Comparison of treatment results between end-stage renal disease patients treated with peritoneal dialysis and hemodialysis

Chronic kidney disease (CKD) develops in the course of different nephropathies, including: diabetic kidney disease, hypertension, glomerulonephritis, ischemic injury and many others. Several systemic complications may develop as a consequence of CKD. The most important include: cardiovascular disease, mineral and bone disorders, anemia, endocrine disorders, malnutrition. These complications contribute to markedly increased risk of premature death in CKD population.

In end-stage renal disease (ESRD) the only option that prolongs live is renal replacement therapy (RRT). RRT methods include: peritoneal dialysis (PD), hemodialysis (HD) and kidney transplantation. The first two methods replace only some functions of healthy kidneys, whereas transplanted kidney can restore full homeostasis. Thus all ESRD patients should be considered for possible transplantation.

In PD peritoneum serves as a dialysis membrane. The key advantages of PD include: ambulatory nature (the only widely available home-based RRT), hemodynamic stability, better preservation of residual renal function, no need for vascular access and – as a consequence – lower risk of bloodstream infections, less restrictive diet.

Patient and/or caregiver competence to perform dialysis procedures at home is a prerequisite to achieve success in PD treatment. Some medical problems such as a history of major abdominal surgery, are also well recognized contraindications to PD.

HD is the most popular method of RRT worldwide. In contrast to PD, HD is an extracorporeal method of blood purification, eliminating excess water (volume) and toxic metabolites using a semipermeable dialysis membrane and a dialysis monitor, known as the ‘artificial kidney’. HD is usually performed in dialysis units (in-center HD; the only HD method utilized in Poland).

In principle, both methods differ substantially and choosing one of them is warranted by many medical and non-medical factors; thus, the choice of dialysis method cannot be a subject of a random assignment.

Material and methods

The aim of the study was to compare the treatment results of patients dialyzed with PD or HD, using the methodological approach of nested case-control matching. A patient on maintenance HD from the large pool of HD population was matched with every patient from PD program who was on dialysis for at least three months. The matching criteria were as

follows: age, gender, anthropometric characteristics, demographic data, etiology of CKD, co-morbidity and duration of renal replacement therapy. Study subjects were recruited from the 'Diaverum' Dialysis Unit in Włocławek and the observation time extended between March 2014 and March 2017. First, retrospective data were collected and analyzed until the initiation of the study, and since this date – the data were collected prospectively. Eighty four patients were included – 42 patients in each group.

The following data were analyzed: anthropometric characteristics, co-morbid diseases, lab test results and clinical characteristics at the dialysis commencement; lab test results over the whole observation period with special attention paid to the fulfillment of values expected/recommended as a standard in dialysis quality monitoring; incidence of dialysis-related and dialysis-unrelated complications that needed hospitalization; procedures of waitlisting for kidney transplantation (hospitalizations related to the first dialysis access creation, implementation of tests qualifying to transplantation, as well as hospitalizations linked to therapeutic programs of hyperparathyroidism and hyperphosphatemia were not included into the analysis). The duration of dialysis treatment on each method (including transfers between methods) as well as treatment termination (when applicable) were also analyzed

Blood pressure and lab test values were analyzed quarterly. If certain measurements were performed many times within three months, the three-month mean values were taken into analysis. Blood pressure measurements were taken in a sitting position after a minimum of 15 minutes of rest. Laboratory tests were performed at the Department of Laboratory Diagnostics of the Provincial Specialist Hospital in Włocławek with the use of the Roche Diagnostics analyzer.

The results were presented in tables, displaying the values, percentages of certain values, mean values and standard deviations. Several graphic illustrations of the results were added using bar graphs and box-and-whisker plots. t-Student test and U Mann-Whitney test was used to detect differences between variables with parametric and non-parametric distribution, respectively. Chi-quadrat and log-rank tests were applied for survival analyses.

Results

12 women and 30 men were included into each group, with mean age of 52.1 years (PD patients were slightly younger – mean 51.2 years). Most of the study subjects were overweight/obese, with mean BMI of 26.9 kg/m^2. Mean Charlson co-morbidity index (CCI) equaled 4.63 for the entire group (being slightly lower for PD patients – 4.31). All analyzed lab tests (including: serum creatinine, eGFR, hemoglobin, ferritin, calcium, phosphate, intact

parathyroid hormone, total protein and albumin, lipid profile, proteinuria) at the dialysis commencement were identical in both groups. The only parameter that significantly differed between the groups was serum transferrin, being higher in PD vs HD patients (32.4% *vs* 26.2 %; p = 0,005). This comparison suggests that the matching process was well-performed and successful.

Both study groups were comparable in terms of etiology of CKD: diabetic kidney disease, glomerular disease and pyelonephritis were leading diagnoses of underlying nephropathies. Hypertension, congestive heart failure, diabetes and ischemic heart disease were the most frequent co-morbid conditions. Their prevalence was similar in both groups.

Mean follow-up was 3.67 years (3.71 years in PD and 3.63 years in HD group). Fifty out of 84 patients were still under follow-up at the end of the study: 21 who started with HD and 29 of those who initiated on PD. Seven patients were transferred from PD to HD and peritonitis was the most important cause of transfer. Fourteen patients died: 6 on PD and 9 on HD. Cardiovascular diseases, sepsis and GI bleeding were the most frequent causes of death. No statistically significant differences in the cause of death were found between the groups, although there were more deaths secondary to heart failure in HD as compared to PD (3 vs 0). Survival was comparable in the two groups, with the trend towards better survival within first period of follow-up among PD patients.

Seventeen patients received kidney transplant during the observation period: 8 in PD and 9 in HD. However, 14 PD patients and 9 HD were waitlisted, with no difference in waiting time (average waiting time for transplantation for the whole group equaled 359 days). Duration of 'active' waiting time was 382 days on average and was longer in PD vs HD (398 vs 358 days, respectively). The period between dialysis commencement and activation on the national waiting list was shorter in PD (609 days) as compared to HD (805 days). For those who were not waitlisted, 6 patients in HD and 2 in PD did not want to be transplanted and in 11 and 7, respectively, kidney transplantation was considered medically contraindicated based on the severity of congestive heart failure.

Almost two thirds of PD patients commenced planned dialysis treatment; in opposite, more than a half of HD patients were initiated on renal replacement therapy program in an unplanned manner.

Mean hospitalization rate equaled 1.28/patient/year and was slightly higher among HD patients (1.35/pt./year) as compared to PD (1.22/pt./year). The mean time of hospitalization however was longer in PD group (11.6 days/pt./year) than in PD (10.8 days/pt./day); both differences were statistically insignificant. No differences were found between the groups

when analyzing the numbers (percentages) of subjects who were never hospitalized during the follow-up, or were in hospital one, two, three or more times during this period of time.

377 hospitalizations (185 in PD and 192 in HD) were recorded over the study period. Cardiovascular disease (including worsening of congestive heart failure) was the leading cause of hospitalizations – amounting to 28.1% of all events (30.7% in HD and 25.4% in PD). This was followed by anemia (22.7% and 15.6%, respectively). No significant differences were noticed between the groups, except for expected differences in the method-specific complications. In PD, dialysis-related peritonitis amounted to 18.9% of all hospitalizations ($p < 0.001$ vs HD; some HD patients also experienced this complications while on PD for a short term); HD patients were frequently admitted (15.1% of all admissions, $p < 0.001$ vs PD) to establish a new vascular access for hemodialysis. HD patients were also more frequently admitted to hospital due to injuries and trauma ($p = 0.042$). No other significant differences were observed. Bacteriemia was numerically more frequent in HD patients (8 cases) vs PD (1), but this difference was statistically non-significant.

Comparing the mean blood pressure (BP) values and the period of BP within the expected targets over the observation period, we found that PD patients were characterized by higher mean values of systolic BP (137.9 vs 129.9 mmHg), diastolic BP (82.0 vs 76.6 mmHg) and mean arterial pressure (MAP; 100.6 vs 94.4 mmHg). BP values of patients treated with PD less frequently fit into the expected ranges of systolic and diastolic BP, both systolic and diastolic BP or MAP (<140, <90, <140/90 and <105 mmHg, respectively).

Hemoglobin concentration, ferritin, transferrin saturation (TSAT), serum albumin, calcium, phosphate and intact parathyroid hormone were among the parameters assessed quarterly. Kt/V was also calculated every three months; due to different nature of both dialysis techniques and principles of calculation the values of this adequacy parameter were not compared directly but values were analyzed in relation to the ranges expected for each method.

Mean Hb concentration values throughout the whole observation periods were equal in both groups (10.4 g/dl for PD and 10.5 g/dl for HD). The percentage of Hb values within defined range over the observation period was also similar.

TSAT was slightly but insignificantly lower in PD (32.1 ± 7.9%) vs HD (36.4 ± 11.98%). In turn, ferritin level was much lower among PD patients (362,9 ± 351,5 μg/l) as compared to HD group (556.7 ± 433.2 μg/l; $p = 0.01$). When analyzing the percentage of values within the expected ranges, they were slightly more frequent within normal ranges in PD patients for both TSAT and ferritin (defined as values between 200 and 500 μg/l as well

as between 200 and 800 μg/l). Ferritin values in some HD patients were much higher than the upper expected limit, which might suggest both iron overload and inflammation.

Serum albumin was significantly lower in PD patients (mean 3.7 g/dl) as compared to those treated with HD (3.9 g/dl; p = 0,002). Albumin in PD patients less frequently fit above expected concentration of 3.5 g/dl (75,3% vs 90,6% of measurements, respectively; p = 0.005).

Calcium concentration over the whole observation period was higher in PD vs HD patients (mean 9.0 ± 0.52 mg/dl vs 8.5 ± 0.63 mg/dl, respectively; p <0.0001), whereas phosphates were virtually equal in both groups (mean 5.5 mg/dl). The frequency of fulfilling expected values was similar in both groups in terms of calcium and phosphate concentrations. In HD patients however more 'excursions' into low phosphate values were observed. This was reflected by slightly higher values of Ca x P product among PD patients (51.3 mg^2/dl^2 vs 46,3 mg^2/dl^2 among those treated with HD); Ca x P product in PD subjects was less frequently lower than 55 mg^2/dl^2 throughout the study period. Intact PTH was equal in both groups; iPTH concertation slightly less frequently fit into target range among PD patients.

As mentioned above, direct comparison of Kt/V values was not suitable. Prevalence of Kt/V values within the defined range was much higher in PD patients (77.5%) as compared to those on HD (54.6%; p <0,001).

Conclusions

Results of the study allowed to draw the following conclusions:

1. Clinical characteristics of patients starting renal replacement therapy from PD or HD in this study did not differ significantly, when taking into account a nested case-control methodological design.
2. Survival of patients on PD did not differ from those on HD.A trend towards better survival on PD was observed over the first six years and then inversed.
3. Independently of the dialysis technique applied, the general status of patients deteriorated over time (as reflected by increasing value of the Charlson comorbidity score).
4. PD and HD patients did not differ in terms of dialysis-dependent and dialysis-independent complications (in the first instance – after adjustment for technical differences between both methods).
5. HD patients are characterized by better long-term control of blood pressure and of selected biochemical parameters with potential prognostic significance (such as serum

albumin or calcium x phosphate product) as compared to those on PD. Better long term control of these variables did not translate however into better prognosis (or if any –potential benefit might be experienced after six years of treatment).

6. PD patients did not differ from HD patients in the rate of being waitlisted for transplantation and the percentage of time spent on the waiting list in an 'active' status.
7. Results of the study do not support any of the analyzed methods as a preferred one in the initial treatment of end-stage renal disease, assuming comparable clinical profile of patients choosing PD or HD at the time of dialysis initiation.