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Comparison of hospitalization cause and risk factors between patients undergoing hemodialysis and peritoneal dialysis

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Abstract

This retrospective study was designed to compare the cause of hospitalization and influencing factors between patients undergoing hemodialysis (HD) and peritoneal dialysis (PD). Baseline data and laboratory parameters of 192 dialysis patients (92 HD patients and 100 PD patients) were compared. Quantitative parameters with normal distribution were assessed using independent *t*-test or analysis of variance (ANOVA). Quantitative parameters with non-normal distribution were assessed by non-parametric test. Qualitative data were statistically compared using χ^2 test. The number of patients with urban employee medical insurance (88 HD patients and 60 PD patients) and rural cooperative medical care (12 HD patients and 40 PD patients) significantly differed ($P <$ .01). The hospitalization rate of PD patients was significantly higher than that of HD counterparts. The average length of hospital stay of PD patients was 10 days, remarkably longer than 8 days of HD patients ($P <$ .01). The primary cause of hospitalization for HD patients was infection-related complications, followed by cardiovascular, cerebrovascular complications and dialysis access disorders. The primary cause of hospitalization for PD patients was infection-related complications, followed by dialysis access disorders, cardiovascular, and gastrointestinal complications. Compared with the HD group, the levels of hemoglobin, serum albumin, alkaline phosphatase, intact parathyroid hormone were significantly decreased, whereas serum urea nitrogen, serum creatinine, phosphorus levels and cardiothoracic ratio were remarkably increased in the PD group (all $P <$ .01). The hospitalization rate of PD patients is relatively higher, and the length of hospital stay is longer. Extensive attention and efforts should be delivered to enhance the understanding of disease and lower the risk of complications for patients.

Abbreviations: HD = hemodialysis, iPTH = intact parathyroid hormone, PD = peritoneal dialysis.

Keywords: average length of hospital stay, hemodialysis, hospitalization rate, peritoneal dialysis

1. Introduction

With the population aging and lifestyle changes, the prevalence rate of chronic kidney disease (CKD) has been ever increased year by year, even in certain developed countries, such as the United States, Canada and Europe.[1] Statistics[2] have revealed that approximately 1% of CKD patients can eventually develop into end-stage renal diseases and require the renal replacement therapy. Previous studies[1–3] have demonstrated that the annual medical expenses of CKD approximately account for 2% to 3% of the overall medical expenses in developed countries.

Conventional renal replacement therapies mainly include hemodialysis (HD), peritoneal dialysis (PD) and kidney transplantation.[4] When patients with end-stage renal diseases receive renal replacement therapy, clinical efficacy, prognostic survival and economic reasons should be taken into consideration. Among the 3 options, kidney transplantation is likely to yield the highest clinical efficacy and best prognostic outcomes. Nevertheless, due to the lack of donor kidney, mating type and economic causes, kidney transplantation is not the primary choice for a majority of patients diagnosed with end-stage renal diseases in developing nations and regions. Consequently, most patients with end-stage renal diseases choose to receive HD and PD, which have been proposed to yield similar clinical efficacy.[4]

Medical expense is a heavy economic burden for patients with chronic renal failure.[5] The consumption of sharing medical resources is disproportionate, the quantity of hospital wards is tight and the choice of dialysis methods may affect their hospitalization rate. According to the annual report of 2016 US Renal Data System (USRDS),[6] patients with end-stage kidney disease are hospitalized twice a year on average, and hospitalization costs account for 40% of the overall medical expenses. The HD and PD rates are inconsistent probably because the small sample size may affect

CY and XZ contributed equally to this work.

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

We declare that subjects have given their informed written consent. And the study protocol was approved by an appropriate ethics committee.

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the calculation of hospitalization rate. Since the diagnosis of hospitalized patients is not delivered and the length of hospital stay is relatively long, the data obtained fail to correctly reflect the hospitalization rate.[6]

The main purpose of this study is to compare the hospitalization rate between patients with end-stage renal disease undergoing HD and PD. Second, it aims to evaluate the impact of the education level, family income and medical insurance upon the hospitalization rate and the potential association. Third, primary disease, cause of hospitalization and the length of hospital stay were statistically compared between end-stage renal disease patients treated by 2 dialysis methods. Fourth, laboratory parameters were recorded and compared between 2 groups, aiming to provide more evidence to reduce the hospitalization rate and improve the quality of life of patients with end-stage renal diseases.

2. Materials and Methods

2.1. Patient enrollment

A total of 192 dialysis patients admitted to Department of Nephrology, Jiangning Hospital from December 2012 to December 2016 were selected and randomly divided in the HD group (n = 92) and PD group (n = 100) using the random number table method. Patients aged <18 years old and those undergoing dialysis for <3 months were excluded from subsequent investigation. Written informed consents were obtained from all participants. The study procedures were approved by the Nanjing Jiangning Hospital Ethics Committee.

2.2. Data sources

All the data were collected and examined by 3 professionals (Xixi Wang, Caixia Yin, Xiumei Zhang) from the hospitalization information database system. All hospitalization records of patients who met the inclusion criteria admitted to our hospital from December 2012 to December 2016 were reviewed. Baseline data were recorded including age, gender, education level, medical insurance payment method, annual family income, dialysis time, primary disease and cause of hospitalization (infection-related complications, dialysis access disorder, cardiovascular complications, gastrointestinal complications, anemia, electrolyte disorders, cerebrovascular complications, etc.). The average length of hospital stay and the frequency of hospitalization were calculated. Biochemical parameters including hemoglobin, serum albumin, alkaline phosphatase, serum phosphorus, intact parathyroid hormone (iPTH), serum aspartate aminotransferase, serum total cholesterol, serum triglycerides, serum low density lipoprotein, blood uric acid, serum urea nitrogen, serum creatinine, heart to chest ratio and heart color ultrasound were recorded and statistically compared between 2 groups.

2.3. Statistical analysis

The quantitative data were expressed as number and proportion, and continuous variables were presented as mean ± standard deviation (SD) or median with interquartile range as appropriate. The quantitative parameters with normal distribution were assessed between 2 groups using the independent *t*-test or analysis of variance (ANOVA). The quantitative parameters with non-normal distribution were assessed between 2 groups using the non-parametric test. The qualitative data were statistically compared using χ^2 test. All tests were 2-sided and *P*-value of < 0.05 was considered to be statistically significant. All data analysis was performed with SPSS 20.0 statistical software package (SPSS Inc., 20.0, Chicago, IL).

3. Results

3.1. Baseline data

Baseline data of all patients in the HD and PD groups are shown in Table 1. A total of 92 patients were assigned in the HD group including 59 male and 33 female. In the PD group, 100 patients were enrolled including 44 males and 56 females. The mean age of patients in the HD group was (51.3 ± 13) years old, significantly younger than (56.3 ± 13) years old in the PD group ($P < .05$). The median dialysis time in the HD group was 51.5 months, remarkably longer compared with 13.0 months in the PD group ($P < .05$). The number of patients with urban employee medical insurance in the HD group was 88, significantly more than 60 in the PD group ($P < .01$). In the HD group, the number of patients with rural cooperative medical care was 12, considerably <40 in the PD group ($P < .05$). The average length of hospital stay significantly differed between the HD and PD groups (8 days vs 10 days, $P < .05$). The hospitalization rate in the HD group was 51.3%, significantly lower compared with 79.8% in the PD group ($P < .05$).

3.2. Cause of hospitalization

The causes of hospitalization in HD and PD patients are illustrated in Table 2. Approximately 33.5% of HD patients were hospitalized due to relevant complications, such as lung infection and bacterial peritonitis, and 34.1% in the PD group. In the HD group, 16.1% of patients were hospitalized because of cardiovascular complications including heart failure and myocardial insufficiency, and the proportion in the PD group was calculated as 12.8%. In the HD group, 4.7% of patients were hospitalized due to digestive system complications including chronic gastritis, gastrointestinal bleeding and enteritis, lower compared with 12.8% in the PD group. In the HD group, 13.6% of patients were hospitalized because of cerebrovascular complications, such as cerebral infarction, cerebral hemorrhage and insufficient blood supply to the brain, higher compared with 4.0% in the PD group. Roughly 10.6% of patients in the HD group were hospitalized due to dialysis access disorders

Table 1

Clinical characteristics and length of hospital stay between 2 groups.

Variable	Hemodialysis (n = 92)	Peritoneal Dialysis (n = 100)	*P*
Gender (male/female)	59/33	44/56	.005
Age (yr)	51.3 ± 13.0	56.3 ± 13.1	.009
The age of HD (mouths)	51.5 (20.3–96.0)	13.0 (3.0–27.0)	<.001
Primary disease (%)			
Chronic glomerulonephritis	54 (58.7)	60 (60.0)	.529
Diabetic nephropathy	19 (20.7)	25 (25.0)	
Others	19 (20.7)	15 (15.0)	
Average days of hospital stay	8 (5–11)	10 (7–14)	<.001

HD = hemodialysis.

Table 2

Comparison of causes of hospitalization between 2 groups [n (%)].

Variable	Hemodialysis	Peritoneal Dialysis	P
Infection	79 (33.5)	136 (34.1)	<.001
Cardiovascular disease	38 (16.1)	51 (12.8)	
Gastrointestinal lesion	11 (4.7)	51 (12.8)	
Cerebrovascular disease	32 (13.6)	16 (4.0)	
Dialysis pathway problem	25 (10.6)	73 (18.3)	
Electrolyte disorder	20 (8.5)	19 (4.8)	
Moderate above anemia	8 (3.4)	29 (7.3)	
Others	23 (9.7)	24 (6.0)	
Total	236 (100)	399 (100)	

including internal dysfunction, peritoneal dialysis tube displacement and occlusion, etc.), and 18.3% in the PD group. In the HD group, 8.5% of patients were hospitalized due to electrolyte imbalance including hyperkalemia, hypokalemia, hyponatremia and hypocalcemia, and 4.8% in the PD group. Approximately 3.4% of HD patients were hospitalized due to moderate anemia or above and 7.3% in the PD group. The proportion of patients with skin itching and hypoproteinemia also significantly differed between the HD and PD groups ($P < .05$).

3.3. Laboratory parameters

Compared with those in the HD group, the levels of hemoglobin, serum albumin, alkaline phosphatase, and iPTH were significantly decreased in the PD group (all $P < .05$). The levels of serum glutamic-oxaloacetic transaminase, total cholesterol, triglyceride, high density lipoprotein cholesterol, low density lipoprotein cholesterol, uric acid, serum urea nitrogen, blood creatinine, phosphorus and heart ratio were considerably increased in the PD group compared with those in the HD group (all $P < .05$). However, the levels of serum glutamic pyruvic transaminase, blood calcium, cardiac color ultrasound EF index and CRP did not significantly differ between the HD and PD groups (all $P > .05$), as illustrated in Table 3.

4. Discussion

The findings of this retrospective study have demonstrated that the hospitalization rate of PD patients was significantly higher than that of their HD counterparts. The average length of hospital stay in the PD group was significantly longer compared with that in the HD group. According to 2016 USRDS report, the hospitalization rate of HD patients is lower than that of PD patients,[5] which is consistent with the results of the current investigation. Patients undergoing PD were enrolled due to specific national conditions in China. Rural cooperative medical care accounts for 40% of the total population, indicating that PD is a relatively economical dialysis method. In the present study, in term of primary disease statistics, the prevalence rate of chronic glomerulonephritis, diabetic nephropathy, and hypertensive nephropathy was relatively high, without statistical significance between the PD and HD groups. The primary cause of hospitalization in the HD group was infection-related complications, followed by cardiovascular complications, cerebrovascular complications and dialysis access disorders, etc., whereas the primary cause of hospitalization in the PD group was infection-related complications, followed by dialysis pathway disorders, cardiovascular complications, gastrointestinal complications and anemia, etc. Previous Canadian studies have demonstrated that the hospitalized patients caused by dialysis-specific infections account for 11.5%[6–10] by analyzing 38,369 chronic dialysis patients and 112,374 hospitalized patients in Canada. In the present study, the primary cause of hospitalization was infection, which was conductive to controlling the infection rate and reducing the hospitalization rate of dialysis patients.

In addition, the mortality rate of hospitalized patients due to cardiovascular complications is higher than that of the hospitalized population, suggesting that cardiovascular disease is the main cause of death. Hypertension and volume overload are also important risk factors for the development of left ventricular hypertrophy of patients treated by HD and PD. Blood pressure control has been proven to be more effective for HD patients compared with PD patients. For HD patients, effective control volume load and some metabolic parameters

Table 3

Comparison of laboratory parameters between 2 groups.

Variable	Hemodialysis	Peritoneal dialysis	P
Hemoglobin (g/L)	105.1 ± 22.9	93.0 ± 19.6	<.001
Serum alanine aminotransferase (μ/L)	13.0 (9.0–18.0)	14.0 (10.0–20.0)	.155
LnALT	2.6 ± 0.6	2.7 ± 0.6	.277
Serum aspartate aminotransferase (μ/L)	15.0 (11.0–20.0)	17.0 (13.0–22.0)	<.001
LnAST	2.7 ± 0.5	2.8 ± 0.4	<.001
Serum total cholesterol (mmol/L)	3.7 ± 1.1	4.5 ± 1.2	<.001
Serum triglyceride (mmol/L)	1.7 ± 0.9	2.0 ± 1.3	.001
Serum HDL (mmol/L)	1.1 ± 0.3	1.2 ± 0.4	.004
Serum VDL (mmol/L)	1.9 ± 0.7	2.3 ± 0.8	<.001
Serum albumin (g/L)	39.0 ± 5.9	32.2 ± 5.4	<.001
Blood glucose (mmol/L)	6.4 ± 4.2	6.7 ± 3.1	.267
Serum uric acid (μmol/L)	324.2 ± 101.2	414.4 ± 106.1	<.001
Serum creatinine (μmol/L)	751.2 ± 275.4	950.7 ± 308.3	<.001
Serum urea nitrogen (mmol/L)	16.8 ± 6.9	21.0 ± 9.4	<.001
Ca of serum (mg/dL)	8.7 ± 1.0	8.8 ± 1.2	.364
P of serum (mg/dL)	4.7 ± 1.6	5.1 ± 1.9	.007
ALP (μ/L)	105.0 (80.0–135.5)	76.0 (61.0–98.0)	<.001
LnALP	4.7 ± 0.5	4.4 ± 0.4	<.001
iPTH (pg/mL)	199.3 (97.3–325.2)	99.7 (32.9–196.6)	<.001
LniPTH	5.2 ± 1.0	4.4 ± 1.2	<.001
EF (%)	59.8 ± 9.9	61.9 ± 8.9	.137
Heart to chest ratio	0.49 ± 0.06	0.52 ± 0.06	.001
CRP	4.9 (1.2–15.5)	2.9 (0.5–18.1)	.097
LnCRP	1.4 ± 1.8	1.1 ± 2.1	.074

ALP = alkaline phosphatase, ALT = alanine aminotransferase, AST = aspartate aminotransferase, CRP = C-reactive protein, EF = ejection fraction, iPTH = intact parathyroid hormone.

can properly control the blood pressure of patients, and the left ventricular end-diastolic volume is associated with the cardio-thoracic ratio. PD can be adopted as a family therapy, which can maintain the quality of life of the patients. However, the risk of cardiovascular disease for PD patients is increased, which captivates widespread attention. In the present study, the cardiothoracic ratio of patients in the PD group was significantly increased. Except for the primary cardiovascular diseases, the increase of volume load in the PD group should be fully considered, which was consistent with the findings of previous reports.[11–14] Consequently, patients should be advised to control the amount of water intake. Diuretics should be appropriately administered to reduce the capacity load, improve the heart function, and reduce the hospitalization rate.

Dialysis access disorders are common complications of both HD and PD.[15–17] Common access disorders occurring during HD process include internal fistula dysfunction, deep venous catheter infection and venous catheter thrombosis. The related complications of PD mainly consist of peritonitis, inadequate dialysis, stoppage of the peritoneum dialysis catheter, displacement or distortion of the dialysis catheter. In this study, the incidence rate of dialysis access disorders in the PD group was higher than that in the HD group, which requires subsequent risk factor analysis.

In the present study, PD patients suffered from a higher risk of gastrointestinal complications compared with HD patients. PD serves as a renal replacement treatment, whereas it probably provokes potential peritoneal injury and long-term exposure of the gastrointestinal tract to biological incompatibility dialysate, which remain to be urgently resolved. Previous studies[18–20] have demonstrated that the risk of gastroesophageal reflux, intestinal obstruction or adhesion and hernia is significantly higher in the PD group, whereas the risk of peptic ulcer, lower gastrointestinal bleeding and bleeding is remarkably increased in the HD group.

In addition, anemia is a common complication of chronic renal failure, which is correlated with the hospitalization of patients undergoing maintenance HD. The hemoglobin level is decreased by 1 g/L, and the risk of hospitalization can be increased by approximately 5%.[21]

In this study, the serum albumin level and iPTH were significantly decreased, whereas serum total cholesterol, triglycerides, high density lipoprotein cholesterol, low density lipoprotein cholesterol, uric acid, serum urea nitrogen, and serum creatinine levels were remarkably increased in the PD group compared with those in the HD group. Low serum albumin, poor nutritional status could cause an increase in the infection rate of PD patients. Low serum albumin in PD patients probably causes gastrointestinal mucosal edema, gastrointestinal dysfunction and volume load increase, eventually leading to an increasing trend in hospitalization rate compared with HD counterparts. Elevating serum albumin level, maintaining the sufficiency of dialysis and reducing the volume load of patients play a vital role in lowering the hospitalization rate of PD patients.[22–24] In this retrospective study, no death was observed in the HD and PD groups within 5 years, indicating that the competition risk for death is partially reduced by the hospitalization, which is consistent with previous findings.[25]

5. Study limitation

This study was a single-center study with a small sample size, which might cause bias to the results. In addition, due to patient compliance in this study, the dialysis adequacy was not analyzed due to incomplete statistical data, which needed further validation by subsequent research.

6. Conclusion

Taken together, the hospitalization rate is relatively high and the length of hospital stay is prolonged, which may be affected by the impacts of medical insurance payment methods and social economy. The hospitalization rate of dialysis patients can be reduced by strengthening the disease education, improving the patients' health awareness, preventing the infection, reducing the volume load, treating anemia and strengthening nutritional support. The quality of life can be improved by lowering the risk of complications.

Author contributions

Caixia Yin contributed to the conception of the study;
Xiumei Zhang performed the clinical trials;
Jiang Zhu contributed to analysis and manuscript preparation;
Zijing Yuan performed the data analyses and wrote the manuscript;
Tao Wang performed the analysis with constructive discussions;
Xixi Wang performed the study design, quality control and manuscript confirmation.

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