptomatic and malnourished patients required parenteral nutrition, but achieved less improvement in weight, body mass index (BMI), SGA score, and GI symptoms. Earlier and longer use of TPN may result in better outcomes.

Parameter	TPN/IDPN	Oral	None
Baseline weight (kg)	50.3±3.48	57.2±14.66	68.9±12.17
Weight change	-0.2±2.03	4.2±5.11	1.8±2.91
Baseline BMI (kg/m ²)	20.0±1.67	21.5±2.20	23.9±1.92
BMI change	0.1±0.82	1.6±1.75	0.6±0.94
Baseline handgrip strength	12.4±4.18	17.9±8.59	28.2±10.4
Handgrip strength change	5.8±3.48	3.6±3.40	-1.7±3.65
Baseline albumin (g/dL)	31.3±3.30	29.5±2.65	37.5±3.32
Albumin change	3.8±4.79	4.5±4.43	0.3±1.71

Diagnostic Value of CT Scan in PD Patients with Encapsulating Peritoneal Sclerosis

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Background: Encapsulating peritoneal sclerosis is a severe complication of long-term peritoneal dialysis, with high morbidity and mortality rates. The diagnosis is based on clinical symptoms plus

macroscopic and microscopic findings during surgery. Computed tomography scans are used to confirm the diagnosis, but there is no consensus on radiologic abnormalities specific for encapsulating peritoneal sclerosis. We compared computed tomography scans of encapsulating peritoneal sclerosis patients with computed tomography scans of long-term peritoneal dialysis patients without encapsulating peritoneal sclerosis.

Methods: We included all encapsulating peritoneal sclerosis patients at our center from 1996 until October 2007 with an available computed tomography scan at the time of diagnosis (n=17). The control group consisted of long-term PD patients (PD>4 years) who underwent a computed tomography scan for various reasons (n=18). The patients were anonymized, and cases and controls were placed in a random order.

The computed tomography scans were independently reviewed by 2 experienced radiologists, and 8 items were scored: peritoneal enhancement, thickening, and calcifications; small- and large-bowel wall thickening; adhesions of bowel loops; signs of obstruction; and fluid loculation. Significant differences between the two groups in specific diagnostic abnormalities were analyzed using the chi-square statistic.

Results: Both radiologists scored individual items similarly in 92% of cases (Table).

Conclusions: With the exception of fluid loculation, the abnormalities typically found in encapsulating peritoneal sclerosis patients were also found in some control patients. Computed tomography is therefore useful to confirm a diagnosis, but cannot be used as a "gold standard" for diagnosing encapsulating peritoneal sclerosis.

Table: Number of positive findings/number of scans that could be judged

	Radiologist 1		Radiologist 2	
	EPS	Control	EPS	Control
Peritoneal enhancement	11/12 ^a	2/11	11/12 ^a	2/11
Peritoneal thickening	16/17 ^a	4/18	16/17 ^a	3/18
Peritoneal calcifications	12/17 ^b	4/18	10/17 ^c	4/18
Large-bowel wall thickening	0/17	2/18	1/17	2/17
Small-bowel wall thickening	1/17	1/18	6/17	5/18
Adhesions of bowel loops	15/17 ^a	1/18	10/17 ^a	2/16
Signs of bowel obstruction	6/17 ^a	1/18	10/17 ^c	1/18
Fluid loculation	5/17 ^c	0/18 ^c	5/17 ^c	0/18 ^c

^a p<0.001; ^b p<0.01; ^c p<0.05.

5. Training and Education

Multidisciplinary Pre-dialysis Education Decreased Incidence of Dialysis, Increased Peritoneal Dialysis Uptake, and Improved Mortality – by Fulfilling the NKF/DOQI Guideline: A Prospective Randomized Cohort Study

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Objectives: Observational studies demonstrated that multidisciplinary pre-dialysis education extended time to dialysis and improved patient outcomes after onset of dialysis. Comparisons were made with inconstant standard of pre-dialysis care. Fewer prospective randomized studies have assessed the effect of multidisciplinary pre-dialysis education on the incidence and outcome of dialysis.

Methods: Late-stage pre-dialysis chronic kidney disease patients of a nephrology outpatient clinic from 2005 to 2007 were enrolled in this prospective cohort study and were randomly referred to receive multidisciplinary pre-dialysis education. The primary endpoints were initiation of dialysis or death. Demographic, clinical, and laboratory findings were assessed at study entry and at start of dialysis. Characteristics of patients who initiated dialysis were compared with a historical control cohort to avoid the confounding effect of the time of knowledge acquisition.

Results: Of 573 patients, 287 attended multidisciplinary pre-dialysis education. The mean estimated glomerular filtration rate (eGFR) of the study population was 23.8 ± 20.1 mL/min. After a mean follow-up of 11.7 ± 2.3 months, the incidence of dialysis was 13.9% in the multidisciplinary pre-dialysis

education group and was 43% in the no multidisciplinary pre-dialysis education group ($p < 0.001$). The uptake rate of PD therapy was 35% in the multidisciplinary pre-dialysis education group, 20.5% in the no multidisciplinary pre-dialysis education group, and 19.8% in the historical control cohort ($p = 0.023$). The overall all-cause and cardiovascular mortality rates were 1.7% and 0% in the multidisciplinary pre-dialysis education group, and 12.2% and 7.3% in the no multidisciplinary pre-dialysis education group ($p < 0.001$ and $p = 0.021$). Univariate analysis identified older age, higher initial creatinine, lower initial estimated glomerular filtration rate, lower initial hematocrit, no multidisciplinary pre-dialysis education attendance, progression to end-stage renal disease, and choice of hemodialysis as prognostic factors for poor 1-year mortality. Multivariate analysis indicated that age, initial creatinine, and multidisciplinary pre-dialysis education remained significant independent prognostic factors.

Conclusions: Multidisciplinary pre-dialysis education fulfilling the NKF/DOQI guideline reduced the incidence of dialysis, increased the uptake of PD, and decreased overall all-cause and cardiovascular mortality in late-stage chronic kidney disease patients.

The Short- and Long-Term Effects of Pre-dialysis Education on Patient Outcomes: Polish Perspective

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Pre-dialysis education, in addition to standard nephrology follow-up, enhances the probability of planned dialysis start and may improve dialysis patient outcomes. The aim of our study was to determine the effect of a structured pre-dialysis education program on dialysis modality selection, elective start of treatment, and survival.

All incident patients starting dialysis treatment at our unit between January 2005 and December 2007 (n=91; age: 60±15 years) entered the study. The pre-dialysis education program consisted of 3–4 visits with a dedicated renal nurse and physician. Clinical data were recorded at the start of dialysis, and mortality data were collected prospectively.

Of the 91 patients enrolled, 50 (57%) had an earlier nephrology follow-up. During the study period, the percentage of patients commencing dialysis after the pre-dialysis education program exposure rose from 20% in 2005 to 70% in 2007 (p<0.001). Peritoneal dialysis was the first-choice therapy in 52% of all patients, and in 72% of patients who participated in the pre-dialysis education program. The pre-dialysis education program was associated with planned

start in 84% of patients as compared with 27% of patients receiving regular unstructured care (p<0.0001). Planned patients – who were younger and who had fewer coexisting diseases – more often started treatment with peritoneal dialysis (65% vs. 40%, p=0.01). At the start of dialysis, the pre-dialysis education program patients had a higher estimated glomerular filtration rate and higher hemoglobin and serum albumin. Kaplan–Meier analysis demonstrated that survival was significantly better in patients who started dialysis electively (p<0.0001). Cox proportional hazards analysis demonstrated that urgent start was an independent predictor of death after adjustment for other variables known to affect outcome.

Structured pre-dialysis education program is associated with a greater likelihood of planned dialysis initiation, better clinical status, and greater probability of choosing peritoneal dialysis as the first treatment option. It can be also a valid factor in dialysis patient outcomes. Further (preferably) randomized studies are required to determine the cost-effectiveness of these interventions.

Nephrologists' Perception of Peritoneal Dialysis in the Netherlands

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It is known that about 50% of patients with stage 5 chronic kidney disease can be treated with peritoneal dialysis. However, penetration of peritoneal dialysis in the Netherlands has never been more than 30%. Currently, it has even decreased to less than 25%. Our aim was to visualize current obstacles to advising peritoneal dialysis as first renal replacement therapy. Accordingly, we asked the opinion of nephrologists about how to tackle these problems.

Methods: A questionnaire was sent to Dutch nephrologists (n=277; 184 clinically active, 34 fellows). Questions were distributed by e-mail. The response rate was 35%.

Results: Medical contraindications (82%), impossibility to train the patient (62%), and unsuitable accommodation (42%) were most common reasons not to start with peritoneal dialysis. Establishment of a nationwide registry of encapsulating peritoneal sclerosis (66%), reducing the price difference between conventional and more biocompatible peritoneal dialysis fluids (60%), and improving information and the education of patients and of nephrologists (both 53%) were the most frequently suggested improvements to peritoneal dialysis. All nephrologists believed that their experience with

peritoneal dialysis was sufficient. Fears about encapsulating peritoneal sclerosis resulting from peritoneal dialysis were held by 16%. Of the 48 nephrologists who indicated that reducing the price difference between peritoneal dialysis fluids would improve penetration of peritoneal dialysis, 58% did not believe that unrestrained expansion of the capacity of center hemodialysis should be discouraged. Establishment of a nationwide registry of encapsulating peritoneal sclerosis (77%) and improvement in the information and education of patients (63%) and of nephrologists (60%) were important factors for improving peritoneal dialysis. This group also found the development of a guideline for monitoring peritoneal function important (65%; 51% of all respondents).

Conclusions: Medical, psychosocial, and logistic problems are main reasons nephrologists do not choose peritoneal dialysis. There is room for improvement of information and education. A nationwide registry of encapsulating peritoneal sclerosis is warranted. The development of a guideline for monitoring peritoneal function was regarded to be important. Financial issues are likely to be involved in modality choice.

6. Outcome and Epidemiology

Outcome in Patients with Gram-Negative and Gram-Positive (Staphylococcus aureus) Peritonitis

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Peritonitis is a significant cause of technique failure and mortality for patients on peritoneal dialysis. We retrospectively reviewed data from our center concerning gram-negative (GNP) and gram-positive [GPP (*S. aureus*)] episodes of peritonitis between January 1996 and August 2007 (n=854, 139 GNP and 90 GPP) to determine if a difference in survival rate occurred with GNP and GPP.

We reviewed outcomes at 3 weeks and at 3 months following the onset of peritonitis with reference to catheter removal (in accord with International Society for Peritoneal Dialysis guidelines) or non removal (CNR), and continuation on CAPD, switch to hemodialysis, or death:

At 3 weeks, 84 GPP patients (96.5%) remained on CAPD, with 3 deaths (3.5%). At 3 months, 69 among the same group of patients (84%) remained on CAPD, 8 (10%)

had transferred to hemodialysis, and 5 (6%) had died. Among GNP patients with catheter removal, 4 (6%) died, and 24 GNP patients with catheter non removal died. Overall, the number of deaths in GPP patients with catheter removal or catheter non removal at 3 weeks was not statistically significant compared with the number of deaths at 3 months. By contrast, the death rate in GNP patients with catheter removal was 6% as compared with 13.4% in GNP patients with catheter non removal. The outcome for GPP patients was independent of catheter removal status. Patients with GNP who underwent catheter removal had a significantly lower death rate than did GNP patients with catheter non removal. Further multicenter studies are necessary to determine if patients with proven GNP benefit from early catheter removal.

CAPD and APD Continuation During Peritonitis Reveal Similar Outcomes

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Objectives: Because few data exist on treatment of peritonitis in patients on automated peritoneal dialysis (APD), a switch to continuous ambulatory peritoneal dialysis (CAPD) is sometimes favored during treatment for APD-related peritonitis. We explored whether treating peritonitis while patients continued with their usual peritoneal dialysis (PD) modality was associated with a difference in outcome.

Methods: We performed a retrospective analysis of episodes of PD-associated peritonitis seen in our centre from January 1993 to September 2006. Patient characteristics, severity of peritonitis, and outcome were compared between APD and CAPD patients.

Results: We included 489 episodes of PD-related peritonitis in 194 patients. Differences in the severity of peritonitis as indicated by initial (ILC) and maximal leukocyte count (MLC) in the peritoneal fluid was not statistically different between the groups {mean ILC [standard deviation (SD)]: 2.9 (5.1) $\times 10^9$ /L in APD vs. 2.5 (4.2) $\times 10^9$ /L in CAPD; mean MLC (SD): 3.9 (6.5) 10^9 /L in APD vs. 3.8 (8.4) $\times 10^9$ /L in CAPD}. Duration of

leukocyte count elevation in PD fluid was significantly longer in APD than in CAPD [mean (SD): 7.0 (5.9) days vs. 5.5 (4.6); $p=0.004$], and APD patients were treated with antibiotics for a longer time than were CAPD patients (17.3 days vs. 15.5 days, $p=0.022$). Outcome was similar for the two PD modalities. In the 230 episodes of APD related peritonitis, patients recovered fully with antibiotic treatment alone 174 times. Catheter removal was performed 38 times, and catheter replacement 6 times. All-cause death occurred in 12 cases. In CAPD-related peritonitis, full recovery was seen 195 times in 259 episodes. Catheter removal and replacement were deemed necessary 37 and 9 times respectively. All-cause death occurred in the course of treatment in 18 cases.

Conclusions: Leukocyte count in the peritoneal fluid stays elevated longer in patients with APD-related peritonitis than in those with CAPD-related peritonitis, and APD patients receive antibiotic treatment longer. Nevertheless, our data do not support a temporary switch to CAPD during treatment for APD-related peritonitis.

Survival on Automated PD Versus Continuous Ambulatory PD in the Netherlands Cooperative Study on Adequacy of Dialysis

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Background: Since its introduction, automated peritoneal dialysis (APD) has increased in use as compared with continuous ambulatory peritoneal dialysis (CAPD). The aim of the present study was to compare overall and technique survival (stay on first peritoneal dialysis modality) of patients treated with APD as compared with CAPD.

Methods: The Netherlands Cooperative Study on the Adequacy of Dialysis (NECOSAD)-2 is a prospective multicenter cohort study of incident adult end-stage renal disease patients (ESRD). In this analysis, patients who were treated with APD (n=87) or CAPD (n=563) at 3 months after the start of dialysis (baseline) were included. A multivariate Cox regression analysis was used to analyze technique and overall survival according to treatment modality. "Event" was defined as a switch of dialysis modality or death; other reasons for dropout were censored. The maximum follow-up was 5 years.

Results: At baseline, the APD patients were slightly younger than the CAPD patients [median age: 53 years (range: 19–83 years) vs. 54 years (range: 19–87 years)], and more patients were male (77% vs. 66%). Of the APD patients, 6 (7%) died and 34 (39%) switched treatment modality. Of the CAPD patients, 91 (16%) died, and 238 (42%) switched treatment modality. The hazard ratio (HR) for APD patients was 0.79 [95% confidence interval (CI): 0.569 to 1.096]. When adjusted for age, the HR became 0.844 (95% CI: 0.607 to 1.173). Restriction for age (18–60 years) dropped the HR to 0.682 (95% CI: 0.443 to 1.052), and restriction to elderly patients (61–87 years) gave a HR of 1.228 (95% CI: 0.739 to 2.042). Restriction for sex gave a HR of 0.709 (95% CI: 0.487 to 1.033) for men and 1.056 (95% CI: 0.533 to 2.093) for women.

Conclusions: Overall and technique survival tend to be better with APD than with CAPD, especially in younger and male patients.

Comparison of Long-Term Survivors on Peritoneal Dialysis and Hemodialysis

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Peritoneal dialysis (PD) and hemodialysis (HD) are complementary therapies for treatment of renal failure. Few data are available comparing the characteristics of survivors on these two modalities.

We studied 591 long-term survivors (>3 years) on dialysis [445 HD, 146 PD; mean age: 60.0±14.3 years (HD) vs. 57.2±14.2 years (PD), $p<0.05$; dialysis vintage: 68.9±29.2 months (HD) vs. 70.3±32.1 months (PD), $p=\text{nonsignificant (ns)}$]. At 3 months, PD patients had higher residual renal function [KRU: 3.44±2.9 mL/min (HD) vs. 4.14±2.3 mL/min (PD), $p<0.05$]. KRU was similar thereafter, and the rate of KRU decline was equal. At 3 years, systolic blood pressure control was lower in PD patients [153.4±25.9 mmHg (HD) vs. 140.4±22.8 mmHg (PD), $p<0.001$]. Hemoglobin (Hb) was similar at start of renal replacement therapy [9.7±1.6 g/dL (HD) vs.

9.6±1.8 g/dL (PD), $p=\text{ns}$], but PD patients had superior Hb at 3, 6, 12, and 24 months. Corrected Ca was similar in both groups. At dialysis start, P was lower in PD patients [2.01±0.66 (HD) vs. 1.80±0.66 (PD), $p<0.05$], and it remained lower. CaxPO₄ was similar at dialysis start [3.68±1.5 (HD) vs. 3.67±1.14 (PD)], but lower in PD patients thereafter. Parathyroid hormone (PTH) was similar at dialysis start [29.8±30.8 pmol/L (HD) vs. 30.3±39.4 pmol/L (PD), $p=\text{ns}$], but a trend to lower PTH in PD patients was observed. Normalized protein catabolic ratio (nPCR) was equal at start of dialysis [0.88±0.3 (HD) vs. 0.85±0.3 (PD), $p=\text{ns}$]. In PD patients, nPCR subsequently fell at 3 years [0.88±0.3 (HD) vs. 0.75±0.1 (PD), $p<0.001$]. Our data suggest that, in the early years after dialysis initiation, PD is advantageous with respect to blood pressure, anemia, and renal bone disease.

Comparison of Hemodialysis and Peritoneal Dialysis – Analysis and Interpretation of Cost Data

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Background: Limited funds and a growing population with end-stage renal disease (ESRD) affect health care systems in many countries. Cost analysis of various dialysis modalities mostly lack hospitalization rates and an exact balance sheet analysis and are therefore not directly comparable.

Objectives: To compare and interpret the complete costs for hemodialysis (HD) and peritoneal dialysis (PD), including overhead costs for treatment of complications and for the hospital itself.

Methods: Files of 60 random ESRD patients who had been on dialysis for more than 18 months were retrospectively studied, and all consumption of health care resources was recorded. These resources included costs for medication [including, as a separate group, costs for erythropoietin stimulating agents (ESAs)], transportation, materials, technical services, overhead costs, ancillary personal costs, costs for radiology and laboratory tests as recorded in an absorption costing for the dial-

ysis department in a large hospital in Austria.

Results: Total costs per patient-year ranged between € 48,100 and € 94,100 for HD and between € 26,900 and € 65,800 for PD. The average annual cost per patient was € 62,870 for HD and € 41,460 for PD (Table).

Conclusions: Our study evaluated the total costs for two different treatment modalities for ESRD in Austria, including a detailed analysis of the absorption costing of a single dialysis center. This is – to our knowledge – the first study in which this accuracy of measurement has been achieved. As compared with HD, CAPD is associated with strikingly lower absolute costs (75:25 ratio for HD vs. PD for years 1–5). Costs for transportation, laboratory tests, ESAs, and overhead are much lower for PD treatment. The study shows a possible cost benefit for the healthcare system when enhancing the ratio HD versus PD towards PD.

Table: Total costs per patient year (€)

	HD	PD
Transportation	11,585	1,136
Medication (except ESA)	4,979	3,483
ESA	4,391	2,761
Treatment ^a	39,655	29,855
Miscellaneous	2,261	4,229
Total	62,871	41,464

^a Includes costs for fluids, physician and nurse fees, laboratory tests, and hospital overhead.
ESA = Erythropoietin-stimulating agents



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