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Cross-sectional Survey of Volume Management in Peri-dialysis Patients in a Single Center

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Abstract: *Objective:* To analyze the risk factors influencing volume overload in patients during the pre-dialysis and early post-dialysis period (peri-dialysis period) by investigating the current situation of volume management of such patients in our hospital, to reduce the incidence of volume overload during this period. *Methods:* A total of 86 patients in the peri-dialysis period (glomerular filtration rate eGFR less than 15 mL/(min·1.73 m^2) to three months after dialysis) who received outpatient treatment, inpatient treatment, and hemodialysis in the hospital from June 2022 to December 2023 were selected as the research objects. General information, clinical symptoms, and laboratory data of the patients were collected. According to the disease evolution process of the patients, they were divided into the non-dialysis stage and the initial dialysis stage. The volume load index of the patients, namely the overhydration (OH) value, was measured by the multi-frequency bioelectrical impedance method. The relevant factors affecting the volume load of patients in the peri-dialysis period were compared and analyzed. *Results:* In the non-dialysis stage, 68 patients (86%) had volume overload, and 21 patients (21%) had normal volume load. In the initial dialysis stage, 53 patients (61%) had volume overload, and 33 patients (38%) had normal volume load. Among the patients with volume overload in the two stages combined, the primary diseases were diabetic nephropathy at 29%, hypertensive nephropathy at 29%, primary nephropathy at 34%, and other renal damage at 8%. Complications included heart failure at 29%, respiratory tract infection at 32%, coronary heart disease at 9%, and anemia at 21%. Among the patients with volume overload, 69% were male, 52% were over 60 years old, 53% had no family member accompaniment, 57% had insomnia, and 55% had an educational level of junior high school or below. *Conclusion:* More than half of the patients in the peri-dialysis period in the hospital are in a state of volume overload, which should arouse the attention of the department. For male patients, those with hypertension, diabetes, insomnia, respiratory tract infection, anemia, and without family member accompaniment, corresponding intervention measures should be taken to reduce the incidence of volume overload during the peri-dialysis period.

Keywords: Peri-dialysis period; Volume overload; Risk factors

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1. Introduction

The peri-dialysis period refers to the period from when the glomerular filtration rate eGFR is less than 15 mL/(min·1.73 m^2) to three months after dialysis [1]. According to the evolution of the disease spectrum and big data analysis, it is expected that by the end of 2025, the number of dialysis patients in China will reach 870,000 [2]. Data released by the US Kidney Disease System in 2016 showed that the mortality rate was the highest in the two months before dialysis. Since most patients in stage 5 of chronic kidney disease (CKD) who enter the peri-dialysis period have different degrees of fluid retention, the high cardiovascular morbidity and mortality caused by systemic hypertension due to volume overload have attracted clinical attention. Professor Mei Changlin led the formulation of the "Chinese Guidelines for the Management of Chronic Kidney Disease in the Peri-dialysis Period," which also analyzed the risk factors for high mortality in this stage, and provided guidelines for the volume management of patients in the peri-dialysis period [1]. This study intends to compare and analyze the relevant factors affecting the volume load of patients in the peri-dialysis period by investigating the current situation of volume management of such patients in our hospital, so as to provide a clinical basis for how to perform volume management well for patients with end-stage renal disease during the peri-dialysis period.

2. Subjects and methods

2.1. Research subjects

A total of 86 patients in the peri-dialysis period, with glomerular filtration rate eGFR < 15 mL/(min·1.73 m^2) to three months after dialysis, who received outpatient treatment, inpatient treatment, and hemodialysis in our hospital from June 2022 to December 2023 were selected as the research subjects. Inclusion criteria: aged ≥ 18 years old, voluntarily choosing to receive outpatient treatment, inpatient treatment, or hemodialysis in the hospital, having basic language communication ability, being conscious, having no severe cardio-pulmonary system diseases, no active tumors, no metal implants in the body, no limb amputations, no significant differences in local body water distribution. Both patients and their families were informed about this study and signed the informed consent form.

2.2. Measurement methods

A multi-frequency bioelectrical impedance analyzer (BLA) was used to measure the volume of patients during the non-dialysis period, and at the 4^{th}, 8^{th}, and 12^{th} weeks after the start of hemodialysis. During the measurement, patients were instructed to remove all metal items. Electrode patches were pasted on the middle fingers, thumbs, and left and right heels (6 skin sites) of the patients as required, and then the wires were connected for detection. The instrument directly outputs the patient's body mass index (BMI), total body water (TBW), extracellular fluid (ECW), intracellular fluid (ICW), extracellular fluid/height (ECW/Height), intracellular fluid/height (ICW/Height), and edema index (ECW/TBW).

2.3. Data collection

General information such as age, gender, body index, smoking history, family escort situation, sleep status, and educational background was collected. Information related to dialysis treatment, including the patient's primary disease, concurrent clinical complications (such as cardiovascular diseases, infections, respiratory diseases, gastrointestinal bleeding, etc.), start time of hemodialysis, and dialysis frequency, was also gathered. In addition,

examination data such as cardiac ultrasound, hemoglobin (Hb), serum albumin (ALB), brain natriuretic peptide (BNP), blood calcium (Ca), blood sodium (Na), left ventricular mass index (LVMI), total urea clearance index (Kt/V), 4-hour dialysis creatinine/blood creatinine ratio (4hD/PCr), and 24-hour urine volume were collected.

2.4. Data analysis

Data collection and data analysis were carried out simultaneously. That is, within 24 hours after each volume measurement, hemodialysis-related information, laboratory tests, and cardiac ultrasound of the patients were collected to record the volume load management of patients. The non-dialysis stage was evaluated once, and the volume collection at the 4^{th}, 8^{th}, and 12^{th} weeks after the start of hemodialysis was used to evaluate the volume management of patients in the initial dialysis stage.

2.5. Statistical methods

Binary logistic regression was used to analyze the factors influencing volume overload in patients during the peri-dialysis period. The test level was $\alpha = 0.05$. A P-value < 0.05 was considered to indicate a statistically significant difference.

3. Results

In the non-dialysis stage, 68 patients (86%) had volume overload, and 21 patients (21%) had normal volume load. In the initial dialysis stage, 62 patients (72%) had volume overload, and 24 patients (28%) had normal volume load. Among the patients with volume overload in the two stages combined, the primary diseases were diabetic nephropathy at 29%, hypertensive nephropathy at 29%, primary nephropathy at 34%, and other renal damage at 8%. Complications included heart failure at 29%, respiratory tract infection at 32%, coronary heart disease at 9%, and anemia at 21%. Among the patients with volume overload, 69% were male, 52% were over 60 years old, 53% had no family member accompaniment, 57% had insomnia, and 55% had an educational level of junior high school or below.

4. Discussion

The results of volume measurement of patients in the peri-dialysis period using bioelectrical impedance technology showed that the volume overload in the non-dialysis stage was significantly higher than that in the initial dialysis stage. During this stage, 6 patients had to undergo emergency hemodialysis due to severe fluid retention or blood potassium levels higher than the critical value (the critical value of blood potassium in our hospital is > 5.5 mmol/L). At the same time, 17% of the patients had concurrent heart failure and respiratory tract infection. In this stage, the volume-overloaded state made it difficult to control the patient's blood pressure and adjust antihypertensive drugs. The combined effect of these two factors led to myocardial cell hypertrophy and fibrosis in some patients, ultimately causing left ventricular hypertrophy (LVH) [3]. This study found that the volume-overloaded state of patients was positively correlated with the patient's age, frequency of insomnia, and duration of the primary disease, and negatively correlated with the total amount of albumin, degree of anemia, and 24-hour total urine volume. Due to the large individual differences in self-management, whether there is family accompaniment was not considered as a factor affecting the patient's volume overload for the time being.

In the initial stage of dialysis, the volume load of patients was controlled to a large extent. The volume measurement of patients in the initial stage of hemodialysis showed that the proportion of patients with volume overload was 70% in the 4th week. However, with the gradual start of regular hemodialysis, the proportion of patients with volume overload decreased to 46% in the 8th week and then increased somewhat compared with the previous level in the 12th week. In the initial stage of hemodialysis, the ultrafiltration effect of hemodialysis improved the overload state of some patients. However, the gradual decline of the patient's residual renal function led to a decrease in urine output. At the same time, the clearance of small and medium-sized molecular toxins gradually restored the patients' appetite. Under the combined effect of these two factors, the volume management of some patients was poor.

Among them, dialysis patients with diabetic nephropathy had more difficulties in volume management during this stage. Moreover, there were occasional symptoms of hypotension and hypoglycemia during dialysis [4]. The habit of excessive drinking and eating in diabetic patients directly led to difficulties in volume management. Due to the autonomic nerve disorder and decreased vascular regulation function in some diabetic patients, it could not effectively stimulate the medulla to secrete adrenaline to regulate blood pressure when the blood volume decreased. Since the patient's ability to regulate osmotic pressure was reduced, hypotension was likely to occur during hemodialysis, resulting in a decrease in the ultrafiltration volume and making it difficult to improve the volume-overloaded state [5]. In addition, the blood glucose level was also an important factor affecting the volume control of patients.

In addition, the patient's comorbidities such as diabetes, hypertension, anemia, malnutrition, and insomnia were also factors affecting the volume management of patients. At the same time, anemia, malnutrition, and diabetes led to a decline in the patients' resistance, resulting in respiratory system infections. Some patients received intravenous infusion treatment, which further increased the patients' volume load. Through interview surveys, it was found that family accompaniment could slightly improve the patients' insomnia, malnutrition, blood pressure, and blood glucose control. Therefore, improving the patient's self-management of the primary disease may play a positive role in their volume management.

5. Conclusion

Bioelectrical impedance technology is a new type of volume evaluation tool that is simple, direct, and capable of quickly providing information on the distribution of body fluids in patients. It has been adopted in clinical practice and can help judge patients' volume loads. Since this study was a single-center investigation, the data provided had the disadvantage of a small sample size. Therefore, further research on the volume management of peri-dialysis patients is still needed.

Disclosure statement

The authors declare no conflict of interest.

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