Comparable outcome of acute unplanned peritoneal dialysis and haemodialysis

Michael Koch¹, Matthias Kohnle¹, Rudolf Trapp¹, Burkhard Haastert², Lars Christian Rump³ and Sendogan Aker¹

¹Nephrologisches Zentrum Mettmann, Mettmann, Germany, ²Medistatistica, Neuenrade, Germany and ³Klinik für Nephrologie, Heinrich-Heine University, Düsseldorf, Germany

Correspondence and offprint requests to: Michael Koch; E-mail: koch@dialyse-mettmann.de

Abstract

Background. The impact of dialysis modality on outcome, especially on infection early in the course of dialysis, in unplanned acute dialysis initiation has not been well evaluated. The aim of the study was to compare the rates and causes of mortality and morbidity in incident dialysis patients started unplanned acute peritoneal dialysis (PD) or haemodialysis (HD).

Patients and methods. In this observational cohort study, incident dialysis patients with initiation of unplanned and acute PD (n = 66) or HD (n = 57) at a single centre from March 2005 to June 2010 were included and followed up for 6 months (0–183 days, mean follow-up time 4.72 months). For PD, surgically placed Tenckhoff catheters were used. All HD patients were dialysed with a central venous catheter (non-tunnelled or tunnelled). There were no significant differences in terms of gender, age and prevalence of diabetes mellitus in either group. The prevalence of heart failure [New York Heart Association (NYHA) Stage III–IV] was significantly higher in the PD group (73 versus 46% in HD group, P < 0.01). The population was stratified to PD and HD comparing mortality, infection, bacteraemia and hospitalization.

Results. Of the 123 patients who commenced acute and unplanned dialysis, n = 44 (35.8%) died during the follow-up period of 0–183 days. There were no significant difference in half-year mortality in n = 20 PD patients (30.3%) versus n = 24 HD patients (42.1%) (P = 0.19). The cardiovascular mortality in PD and HD patients were 9.1 and 10.5%, respectively (P = 1.00). Overall mortality due to infection was higher in the HD (17.5%) versus in the PD group (9.1%), however, not significant (P = 0.19). HD patients had significantly higher probability of bacteraemia in the first 183 days compared to PD patients (21.1 versus 3.0%, P < 0.01). Group comparison by Poisson regression analyses showed that the relative risk of bacteraemia in the PD group versus HD group was 0.16 (95% confidence interval, 0.05–0.57, P = 0.005). The significant difference was not affected by the confounder’s patient age at time of dialysis, male sex, heart failure (NYHA III–IV), diabetes, malignancy and peripheral arterial occlusive disease Stage IV. There were high proportions of hospitalization after the initiation of dialysis in both groups (PD 75.0% and HD 67.3%, P = 0.40). Univariate and multiple regression analyses revealed only age at initiation of dialysis to be significantly associated with overall mortality (P < 0.05).

Conclusions. Dialysis modality (PD versus HD) in an acute unplanned dialysis setting showed, in our population, no significant influence on survival. HD patients had a significantly higher risk of bacteraemia, perhaps due to central venous dialysis catheter. PD seems to be a safe and efficient, at least comparable, alternative to HD in acute unplanned dialysis settings.

Keywords: catheter; haemodialysis; infection; mortality; peritoneal dialysis

Introduction

In acute unplanned settings, haemodialysis (HD) was preferred in most dialysis units with a high rate of central venous catheter (CVC) use at dialysis initiation among incident HD patients. Despite of the National Kidney Foundation’s efforts to reduce incidence and prevalence rates of vascular catheter use for dialysis, it has been shown that unplanned dialysis initiation using temporary haemodialysis, catheters are independently associated with greater mortality in incident dialysis patients with a high rate of infectious complications [1]. Infectious complications represent a major cause of morbidity and the second leading cause of death in dialysis populations [2, 3]. The early risk for bacteraemia in HD patients is related to the use of HD catheters as the initial access [3, 4]. The United States Renal Data System (USRDS) Wave 2 Study identified initial dialysis access as the main antecedent of bacteraemia or septicemia. The risk for bacteraemia or septicemia for peritoneal dialysis (PD) catheters was not significantly different from those for arteriovenous grafts or native arteriovenous fistulae but was substantially less than those for permanent or temporary HD catheters [5]. The risk for infection is particularly pronounced in elderly patients [6].
elderly patients indicate that 15.1% of patients with an HD catheter die in the first 90 days compared with 6.7% with a fistula [7].

Other studies have not observed an appreciable impact of dialysis modality on infection. Powe et al. [8] has reported no significant difference in sepsisemia rates between PD and HD patients. A single-centre study reported that dialysis modality was not an independent predictor of overall infection rate in a cohort of incident dialysis patients but was a strong predictor of type of infection that they experienced. Specifically, HD was associated with a greater risk of bacteremia, whereas PD was associated with a greater risk of peritonitis [9]. McDonald et al. showed from the ANZDATA registry that the effect of dialysis modality on survival depends on time, age and presence of comorbidities. Treatment with PD was advantageous initially but with higher mortality after 12 months [10].

The aim of the study was, in attempt to reduce the initiation of HD via CVC, to answer the question whether initiation of the dialysis in an acute and unplanned setting with a PD catheter results in less complications, such as catheter-related infections, hospitalizations and mortality as in HD patients with CVC as an initial vascular access method. We compared in an observational nonrandomized single-centre cohort, the survival and complication rate in patients with an acute and unplanned PD versus HD via CVC access in the first 6 months.

Materials and methods

Patient population

Patients who started acutely and unplanned with HD or PD between March 2005 and January 2010 in our centre of Nephrology (certified according to DIN EN ISO 9001) were included in the study. Unplanned dialysis initiation was defined as beginning dialysis urgently due to late referral or unexpected deterioration of residual renal function with uraemic syndrome or overhydration in patients without functional fistula for dialysis and therefore needing a central venous dialysis catheter. Each patient was followed up at risk for 183 days after starting dialysis with a range of time, age and presence of comorbidities. Treatment with PD was advantageous initially but with higher mortality after 12 months [10].

Most previous reports that used USRDS data did not include the critical first months on dialysis. This is a time when a high proportion of patients are using HD catheters with increased the risk for bacteremia [11].

The impact of dialysis modality on outcome in acute unplanned settings during the first few months of dialysis have not been well studied, perhaps because of underuse of PD in acute unplanned settings [12].

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was too long. Depending on the residual renal function, treatment volume varied between 10 and 20 L/12 h. After improvement of the acute medical condition, the patients could choose their preferred maintenance dialysis strategy, HD patients were dialysed for 9–15 h/week depending on their residual renal function. For PD access, the two-cuff Tenckhoff catheter was placed laparoscopically. For HD access, the non-tunnelled double-lumen Shaldon catheter (n = 38) or the tunnelled single-lumen Demers catheter (n = 19) was used. With the backup of a 24-hour standby surgery and anesthesia service, the Demers- and Tenckhoff catheters were implanted under general anesthesia. During surgery, catheter function was proved with volume charge and discharge. Within 12 h after implantation and after proof of a short discharge cycle, therapy was started.

Clinical and laboratory measurements

Patients were considered as having diabetes if they were maintained on drug treatment (insulin or oral antidiabetics) at the beginning of the observation period or had a medical history of diabetes that did not require drug therapy at the time of examination. A patient was considered as having peripheral arterial occlusive disease (PAOD) if the patient had a history of peripheral revascularization, if one of the foot pulses was not palpable or if the patient presented with foot lesions due to PAOD. Malignancy was specified if an active or inactive malignant disease had been reported. Sepsis or bacteremia due to catheter-related infection was diagnosed if blood cultures—performed in the presence of considerable C-reactive protein (CRP) increase or deterioration of the patient’s condition—were positive. CVC-related bacteremia, infection or sepsis were diagnosed if blood cultures were positive on blood collected from the catheter in combination with further clinical and laboratory findings for infection and sepsis. If blood cultures were negative due to, for example, early antibiotic treatment, or were not available, and if other infection conditions such as pneumonia, urinary tract infection or foot gangrene could be excluded, a significant increase in CRP shortly before death (<3 days) was also assumed (nonproven) to be catheter-related infection.

Statistics

Descriptive statistics. The baseline patient characteristics, including hospitalization events and days, are described for both dialysis strategies. Hospitalizations at time of dialysis were evaluated as baseline characteristics. Values are expressed as percent, as mean ± standard deviation, if assumed normally distributed or—for log-normally distributed variables—as geometric mean ± SDF. Skewed variables were expressed as median (range). The two groups were compared using the Fisher's exact test, the Student's t-test or the Wilcoxon's rank-sum test, as applicable.

Half-year prevalences and incidences of bacteremia were estimated along with 95% confidence intervals (CI). Multiple bacteremia events in the same patient were included for incidence estimation. The time at risk for bacteremia was the time between start of dialysis and last observation or, if earlier, change to arteriovenous fistula. Both groups were compared by fitting a univariate Poisson regression model, which was further adjusted in a multiple model for the possible confounders age, sex, heart failure [New York Heart Association (NYHA) III–IV], diabetes, malignancy and PAOD (Stage 4).

For mortality within the first 183 days of dialysis, probabilities were estimated for both therapy groups respective for tunnelled/non-tunnelled catheter/HD and compared using the Fisher's exact test. Similarly, the secondary outcomes, half-year mortalities due to specific reasons and hospitalization during the observation period were analysed. Only rehospitalizations after start of dialysis were counted as outcomes. In this case, time at risk was counted only from the first day after discharge from hospital at time of dialysis until death or the last observation day. Thus, those patients who were hospitalized during the entire observation period (n = 14), i.e. from time of dialysis until the last observation day, were defined as 'missing' for the rehospitalization. For other outcome analyses, all patients were included without excluding these 14 patients. Frequencies of hospitalizations and the number of hospital days were described nonparametrically by percentiles and compared statistically by Wilcoxon's rank-sum test.

For mortality, univariate and multiple logistic regression models were fitted to adjust for possible confounders and to investigate other risk factors. In addition to the primary risk factors PD and HD, the independent variables age, sex, NYHA Stages III–IV, diabetes, malignancy and PAOD Stage 4 were included in univariate and fixed multiple models.

Test conditions and software. All statistical tests are two sided at a significance level of 5%. All analyses were performed using SAS for Windows XP_PRO, version 9.2 (SAS Institute, Cary, NC).
Results

Baseline characteristics

The baseline characteristics of the 123 incident dialysis patients with the two groups (PD, n = 66; HD, n = 57) are shown in Table 1. There were no significant differences in terms of gender, age, prevalence of diabetes mellitus, PAOD and hospitalization at the beginning of dialysis treatment. The prevalence of heart failure (Stages III–IV according to the NYHA) was significantly higher in the PD cohort. HD patients had a significantly higher baseline serum creatinine (HD 5.01*/:1.61 versus PD 4.14*/:1.75; P = 0.046) with a significantly lower estimated glomerular filtration rate (HD 10.7*/:1.7 versus 13.6*/:1.8. P = 0.025). HD patients suffered more frequently from malignancy (26% versus 8%, P = 0.007) and had higher systolic blood pressure (130.1 versus 118.5 mm Hg, P = 0.006). The mean observation time did not differ significantly between the two groups (PD 4.8 ± 2.0 versus HD 4.6 ± 2.0 months).

Bacteraemia

HD patients had a significantly higher proportion of bacteraemia in the first half-year compared to PD patients (21.1% versus 3.0%, P < 0.01) (Table 2). In the HD group, incidence was 0.72 (95% CI, 0.38–1.24) per patient year, with 13 catheter infections in 18.0 patient years at risk. In the PD group, incidence was 0.12 (95% CI, 0.02–0.35) per patient year at risk, with 3 catheter infections in 25.6 patient years. Only two patients (1.6% of 123) suffered peritonitis with an effective treatment.

Poisson regression analyses

Group comparison by Poisson regression analyses showed that the relative risk of bacteraemia in the PD group versus HD group was 0.16 (95% CI, 0.05–0.57), whereby the difference was statistically significant (P = 0.005). The clearly significant difference between HD and PD was not affected by the additional confounders patient age at time of dialysis, male sex, heart failure (NYHA III–IV), diabetes, malignancy and PAOD (Stage 4) in a multiple Poisson model. None of these covariables had a significant impact on the risk of bacteraemia (Table 3).

Mortality

Half-year mortality in the follow-up period of 0–183 days was 35.8% (n = 44) in all 123 patients. There were no significant differences in overall mortality between the groups [PD n = 20 (30.3%) versus HD n = 24 (42.1%); P = 0.191] (Table 2). The estimated mortality was a little less in PD compared to HD, which was statistically only by chance. But it could not be excluded that the power was too low to detect a low difference. The half-year cardiovascular mortality in PD and HD patients was 9.1 and 10.5%, respectively, without a significant difference (P = 1.000) (Table 4). Despite the higher prevalence of heart failure at baseline in the PD group (73 versus 46%), the rate of cardiovascular mortality was not correspondingly higher. Half-year mortality due to infection was higher in the HD group (17.5%) versus in the PD (9.1%), however, without significance (P = 0.187) (Table 4). In the HD group, there were 5 (50%) patients with a CVC-related infections, 4 (40%) patients with an infection of unknown focus and 1 (10%) patient with pneumonia. In the PD group, there were 3 (50%) patients with an infection of unknown focus, 2 (33.3%) patients with an infection due to foot ulcer because of PAOD and 1 (16.7%) due to Clostridium difficile infection. Furthermore, overall mortality was compared between the groups with tunnelled/non-tunnelled catheter/PD: patients with tunnelled catheter (n = 19) had the lowest half-year mortality (n = 6, 31.6%). In contrast, patients

Table 1. Baseline characteristics of all patients with incident HD (n = 57) or PD (n = 66a)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>HD</th>
<th>PD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>34 (60%)</td>
<td>42 (64%)</td>
<td>0.71f</td>
</tr>
<tr>
<td>Age at start of dialysis², years</td>
<td>74.1 ± 13.3</td>
<td>72.6 ± 13.4</td>
<td>0.540c</td>
</tr>
<tr>
<td>Weight², kg (4 missings)</td>
<td>76.0 ± 19.8</td>
<td>77.4 ± 16.8</td>
<td>0.681c</td>
</tr>
<tr>
<td>Systolic BP², mmHg</td>
<td>130.1 ± 24.8</td>
<td>118.5 ± 21.3</td>
<td>0.006a</td>
</tr>
<tr>
<td>Diastolic BP², mmHg</td>
<td>70.3 ± 13.3</td>
<td>68.6 ± 11.7</td>
<td>0.446c</td>
</tr>
<tr>
<td>Serum creatinine², mg/dl (3 missings)</td>
<td>5.01*/:1.61</td>
<td>4.14*/:1.75</td>
<td>0.046c</td>
</tr>
<tr>
<td>Serum urica², mg/dl (3 missings)</td>
<td>179*/:1.6</td>
<td>185*/:1.5</td>
<td>0.639a</td>
</tr>
<tr>
<td>GFR (MDRD²) (3 missings)</td>
<td>10.7*/:1.7</td>
<td>13.6*/:1.8</td>
<td>0.025d</td>
</tr>
<tr>
<td>Heart failure (NYHA Stage III–IV)</td>
<td>26 (46%)</td>
<td>48 (73%)</td>
<td>0.003a</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>26 (46%)</td>
<td>34 (52%)</td>
<td>0.589a</td>
</tr>
<tr>
<td>Malignancy</td>
<td>15 (26%)</td>
<td>5 (8%)</td>
<td>0.007b</td>
</tr>
<tr>
<td>PAOD, Stage IV</td>
<td>14 (25%)</td>
<td>18 (27%)</td>
<td>0.21h</td>
</tr>
<tr>
<td>Hospitalization at start of dialysis</td>
<td>51 (89%)</td>
<td>63 (95%)</td>
<td>0.300h</td>
</tr>
<tr>
<td>Observation time within the first 183 days, months¹#</td>
<td>4.6 ± 2.0 (0.1–6.0)</td>
<td>4.8 ± 2.0 (0.2–6.0)</td>
<td>0.301h</td>
</tr>
</tbody>
</table>

aValues are expressed as numbers unless indicated otherwise. Percentages may be rounded.

bP-values computed by Fisher’s exact test.

cP-values are expressed as mean ± SD.

dP-values computed by Student’s t-test.

eGeometric mean */: standard deviation factor.

fP-values computed by Student’s t-test for log values.

⁶Values are expressed as median (range).

⁷P-values computed by Wilcoxon’s rank-sum test.
with a non-tunnelled catheter \((n = 38)\) showed a high mortality with 47.4\% \((n = 18)\). However, the mortality rate in patients with PD catheter \((n = 66)\), respectively, PD was with \((n = 20, 30.3\%)\) the same as in patients with a non-tunnelled catheter. Fisher’s exact test did not show a significant difference between the three groups \(P = 0.209\). A relatively high proportion of patients died of unknown causes, especially in the PD group, with 30\% of all deaths \((HD\ population 16.7\%).

### Logistic regression analyses

Both univariate and multiple logistic regression analyses showed only age at initiation of dialysis as a significant predictor of overall mortality \((P < 0.05)\). Dialysis modality, gender, diabetes mellitus, peripheral vascular disease and malignancy did not significantly affect survival in the short follow-up period. Interestingly, also heart failure was not significantly associated with overall mortality (Table 5).

### Hospitalization

Almost all patients were already hospitalized before initiation of dialysis with 89\% \((n = 51)\) of the HD and 95\% \((n = 63)\) of the PD patients (Table 1). There was a high proportion of hospitalization after the initiation of dialysis in both groups \((PD\ 75.0\%\ and\ HD\ 67.3\%,\ P = 0.401)\) (Table 2). In total, 14 \((11.4\%)\) patients were hospitalized during the entire observation period. Eight patients were on HD with a range of 2–64 hospitalization days and six patients were on PD with a range of 5–45 hospitalization days. No patient was hospitalized for >6 months. The cause of hospitalization was infectious in 15 of 81 hospital visits \((18.5\%)\) in the PD group and in 13 of 56 hospital visits \((23.2\%)\) in the HD group \((P = 0.525)\).
**Discussion**

A high percentage of the patients starting dialysis does not have a permanent vascular access or PD catheter at the initiation of renal replacement therapy, despite much effort to decrease the use of CVCs and having a nephrology follow-up [4, 12, 13]. Lorenzo et al. [1] showed that late referral and temporary catheters are independently associated with mortality in incident dialysis patients. To our knowledge, in order to reduce the need for vascular catheters, only a few studies have compared survival and complications between HD initiation via CVC (tunneled or non-tunneled) and PD via PD catheter in acute and unplanned settings. Recently, Lobbezoo et al. [14] found no significant difference between unplanned PD and HD patients regarding patient survival and survival free of rehospitalization. Uchida et al. [15], however, found that the 3-year survival rates were significantly higher in PD patients than in HD patients. The results of Noshad et al. [16] showed in nondiabetic patients there was no survival difference between the two groups.

Our results showed no significant difference in overall mortality rate between incident PD and HD patients with acutely initiated unplanned automated PD or HD via tunneled or non-tunneled CVCs in the first 6 months. Also, there were no significant differences in cardiovascu lar or infectious mortality between the two groups, but the power of the statistical tests were low because of small numbers of events. However, HD patients had tendentially higher overall and infectious mortality risk. We had significant higher risk of bacteraemia in HD patients compared to PD patients.

The analysis of the USRDS Wave 2 Study identified initial dialysis access as the main antecedent of septicaemia or bacteraemia. There, the hazard ratio for PD catheters was less than those for permanent or temporary HD catheters or grafts or native arteriovenous fistulae but was substantially higher overall and infectious mortality risk. We had significantly higher risk of bacteraemia in HD patients compared to PD patients.

The study data of Liberek et al. suggested that the outcome of patients transferred from HD to PD is similar to that achieved in patients in whom PD was the first therapy choice. Thus, the authors recommended that this option should be strongly considered in patients experiencing complications on HD, mainly vascular access problems, heart failure or intradialytic hypotension [20]. Kagan and Rapoport [21] presented several case reports of successful use of chronic PD in refractory heart failure. They proposed that this modality should be more widely used in this condition. Also, the new French 2008 guidelines on PD recommend switching from HD to PD in patients with severe congestive heart failure [22]. These data and our study results show that PD is an alternative in the unplanned dialysis setting in elderly patients with severe heart failure if the dialysis unit has the capabilities for an assisted automated PD [23].

In the unplanned setting, the experience with urgent start of PD in patients with no access is sparse [24]. Aslam et al. [9] resumes in their work the placement of permanent accesses (fistula or PD catheter) before the start of dialysis to avoid use of HD catheters. Lobbezoo et al. and Povlsen et al. showed that the immediate use of a PD catheter right after insertion does not increase the risk of infectious complications nor does it affect long-term PD technique survival or patient survival and that PD is a safe and feasible modality for unplanned start on dialysis, also for late referred elderly patients. The authors conclude that PD is
a suitable alternative to haemodialysis for chronic patients needing urgent renal replacement therapy [14, 25]. Moreover, unplanned dialysis patients can be treated like other patients using an integrative approach with starting PD and transferring later to HD. Van Biesen et al. has shown that patient outcome is not jeopardized by starting patients on PD, at least if patients are transferred in a timely manner to HD when PD-related problems arise [26].

Our results also show that PD is a safe and efficient alternative to haemodialysis in unplanned acute dialysis settings. The high rate of PD therapy (almost 30 %) with an experienced staff and the availability of assisted PD in our unit may have an impact on patient choice and acceptance of PD [27]. The results demonstrate that with a dedicated approach the use of PD also for unplanned dialysis patients can be increased. Our study findings should be interpreted, as suggested in other studies, as a part of the decision making about dialysis modality selection in conjunction with patient preference, individual circumstances, unit practice patterns and the other well-characterized pros and cons of selecting PD versus HD therapy.

We realize that the observational and retrospective design of our study and the use of a non-matched control group is a limitation. It is can be argued that patient selection may bias the results in our study. However, a randomized study of the dialysis modality seems to be difficult to achieve [28]. Furthermore, due to the relatively small numbers of patients and events, the power of statistical tests is low, in particular comparing specific mortalities.

Nevertheless, our observations suggest that the PD therapy may be a feasible, safe and complementary alternative to HD not only in the chronic but also in the acute setting, especially in an elderly high-risk patient population with severe heart failure.

Conflict of interest statement. None declared.

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