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Application Prospect of ChatGpt for Self-Management of Hemodialysis Patients

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Abstract: Hemodialysis makes it possible for patients with end-stage renal disease to survive. However, patients are faced with various dialysis-related complications due to their inadequate management ability. Recently, the newly emerged artificial intelligence ChatGPT has brought great impact on all walks of life. This paper aims to explore the application of artificial intelligence ChatGPT in the long-term self-management of hemodialysis patients, hoping that the more intelligent management of ChatGPT can reduce the complications of hemodialysis patients and improve the quality of life of patients. This paper will discuss the application prospect of ChatGPT in hemodialysis patients from the aspects of nutrition, hyperkalemia, exercise rehabilitation and volume load.

1. Preface

The incidence of end-stage renal disease (ESRD) is increasing year by year. In recent years, under the influence of population aging and other factors, CKD has become the third biggest "killer" after tumor and cardiovascular disease, and is increasing to uremia at a rate of 5-8% every year, resulting in more than 1.6 million dialysis patients worldwide [1-2]. According to statistics, the number of maintenance hemodialysis (MHD) patients in China has exceeded 500,000 by 2017 [3]. Kidney replacement therapy for ESRD often includes kidney transplantation, peritoneal dialysis and hemodialysis [4]. Considering cost, quality of life and other factors comprehensively, hemodialysis (HD) is the main method of kidney replacement therapy for ESRD [5]. Studies have shown that in the Blood Purification Center of Affiliated Hospital of Jiangsu University, a total of 662 new ESRD patients received hemodialysis treatment in the past five years [6]. However, lost productivity and the cost of hemodialysis treatment pose major challenges for low - and middle-income countries [7]. In our country, the number of patients with ESRD increases year by year, and the cost of medical insurance for ESRD patients exceeds 10 billion yuan every year, bringing tremendous pressure to the national economy [8]. In South Africa, although dialysis is provided by the state, the transportation cost of hemodialysis families accounts for 27.1% of the family income [9]. Because of its high disability rate and high medical cost, ESRD brings huge economic burden to individuals and society.

Hemodialysis has prolonged the survival of patients, but due to inadequate management, patients are often accompanied by a variety of dialysis-related complications [10], such as malnutrition,

volume overload, physical activity disorders and inadequate dialysis. Zhang Xiaohua et al. investigated hemodialysis patients and found that the rate of blood calcium, blood phosphorus and serum parathyroid hormone reaching the standard was less than 60% [11]. Multiple complications are important factors leading to high mortality of ESRD. Wang Li et al. found that the case fatality rate of ESRD patients on hemodialysis increased year by year, from 2019 to 2021, it was 10.2%, 10.4% and 11.0% respectively [12]. Relevant studies have shown that good self-management is of great significance in improving the quality of life of hemodialysis patients [13]. Yao Jing et al. randomly divided 100 patients with maintenance hemodialysis into the control group and the experimental group. The experimental group was given personalized diet education (formulated by the health education group), and found that health education could reduce the risk of calcium and phosphorus metabolism of patients and increase the occurrence of malnutrition related events [14]. Studies have shown that intelligent teams established by professionals can improve patients' self-management ability and even delay disease progression [15]. Therefore, it is of great significance for the long-term management of end-stage renal disease to explore an intelligent software that can dynamically monitor and timely develop personalized guidance programs.

ChatGPT, developed by Us-Based artificial intelligence lab OpenAI, has emerged as a major innovation in AI in recent years. Compared with the previous specialized artificial intelligence, ChatGPT has the characteristics of universality and humanization, attracting the attention of all walks of life. Based on GPT-3.5 large-scale language model, ChatGPT has powerful language understanding, recombination and integration capabilities, and enjoys a high reputation in medical, education, law and other fields [16]. ChatGPT can analyze health problems arising during the COVID-19 pandemic, perform logical analysis based on the information received, and output life precautions, but these text answers do not exist on the Internet [17]. ChatGPT's versatility and "understanding of human speech" have significant implications for the medical industry, especially the long-term management of chronic diseases. In the following literature review, we will explore the progress of ChatGPT in the prospects for self-management in hemodialysis patients.

2. Application of ChatGPT in nutrition management of hemodialysis patients

Malnutrition is an important complication in hemodialysis patients. Wei Wang et al. studied 2,678 MHD patients from 29 dialysis centers and found that 40.3% (1084/2687) patients had nutritional risks of varying degrees [18]. Hemodialysis patients are at greater risk of malnutrition, and all nutritional indicators are closely related to survival. Malnutrition is an important risk factor for the long-term survival of hemodialysis patients, so long-term nutritional management is crucial for the prognosis of end-stage renal disease.

Equipped with rich knowledge of nutrition and medicine, ChatGPT is able to evaluate the nutritional status of patients according to their current physical state (such as body weight, subcutaneous fat, biochemical indicators, etc.), and make personalized diet plan combined with the diet structure of low salt, low fat and high quality protein, and carry out regular monitoring and timely adjustment. In addition, ChatGPT helps patients establish a regular, workable lifestyle, three meals and energy distribution based on their eating habits and financial conditions. For patients with sub-standard ESRD nutritional status and underlying diseases, ChatGPT can make a diet more suitable for the patient based on the low salt and low-fat diet and combined with the patient's gender, age, underlying diseases and other factors. For example, for diabetic patients, ChatGPT can make recipes suitable for ESRD malnutrition patients with diabetes from the aspects of food selection, types of meals, cooking methods and proportions of meals, based on the patient's BMI, daily activity, fasting and 2-hour postprandial blood sugar, etc.

Personalized nutrition guidance is helpful to improve the nutritional status of hemodialysis

patients, improve the quality of life of patients, reduce the incidence of abnormal mineral and bone metabolism, infection and other complications caused by malnutrition, so as to reduce the mortality of hemodialysis patients. ChatGPT is therefore important for the long-term nutritional management of end-stage renal disease.

3. Application of ChatGPT in the management of hyperkalemia in hemodialysis patients

Severe decrease of renal potassium excretion function in patients with end-stage renal disease is an important cause of hyperkalemia [19]. Severe hyperkalemia, however, can lead to arrhythmia and even cardiac arrest. Hemodialysis is an important treatment for end-stage renal disease complicated with hyperkalemia. It has been reported that rational diet and drink management during dialysis can reduce the incidence of hyperkalemia in hemodialysis patients [20].

ChatGPT has a strong learning ability and a large data reserve, which can help patients manage their blood potassium level rationally according to their blood potassium level, from various aspects such as diet management and medication guidance, so as to prevent the occurrence of hyperkalemia.

3.1. Dietary guidance

ChatGPT can help patients identify high-potassium foods and avoid consuming too much potassium. At the same time, providing patients with a variety of low-potassium food options based on their tastes, cultural background and lifestyle can help patients maintain healthy eating habits.

3.2. Patient education

ChatGPT can provide patients with information about hyperkalemia, the severity of the condition and the complications that can result from hyperkalemia. Improve patients' self-management ability by educating them on how to prevent hyperkalemia.

3.3. Drug management

ChatGPT can assist physicians in evaluating patients' drug regimens, especially for drugs that may affect potassium metabolism, such as potassium retention diuretics, ACE inhibitors, ARBs, etc. At the same time, remind patients to be aware of the side effects of medications and monitor blood potassium levels regularly.

3.4. Remote monitoring and early warning

Using physiological indicators and disease data provided by the patient, ChatGPT can assess the patient's blood potassium level in real time, and send an alert to the patient if they notice any abnormalities, reminding them to seek medical attention. At the same time, ChatGPT can transmit critical data to the patient's doctor so that the doctor can keep abreast of changes in the patient's condition.

3.5. Psychological support

Hyperkalemia can also have an impact on patients' mental health. ChatGPT can provide psychological support to help patients cope with their illness and develop a positive attitude.

In conclusion, the application of ChatGPT in the management of hyperkalemia in hemodialysis patients covers dietary guidance, patient education, medication management, remote monitoring and early warning, and psychological support. By fully utilizing the function of ChatGPT, it is

expected to reduce the incidence and related complications of hyperkalemia in hemodialysis patients and improve the quality of life and prognosis of patients.

4. Application of ChatGPT in exercise rehabilitation management of hemodialysis patients

Hemodialysis patients tend to have different degree of self-reliance and physical activity barriers, and develop good exercise habits can improve the quality of life of patients [21]. The DOPPS study reported that patients who exercised more than once a week had better outcomes, regardless of their physical condition or social factors [22]. Many observational studies have shown an association between physical activity and lower mortality in patients with CKD and dialysis [23-26]. Studies have shown that even among CKD patients with multiple disabilities, avoiding a sedentary lifestyle is associated with better outcomes [27]. However, there is still a large gap between theoretical knowledge and practical clinical practice. JRDR reports that more than 60 percent of dialysis patients of all ages and years of dialysis have no exercise habits. The proportion of patients with no exercise habit increased with age and dialysis time. Studies have shown that only 6.9% of patients with CKD meet recommended levels of physical activity [28]. Exercise is crucial to the prognosis of patients with end-stage renal disease. Therefore, it is particularly important to develop appropriate exercise programs for patients to improve their exercise initiative for the long-term survival of hemodialysis patients.

ChatGPT has a wealth of exercise and fitness knowledge, and can make exercise programs suitable for patients from the aspects of exercise mode, frequency, intensity and time according to their body mass index, heart rate, blood pressure, breathing, nutritional status and other factors. This helps to improve the patient's calcium and phosphorus metabolism, nutritional status, quality of life, psychological and sleep status, prevent muscle atrophy, improve immunity, cardiopulmonary function and dialysis adequacy, while helping to control blood pressure and blood sugar. For patients who do not exercise regularly, due to poor cardiopulmonary adaptability and decreased muscle mass and function, ChatGPT can guide patients to start from basic mild intensity aerobic exercise such as slow walking, cycling and jogging, and gradually increase the intensity and amount of exercise to improve the body's motor function and increase the daily exercise ability. Through the gradual process, enhance the body's endurance, but also can consume body fat, especially suitable for obese patients. This exercise program will not only avoid discomfort such as muscle soreness caused by excessive exercise intensity, but also bring good experience to patients to promote their exercise initiative. For frail or diabetic patients, ChatGPT can calculate the amount of energy consumed by prescribed exercise prescriptions, ensuring both the body's physical activity and the patient's safety.

In conclusion, the rich knowledge and strong learning ability of ChatGPT can be used to provide targeted suggestions on exercise rehabilitation management for hemodialysis patients, improving the quality of life and long-term prognosis of patients. Personalized exercise prescription and effective exercise guidance can help improve patients' exercise initiative, thus bringing better treatment effect and quality of life for hemodialysis patients.

5. Application of ChatGPT in volume load management of hemodialysis patients

Volume overload is one of the common complications in hemodialysis patients, and also an important factor affecting cardiovascular death [29]. Interdialytic weight gain (IDWG) represents volume overload and is the simplest marker of fluid volume overload. Fluid volume overload is potentially detrimental to survival and cardiovascular disease [30-31]. High sodium diet and dialysate with high sodium concentration are important causes of fluid increase [32]. Due to the dysfunction of renal excretion, high sodium concentration increases the body's water intake and

leads to increased blood volume, which is manifested as increased IDWG [33].

Interdialysis volume overload can easily lead to hypertension and heart failure in patients, and may also lead to hypotension, arrhythmia and inadequate dialysis during dialysis. Long-term volume overload is an independent risk factor for death in hemodialysis patients. Therefore, volume load management is very important for hemodialysis patients.

ChatGPT has a robust medical database to advise hemodialysis patients based on their serum sodium, serum calcium, plasma natriuretic peptide concentration, body weight and other indicators. For patients with thirst and dry skin, ChatGPT can advise patients to control reasonable sodium intake, including the types and amounts of foods containing sodium in three daily meals, and remind patients of the maximum range of daily fluid intake to maintain fluid balance and avoid weight gain during dialysis. ChatGPT can prompt patients with symptoms related to volume overload, such as cardiac fatigue and edema, during interdialysis to reassess their dry weight to calculate the appropriate ultrafiltration amount and adjust the ultrafiltration amount according to the patient's tolerance to gradually achieve the target weight within days to weeks. For patients with cardiac fatigue, sitting breathing, edema, weight gain and ultrafiltration below the target value, ChatGPT can prompt patients to monitor blood sugar and other indicators and seek prompt medical attention. For patients with edema, weight gain and prone to low blood pressure during dialysis, ChatGPT can remind patients to undergo appropriate tests, such as albumin and cardiac color ultrasound. Based on a patient's albumin, hemoglobin and other indicators, ChatGPT can determine the cause of low blood volume and prompt the patient to seek targeted medical attention. In addition, ChatGPT can analyze a patient's vital signs to determine if his or her life is in danger and alert the patient to seek medical attention immediately.

In conclusion, ChatGPT has potential applications in volume load management of hemodialysis patients. It can provide personalized advice to patients based on their physiological indicators, symptoms and test results, help patients control sodium intake, fluid intake and ultrafiltration, as well as prompt patients for further tests and medical treatment if necessary. In this way, ChatGPT helps to improve volume load management in hemodialysis patients, reduce the risk of cardiovascular complications, and improve patient quality of life and long-term prognosis.

6. Application of ChatGPT in the management of anemia in hemodialysis patients

Renal anemia is one of the most common complications in end-stage patients with chronic kidney disease, and it is also an important cause of disease deterioration [34]. The pathogenesis of renal anemia is complex, and the core involves erythropoietin deficiency and iron metabolism disorder. At present, the conventional methods for treating renal anemia include supplementation of erythropoietic stimulant iron, folic acid, hypoxic-inducing factor prolyl hydroxylase inhibitors, and blood transfusion as a remedial treatment. The treatment of patients with renal anemia is very necessary, but the specific treatment plan needs to be defined based on serum tests. If excessive iron supplementation should be avoided, a series of hazards should be caused by serum iron overload in patients.

ChatGPT has rich knowledge of nutrition, and can make personalized three meals rich in iron and vitamin B12 for patients according to their hemoglobin, serum iron and other examinations and preferences, and suggest patients to review regularly. ChatGPT can have the basis of medical knowledge, can process pictures, data and other functions, can guide the patient's serum iron, iron saturation and other indicators to guide the patient whether the medication is reasonable, and whether the patient should consult a professional doctor in time to adjust the treatment plan. In addition, gastrointestinal bleeding in patients with end-stage chronic kidney disease is clinically more common. ChatGPT can determine whether the patient has discomfort such as heart fatigue,

recent stool color, blood routine, blood pressure, heart rate, etc., determine whether the patient has digestive tract bleeding, judge the critical condition, and ask the patient to seek medical treatment in time.

7. Application of ChatGPT in the management of calcium and phosphorus metabolism in hemodialysis patients

Disturbance of calcium and phosphorus metabolism is one of the common complications in patients with chronic kidney disease, and if it is not properly controlled, the residual kidney function of patients will be further lost, which may also lead to abnormal mineral and bone metabolism [35]. Phosphorus is an important mineral required by the body, but excessive dietary phosphorus intake is detrimental to bone, kidney and cardiovascular system, especially patients with chronic kidney disease are more vulnerable to the harm of high-phosphorus diet [36]. Patients with hyperphosphatemia often have discomfort such as unbearable itching of the skin. Disturbance of calcium and phosphorus metabolism leads to secondary hyperparathyroidism. Chronic kidney disease has a high clinical incidence in China, and diet regulation is one of the important aspects in the research related to this disease.

By using the knowledge theory of nutrition and medicine such as ChatGPT, the daily diet of patients can be guided according to serum calcium and phosphorus, parathyroid hormone and other indicators, such as avoiding nut foods. According to the condition of blood calcium, patients can be reminded to supplement calcium or calcium-rich foods appropriately. In order to minimize the high phosphorus and low calcium state of patients, reduce the occurrence of vascular calcification, pathological fracture and other complications.

8. Advantages and challenges of ChatGPT

ChatGPT is a large-scale language model that marks a new milestone in artificial intelligence. ChatGPT can be trained to respond more fully to multiple verbal conversations with humans than previous smart software, and can evolve at a speed that the human brain cannot. ChatGPT holds promise in the long-term management of hemodialysis patients. By providing personalized guidance for individual differences, the self-management ability of patients can be improved to a greater extent, the occurrence of dialysis-related complications can be reduced, and the long-term quality of life of hemodialysis patients can be guaranteed. However, in the process of collecting patient information and behavioral data, ChatGPT has the risk of personal information being leaked and abused. In addition, ChatGPT's data sources mainly include web text data, social media data, etc., and its flexibility in data analysis and processing is no substitute for professionals specializing in the medical industry. Therefore, the impact of ChatGPT in the long-term management of hemodialysis patients is very important, but still needs to be combined with the clinical experience of professional physicians.

9. Future development prospects of ChatGPT

By allowing professional hemodialysis doctors to "tune" ChatGPT, it can provide reliable data sources for ChatGPT to better serve hemodialysis patients in the future. However, in addressing the issue of data security and privacy protection, it is recommended that ChatGPT adopt a reasonable data protection mechanism, including the authority on the use of data, the safe disposal of data, etc., to ensure that patient information is not misused or leaked. In addition, it is recommended to set up a set of laws and regulations on privacy protection in ChatGPT to strictly control the collection and use of patient information. In the future, all walks of life should give full play to ChatGPT's

advantages and supervise and train its shortcomings to better serve the society.

10. Conclusions

ChatGPT holds great promise for long-term self-management of hemodialysis patients. By accurately assessing individual specificities based on big data, a personalized approach to self-management can be provided to patients. Despite its limitations, ChatGPT is important for maintaining long-term self-management ability and improving quality of life in hemodialysis patients.

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