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ARTICLE

Effects of Internet Plus-Based Continuous Nursing on Hemodialysis Adherence in Patients with Chronic Renal Failure: A Retrospective Study

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Abstract

Aims/Background Chronic renal failure (CRF) is the eventual outcome shared by various progressive renal diseases, posing a serious threat to the physical health of patients. CRF patients are required to undergo hemodialysis (HD), which imposes heavy psychological and mental burdens for most individuals. This study explores the effects of Internet Plus-based continuous nursing on the compliance of CRF patients with HD.

Methods This study retrospectively analyzed the clinical data of 160 CRF patients undergoing HD in the Yantai Yuhuangding Hospital from March 2021 to April 2023, after excluding eight cases from an originally selected cohort of 168 cases. These patients were divided into two groups: 79 cases who received the routine nursing from March 2021 to March 2022 were categorized as the routine group, whereas 81 cases who were given Internet Plus-based continuous nursing from April 2022 to April 2023 were assigned into the observation group. The treatment adherence, self-management behaviors, quality of life and incidence of HD complications were compared in both groups.

Results Both groups demonstrated no significant difference in the baseline information ($p > 0.05$). The scores of adherence in terms of HD attendance, medications, fluid restrictions and diet recommendations in the observation group were significantly higher than those in the routine group ($p < 0.001$). No significant difference in the Hemodialysis Self-Management Instrument (HDSMI) scores on the day of discharge between the two groups was found ($p > 0.05$). After 6 months of follow-up, the observation group showed significantly higher scores of partnership, problem solving, self-management execution and emotional processing than the routine group ($p < 0.001$). Both groups had no significant difference in the scores of Kidney Disease-Targeted Areas (KDTA) and 36-Item Short Form (SF-36) on the day of discharge ($p > 0.05$). After 6 months of follow-up, the scores of KDTA and SF-36 in the observation group were significantly higher than those in the routine group ($p < 0.001$). The incidence of HD complications in the observation group (7.41%) was significantly lower than that in the routine group (21.52%) ($p < 0.05$).

Conclusion Internet Plus-based continuous nursing can effectively improve treatment adherence, self-management behaviors as well as quality of life in patients, and reduce the incidence of HD complications.

Key words: internet; continuity of patient care; kidney failure; chronic; renal dialysis; patient compliance

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Introduction

Chronic kidney disease (CKD) is a global public health problem marked by the rapid growth of CKD patient population, with an estimated 843.6 million patients being recorded worldwide in 2017 (Jager et al, 2019). Chronic renal failure (CRF) refers to the decline of glomerular filtration rate caused by CKD, concurrent with the related metabolic disorders and clinical symptoms. It is characterized as a progressive and irreversible deterioration of renal function (Wang et al, 2021), representing the most common public health problem affecting the elderly population worldwide (Hussein et al, 2022). CRF can occur at all ages and the clinical manifestations vary greatly across the affected population. The incidence of CRF has grown on an annual basis, together with the improvement of living standards. CRF has become one of the major chronic diseases affecting the Chinese people (Dai et al, 2021).

Hemodialysis (HD) is an effective mean to treat CRF in clinical settings (Li, 2020b). Despite the benefits in maintaining physical function and slowing down the occurrence of complications, HD alone is not a panacea for curing CRF. Treatment adherence refers to the concept of patients taking the responsibility of managing their own health by actively complying with the prescribed treatment. Regarded as a positive and proactive behavior, adhering to treatment leads to a change in lifestyle (Mir, 2023). Poor treatment adherence or treatment non-adherence is associated with poor health outcomes, which raise morbidity and mortality rates, as well as health expenditures (Mhammedi et al, 2019). Treatment non-adherence is a relatively common problem among CRF patients undergoing HD, resulting in poor health outcomes (Murali et al, 2019). Thus, it is imperative to improve the HD adherence among CRF patients.

The concept of Internet Plus, which can realize effective real-time information exchange and knowledge transfer, has gradually gaining popularity in the medical care sector in recent years (Zhang et al, 2024). However, there remains a significant gap in understanding how Internet Plus can specifically enhance continuous nursing and improve HD adherence among CRF patients, profoundly affecting the effectiveness of patient self-management and daily care. Compared to routine care, continuous nursing is a more comprehensive and detailed form of nursing care, extending the nursing service from the hospital to the outside. The conventional continuous nursing is limited to time, space and human resources, which is characterized by a lack of effective remote monitoring and immediate guidance, making it difficult to provide personalized nursing support for CRF patients with HD. As a result, many patients cannot maintain high compliance in diet control, fluid intake, medication use, and complication prevention, which may further influence disease control effects and quality of life. Thus, through advanced technologies such as big data, cloud computing, and artificial intelligence, this study provided patients with one-stop services such as health education, remote monitoring, intelligent early warning, online consultation, and psychological support, and explored the effects of Internet Plus-based continuous nursing on HD adherence among CRF patients.

Methods

Study Participants

The clinical data of 160 CRF patients undergoing HD in the Yantai Yuhuangding Hospital from March 2021 to April 2023 were retrospectively analyzed, after excluding eight cases from the selected cohort of 168 cases. The inclusion criteria of the present study are as follows: (1) patients aged >18 years old; (2) patients with a HD time of ≥3 months with a frequency of 2–4 times/week; and (3) patients who were literate with normal mental consciousness. Individuals with the following criteria were excluded: (1) patients with incomplete medical records; and (2) patients with severe heart, brain, liver and other organ failure. A total of 79 patients who received the routine nursing from March 2021 to March 2022 were assigned to the routine group, whereas 81 cases who were treated with Internet Plus-based continuous nursing from April 2022 to April 2023 were assigned to the observation group. This study conformed to the principles of Declaration of Helsinki (World Medical Association, 2013).

Nursing Methods

Routine Group

The subjects in the routine group received routine nursing, which was implemented based on details below:

(1) Patients admitted to the hospital for HD treatment were each given a health knowledge brochure, and the nursing staff gave them health guidance and explained the relevant knowledge about the diseases they were diagnosed with, in the aspects of self-management, medication adherence, and matters needing attention.

(2) The nursing staff monitored the vital signs of the patients during HD treatment and carefully managed their arteriovenous fistula sites after treatment.

(3) The nursing staff explained to the patients on how to control their diets, for instance, eating starch-containing food as staple and consuming low protein, low salt, and high-energy foods as much as possible to reduce the burden on the kidneys.

(4) The nursing staff adopted a sincere attitude while communicating with the patients and answering their questions, and encouraged them to adhere with the treatment by alleviating their anxiety.

(5) When the patients were discharged from the hospital, the nursing staff reminded the patients and their families to return to the hospital regularly, as scheduled, for examination. In the first month after discharge, the nursing staff should carry out weekly telephone follow-up with the patients, inquire about their living habits and management, and answer their questions. After that, the patients were followed up twice a month for 6 months.

Observation Group

The subjects in the observation group were treated with Internet Plus-based continuous nursing for 6 months, which was executed in accordance with the details set out in the following:

(1) After patients were admitted to the hospital, nursing staff collected their basic information, such as home address, contact information and emergency contact number, and recorded them in a separate information management system, which facilitates the timely update of patient information when necessary, and the recorded data were synchronized in a mobile application created to ease information and results viewing by patients. The nursing staff also assisted the patients to download the mobile application so that they could keep abreast of their examination results, dialysis data and treatment costs by accessing the app.

(2) The patients' information data were transformed into charts, which were available for viewing by patients on the mobile app. Specifically, after each HD treatment, the monitoring results were summarized and the data changes were displayed in form of charts. Regarding data with large fluctuations, physicians should be informed by the nursing staff and analyzed the reasons behind such trends prior to sending feedback about the results to the patients.

(3) Nursing staff carried out home management for patients through mobile app, provided medication guidance, and set alarm to alert patients during pill time. Based on the recorded data, nursing staff developed a reasonable nutritional diet plan with physicians and nutritionists. After each HD treatment, the patients were instructed to control weight, limit water and salt intake, do proper exercise, and supply information related to diet, medication, exercise and sleep in the mobile app, as part of the effort to foster good lifestyle habits and strengthen immunity.

(4) Nursing staff shared essential knowledge about CRF and HD treatment, including pathogenesis, clinical manifestations, treatment plan, complication prevention, and nursing measures, with patients every week in the form of passages, pictures, videos and voice clips through a health knowledge web page created on the mobile app. Knowledge-sharing in this case was conducted to enhance the understanding of patients and their families about the disease and treatment they were dealing with. Meanwhile, patients' questions were taken note of by the nursing staff, who would share the relevant knowledge in response to those questions on the web page.

(5) An online health education meeting was organized once a month, lasting 30 to 60 minutes each time. The meeting was chaired by physicians, and nutritionists and psychologists were invited to participate.

(6) The online nursing consultations, specialized follow-up consultations, and difficult nursing problem consultations were set up through the mobile app, on which the physicians and nursing staff could respond to patients' questions concerning nursing care and nutrition. In addition, a patient communication group was created in the app to promote patients' exchanges, mainly to share their self-management experience and alleviate negative emotions felt by others.

(7) An online applet for reexamination was established in the mobile app. Patients who return to the hospital for HD or follow-up can schedule a follow-up appointment through an applet to shorten the waiting time at the hospital.

General Information

The patients' general information, including sex, age, body mass index (BMI), primary diseases, course of disease, HD duration, weekly HD frequency, weekly HD time, HD access, education levels and marital status, was gleaned from the medical record system.

Observation Indicators

Treatment Adherence

This study adopted End-Stage Renal Disease-Adherence Questionnaire (ESRD-AQ) developed by Kim et al (2010) to assess the treatment adherence of patients after 6 months of follow-up. The first part of this questionnaire covers the acquisition of general information about the patients' history of end-stage renal disease and renal replacement therapy (5 items), and the remaining four parts are concerning adherence to HD attendance (14 items), medications (9 items), fluid restrictions (10 items), and diet recommendations (8 items). A high score indicates better adherence to treatment.

Self-Management Behaviors

The Hemodialysis Self-Management Instrument (HDSMI) was used to evaluate the self-management behaviors of patients on the day of discharge and after 6 months of follow-up. This scale was developed by Song (2009) and had been tested for reliability and validity by Li et al (2015). HDSMI consists of 20 items, involving four dimensions, namely partnership, problem solving, self-management execution, and emotional processing, totaling a score of 80 points. A higher score is an indicator of better self-management behaviors.

Quality of Life

This study utilized the Kidney Disease Quality of Life Short Form 1.3 (KDQOL-SF$^{TM\ 1.3}$) to evaluate quality of life in patients on the day of discharge and after 6 months of follow-up. Compiled by Hays et al (1997), the KDQOL-SF$^{TM\ 1.3}$ was specifically employed to evaluate the quality of life in patients with dialysis and kidney disease. This tool encompasses items that evaluate kidney disease-related quality of life (Kidney Disease-Targeted Areas, KDTA) and general health quality of life (36-Item Short Form, SF-36), covering a total of 19 dimensions and 79 items. KDTA scale consists of 11 dimensions, including 12 items for symptoms and discomfort, 8 items for impact of kidney disease on daily life, 4 items for burden of kidney disease on life, 2 items for work status, 3 items for cognitive function, 3 items for social quality, 3 items for sexual function, 4 items for sleep quality, 2 items for social support, 2 items for encouragement from medical staff, and 1 item for patient satisfaction. SF-36 scale is composed of 8 dimensions (Ware, 2000), including 10 items for physiological function, 4 items for physiological function, 2 items for physical pain, 5 items for general health status, 4 items for energy, 2 items for social function, 3 items for emotional function, and 5 items for mental health. The original code of each item was converted into a score within the range of 0–100 by percentage ratio. Different items had different original code ranges,

with the lowest being 1–2 points and the highest being 1–10 points. The items in the same dimension were summed to obtain an average value. A high score in each dimension indicates better quality of life.

Incidence of HD Complications

The incidence of internal fistula occlusion, subcutaneous hematoma, phlebitis, hypotension, hypoglycemia and hypertension during the follow-up period was calculated using the formula in the following:

Incidence of complication (%) = Number of complications in each group/Total number of patients in each group $\times$ 100.

Statistical Analysis

The data of this study were processed using SPSS 26.0 (IBM Corp, Armonk, NY, USA). Data of categorical variables are expressed as counts and percentages and tested by Chi-square test. The normal distribution of continuous variables was analyzed by Shapiro-Wilk test. The data conforming to a normal distribution are expressed as mean $\pm$ standard deviation, and were analyzed using *t*-test, while the data not adhering to a normal distribution are presented as median (P_{25}, P_{75}), and were tested using Mann-Whitney *U* test. $p < 0.05$ was considered statistically significant.

Results

Comparison of General Data

Out of the 79 patients in the routine group, 47 of them are males while the rest are females, who collectively had a median age of 55.00 (49.00, 60.00) years. Meanwhile, there were 81 patients in the observation group had, including 52 males and 29 females, with a median age of 58.00 (51.00, 61.00) years. No significant difference was observed in general data between the two groups ($p > 0.05$, Table 1).

Comparison of Treatment Adherence

The scores of adherence to HD attendance, medications, fluid restrictions and diet recommendations in the observation group were significantly higher than those in the routine group ($p < 0.001$, Table 2).

Comparison of Self-Management Behaviors

Both groups demonstrated no difference in the HDSMI scores on the day of discharge ($p > 0.05$). After 6 months of follow-up, the observation group showed significantly higher scores of partnership, problem solving, self-management execution and emotional processing than the routine group ($p < 0.001$, Table 3).

Comparison of Quality of Life

Both groups showed no statistical difference in the scores of KDTA and SF-36 on the day of discharge ($p > 0.05$). After 6 months of follow-up, the observation group demonstrated significantly higher scores of KDTA and SF-36 than the routine group ($p < 0.001$, Table 4).

Table 1. Comparison of general data.

Items		Routine group (n = 79)	Observation group (n = 81)	χ^2/Z	*p*
Age (years)		55.00 (49.00, 60.00)	58.00 (51.00, 61.00)	–1.809	0.070
BMI (kg/m^2)		19.60 (19.34, 19.91)	19.58 (19.35, 19.80)	–1.002	0.316
Sex	Male	47 (59.49)	52 (64.20)	0.375	0.540
	Female	32 (40.51)	29 (35.80)		
Course of disease (years)		2.00 (1.00, 4.00)	3.00 (2.00, 4.00)	–0.759	0.448
Primary diseases	Chronic glomerulonephritis	40 (50.63)	42 (51.85)	0.076	0.963
	Diabetic nephropathy	22 (27.85)	21 (25.93)		
	Hypertensive nephropathy	17 (21.52)	18 (22.22)		
HD duration (months)		17.00 (14.00, 24.00)	19.00 (10.50, 24.00)	–0.012	0.990
Weekly HD frequency (times/week)		2.00 (2.00, 3.00)	3.00 (2.00, 3.00)	–0.784	0.433
HD administration	Arteriovenous fistula	62 (78.48)	62 (76.54)	1.820	0.402
	Long-term catheters	10 (12.66)	7 (8.64)		
	Short-term catheters	7 (8.86)	12 (14.81)		
Education levels	Junior high school and below	28 (35.44)	34 (41.98)	0.722	0.697
	Senior high school	35 (44.30)	32 (39.51)		
	Junior college and above	16 (20.25)	15 (18.52)		
Marital status	Married	45 (44.30)	42 (51.85)	0.421	0.516
	Unmarried/divorced/widowed	34 (55.70)	39 (48.15)		

Data of quantitative variables not adhering to normal distribution are presented as median (P_{25}, P_{75}), while data of categorical variables are expressed as count (percentage).
Abbreviations: BMI, body mass index; HD, hemodialysis.

Table 2. Comparison of ESRD-AQ scores.

Groups	Adherence to HD attendance	Medication adherence	Adherence to fluid restrictions	Adherence to diet recommendations
Routine group (n = 79)	493.00 (437.00, 532.00)	158.00 (138.00, 178.00)	137.00 (119.00, 148.00)	131.00 (120.00, 152.00)
Observation group (n = 81)	546.00 (521.50, 568.00)	178.00 (165.50, 185.00)	162.00 (143.00, 173.00)	159.00 (144.00, 174.00)
Z	–6.985	–5.534	–6.868	–6.824
p	<0.001	<0.001	<0.001	<0.001

Data of quantitative variables not adhering to normal distribution are presented as median (P_{25}, P_{75}).
Abbreviations: ESRD-AQ, End-Stage Renal Disease-Adherence Questionnaire.

Table 3. Comparison of HDSMI scores.

Groups	Partnership		Problem solving		Self-management execution		Emotional processing	
	The day of discharge	After 6 months of follow-up	The day of discharge	After 6 months of follow-up	The day of discharge	After 6 months of follow-up	The day of discharge	After 6 months of follow-up
Routine group (n = 79)	10.00 (10.00, 11.00)	12.00 (10.00, 12.00)	11.00 (10.00, 13.00)	13.00 (12.00, 14.00)	14.00 (12.00, 15.00)	14.00 (13.00, 16.00)	9.00 (7.00, 9.00)	10.00 (9.00, 11.00)
Observation group (n = 81)	11.00 (9.00, 12.00)	13.00 (12.00, 13.00)	11.00 (10.00, 12.00)	15.00 (13.00, 16.00)	14.00 (11.50, 16.00)	19.00 (16.00, 20.50)	8.00 (8.00, 10.00)	13.00 (12.00, 13.00)
Z	–0.889	–5.610	–0.741	–6.334	–0.057	–9.543	–0.432	–11.184
p	0.374	<0.001	0.459	<0.001	0.955	<0.001	0.666	<0.001

Data of quantitative variables not adhering to normal distribution are presented as median (P_{25}, P_{75}).
Abbreviations: HDSMI, Hemodialysis Self-Management Instrument.

Table 4. Comparison of KDQOL-SF$^{TM\ 1.3}$ scores.

Groups	KDTA		SF-36	
	The day of discharge	After 6 months of follow-up	The day of discharge	After 6 months of follow-up
Routine group (n = 79)	53.00 (51.00, 55.00)	59.00 (56.00, 63.00)	57.00 (54.00, 58.00)	66.00 (63.00, 70.00)
Observation group (n = 81)	53.00 (51.00, 56.00)	65.00 (62.00, 69.00)	55.00 (53.00, 58.00)	72.00 (66.50, 76.00)
Z	–0.249	–7.279	–1.868	–5.504
p	0.803	<0.001	0.062	<0.001

Data of quantitative variables not adhering to normal distribution are presented as median (P_{25}, P_{75}).
Abbreviations: SF-36, 36-Item Short Form; KDTA, Kidney Disease-Targeted Areas; KDQOL-SF$^{TM\ 1.3}$, Kidney Disease Quality of Life Short Form 1.3.

Table 5. Comparison of incidence of HD complications.

Groups	Internal fistula occlusion	Subcutaneous hematoma	Phlebitis	Hypoglycemia	Hypertension	Hypotension	Total number
Routine group (n = 79)	4 (5.06)	4 (5.06)	2 (2.53)	2 (2.53)	3 (3.40)	2 (2.53)	17 (21.52)
Observation group (n = 81)	1 (1.23)	2 (2.47)	1 (1.23)	0 (0.00)	1 (1.23)	1 (1.23)	6 (7.41)
χ^2	-	-	-	-	-	-	6.470
p	-	-	-	-	-	-	0.011

Data of categorical variables are expressed as count (percentage).

Comparison of Incidence of Hemodialysis Complications

The incidence of HD complications in the observation group (7.41%) was significantly lower than that in the routine group (21.52%) ($p < 0.05$, Table 5).

Discussion

At present, the clinical studies on the effect of Internet Plus-based continuous nursing on the HD adherence among CRF patients remain scanty. On this basis, this retrospective study explored the effect of Internet Plus-based continuous nursing, and found that this particular mode of nursing can effectively improve the treatment adherence, self-management behaviors and quality of life among patients, and reduce the incidence of HD complications.

Effects of Internet Plus-Based Continuous Nursing on Treatment Adherence

For CRF patients, beyond medication adherence, complying with dietary and fluid restrictions is also equally crucial to ensure the health improvement among patients undergoing HD. Inadequate compliance with these requirements after discharge may lead to excessive bleeding, increased build-up of toxic substances, cardiovascular problems, and even premature death (Rahdar et al, 2019). A study by Kim et al (2022) has confirmed that treatment adherence enhancement programs can effectively heighten treatment adherence among HD patients. According to Kim and Kim (2019), social support, especially a high level of support provided by health professionals, can improve the self-care adherence of patients. In the present study, the subjects in the observation group were managed and cared with Internet Plus-based continuous nursing. Compared with the routine group, the observation group showed significantly higher scores of adherence to HD attendance, medications, fluid restrictions and diet recommendations, consistent with the findings in a previous study (Ni et al, 2019), suggesting that the application of Internet Plus-based continuous nursing can improve the treatment adherence in HD patients. Since CRF patients undergoing HD may not necessarily be given comprehensive education during the brief stay in hospital, they may require long-term home treatment and be equipped with proper self-management skills after discharge. Therefore, it is crucial for both patients and medical staff to maintain contact with each other after discharge. At present, the utilization of Internet in clinical applications is gaining precedence, gradually replacing traditional methods and becoming the main platform for facilitating chronic disease management and home treatment guidance. In this study, we utilized a mobile app to record case information; analyze examination data; provide guidance on medication, diet and exercise; and share health education knowledge in the form of text, pictures and videos with the patients. With the advent of nursing mode transformation, the scenarios where patients are followed up by medical staff through phone calls at home will slowly become history. By implementing continuous nursing outside the hospital, patients would become more attentive to their biochemical test results following HD treatment and more cooperative with treatment. Aside from that, such nursing mode would keep raising the nursing potential and quality.

Effects of Internet Plus-Based Continuous Nursing on Self-Management Behaviors

Through retrospective analysis of the HDSMI scores between the two groups, this study found that the scores of partnership, problem solving, self-management execution, and emotional processing in the observation group were significantly higher than those in the routine group, indicating the beneficial potential of implementing Internet Plus-based continuous nursing in improving the self-management ability of CRF patients undergoing HD. This finding confirmed a prior set of research results (Li et al, 2021). Self-management skills are important for patients to cope with chronic diseases, while improving the self-sufficiency of patients, potentially controlling healthcare costs incurred from lack of proper treatment and management (Li et al, 2020a). The subjects in the routine group were only followed up through telephone by medical staff to inquire about their recent physical condition; however, this mode of nursing is not conducive to nurse-patient interaction. Besides, under this conventional nursing mode, patients and their families would not be proactive enough to implement the recommended restrictions or measures at home. The special mobile app developed to cater to the Internet Plus-based continuous nursing needs in this study offers tremendous spatial and temporal flexibility for nurse-patient communication. Using this app, medical staff can provide personalized nursing guidance for patients according to their examination data and other disease records, and share health education knowledge with patients in either visual or audio format. Through continuous learning and interaction, the patients will gradually be well acquainted with the importance of self-management, which is key to improving subjective initiative and self-management level (Hosseini et al, 2023).

Effects of Internet Plus-Based Continuous Nursing on Quality of Life

Yao et al (2023) has found that Internet Plus-based continuous nursing exerts a strong influence on restoring the physiological function and improving the quality of life in patients with severe adrenal tumors. Separately, the present study showed that after 6 months of follow-up, the observation group had significantly higher KDTA and SF-36 scores than the routine group, indicating that Internet Plus-based continuous nursing has a high efficacy in improving the quality of life in CRF patients undergoing HD. Continuous nursing is an important method to improve the quality of life in patients undergoing HD. At present, there is a severe shortage of medical and health resources in China, and thus face-to-face continuous nursing is difficult to achieve. In modern times, the application of Internet technology has become more prevalent in patient management outside the hospital, addressing the inconvenience typically encountered during the traditional telephone follow-up. In this study, the patients of the observation group, who were managed with Internet Plus-based continuous nursing could access health education knowledge, online consultation and other services all in the mobile app. Combining technology with nursing management is beneficial for mastery of self-care knowledge, enhancement of disease cognition and management ability, as well as improvement of health literacy and quality of life (Zhou et al, 2021).

Effects of Internet Plus-Based Continuous Nursing on Incidence of HD Complications

The study by Pretto et al (2020) revealed that the declining quality of life in CRF patients undergoing HD is associated with HD complications; therefore, reducing the incidence of HD complications is essential to improve the quality of life in patients. With Internet Plus-based continuous nursing, medical staff can provide personalized nursing guidance and health education for patients. Through the mobile app, medical staff can also monitor the changes in patients' condition and accordingly give timely guidance and intervention to avoid complications. In addition, the core principle of Internet Plus-based continuous nursing lies in the self-management and self-monitoring by patients themselves. Through the instruction of nursing staff, patients can carry out proper daily care and observe condition changes, thus improving their disease cognition and management ability. The results of this study demonstrated that the incidence of HD complications in the observation group was significantly lower than that in the routine group, further substantiating the effectiveness of Internet Plus-based continuous nursing in reducing the incidence of HD complications.

Conclusion

Internet Plus-based continuous nursing can effectively improve treatment adherence, self-management behaviors as well as quality of life in patients, and reduce the incidence of HD complications. This study also proves that this nursing mode can provide accurate treatment and nursing guidance for CRF patients.

Several shortcomings of the current study should be acknowledged. This study only conducted a follow-up on the included patients for 6 months, a period that is not compatible with the fact that CRF is a chronic disease requiring long-term care and management. Future studies should extend the follow-up time to fully assess the effects of Internet Plus-based continuous nursing on long-term efficacy and quality of life. Additionally, this study is a single-center retrospective study, yielding results that might not be generalizable to other populations due to regional and cultural differences. In the future, multicenter studies should be carried out to further verify the universal applicability of Internet Plus-based continuous nursing.

Key Points

- Internet Plus-based continuous nursing has a positive impact on the treatment compliance among patients with chronic renal failure undergoing hemodialysis.
- Internet Plus-based continuous nursing improves self-management behaviors of patients with chronic renal failure undergoing hemodialysis.
- Internet Plus-based continuous nursing reduces the incidence of hemodialysis complications.
- Internet Plus-based continuous nursing improves quality of life of patients with chronic renal failure undergoing hemodialysis.

Availability of Data and Materials

All the data used for analysis in this study are supported by existing data in the network database, and in this published article, all the study's generated data are presented.

Author Contributions

XL and XB designed the research study; JL performed the research; YL collected and analyzed the data. XL, JL, YL and XB have been involved in drafting the manuscript and all authors have been involved in revising it critically for important intellectual content. All authors gave final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

This study has been approved by the ethics committee of Yantai Yuhuangding Hospital, approval No. 2024-170. Patients and their families who were aware of the purpose and significance signed an informed consent.

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Conflict of Interest

The authors declare no conflict of interest.

References

Dai P, Chang W, Xin Z, Cheng H, Ouyang W, Luo A. Retrospective Study on the Influencing Factors and Prediction of Hospitalization Expenses for Chronic Renal Failure in China Based on Random Forest and LASSO Regression. Frontiers in Public Health. 2021; 9: 678276. https://doi.org/10.3389/fpubh.2021.678276

Hays RD, Kallich JD, Mapes DL, Coons SJ, Amin N, Carter WB, et al. Kidney Disease Quality of Life Short Form (KDQOL-SF^{TM}), Version 1.3: A Manual for Use and Scoring. Santa Monica. RAND Corporation: CA. 1997.

Hosseini A, Jackson AC, Chegini N, Dehghan MF, Mazloum D, Haghani S, et al. The effect of an educational app on hemodialysis patients' self-efficacy and self-care: A quasi-experimental longitudinal study. Chronic Illness. 2023; 19: 383–394. https://doi.org/10.1177/17423953211073365

Hussein SF, Al-qaisi AHJ, Morad TS. The changes of nitric oxide serum levels in patients with end-stage renal disease. World Bulletin of Public Health. 2022; 14: 96–99.

Jager KJ, Kovesdy C, Langham R, Rosenberg M, Jha V, Zoccali C. A single number for advocacy and communication-worldwide more than 850 million individuals have kidney diseases. Kidney International. 2019; 96: 1048–1050. https://doi.org/10.1016/j.kint.2019.07.012

Kim Y, Evangelista LS, Phillips LR, Pavlish C, Kopple JD. The End-Stage Renal Disease Adherence Questionnaire (ESRD-AQ): testing the psychometric properties in patients receiving in-center hemodialysis. Nephrology Nursing Journal. 2010; 37: 377–393.

Kim B, Kim J. Influence Of Uncertainty, Depression, And Social Support On Self-Care Compliance In Hemodialysis Patients. Therapeutics and Clinical Risk Management. 2019; 15: 1243–1251. https://doi.org/10.2147/TCRM.S218934

Kim H, Jeong IS, Cho MK. Effect of Treatment Adherence Improvement Program in Hemodialysis Patients: A Systematic Review and Meta-Analysis. International Journal of Environmental Research and Public Health. 2022; 19: 11657. https://doi.org/10.3390/ijerph191811657

Li H, Cao YD, Jiang YF, Wang JJ. Introduction and reliability and validity testing of the self-management scale for hemodialysis patients. Chinese Journal of Nursing. 2015; 50: 1392–1395. (In Chinese)

Li WY, Chiu FC, Zeng JK, Li YW, Huang SH, Yeh HC, et al. Mobile Health App With Social Media to Support Self-Management for Patients With Chronic Kidney Disease: Prospective Randomized Controlled Study. Journal of Medical Internet Research. 2020a; 22: e19452. https://doi.org/10.2196/19452

Li Q. Effects of Different Hemodialysis Treatments on Abnormal Mineral and Bone Metabolism in Patients with Chronic Renal Failure. Proceedings of Anticancer Research. 2020b; 4.

Li F, Wang Y, Shi S. Observation of the effect of closed-loop health management based on an internet platform in patients with peritoneal dialysis: a randomized trial. Annals of Palliative Medicine. 2021; 10: 7832–7840. https://doi.org/10.21037/apm-21-1402

Murali KM, Mullan J, Roodenrys S, Hassan HC, Lambert K, Lonergan M. Strategies to improve dietary, fluid, dialysis or medication adherence in patients with end stage kidney disease on dialysis: A systematic review and meta-analysis of randomized intervention trials. PLoS ONE. 2019; 14: e0211479. https://doi.org/10.1371/journal.pone.0211479

Mhammedi SA, Hamdi F, Benabdelhak M, Bentata Y, Haddiya I. Therapeutic compliance: another challenge for patients on chronic haemodialysis. Pan African Medical Journal. 2019; 33: 28. (In French)

Mir TH. Adherence Versus Compliance. HCA Healthcare Journal of Medicine. 2023; 4: 219–220. https://doi.org/10.36518/2689-0216.1513

Ni Z, Jin H, Jiang G, Wang N, Peng A, Guo Z, et al. A Telemedicine-Based Registration System for the Management of Renal Anemia in Patients on Maintenance Hemodialysis: Multicenter Study. Journal of Medical Internet Research. 2019; 21: e13168. https://doi.org/10.2196/13168

Pretto CR, Winkelmann ER, Hildebrandt LM, Barbosa DA, Colet CDF, Stumm EMF. Quality of life of chronic kidney patients on hemodialysis and related factors. Revista Latino-americana De Enfermagem. 2020; 28: e3327. https://doi.org/10.1590/1518-8345.3641.3327

Rahdar Z, Haghighi MJ, Mansouri A, Siasary A, Alahyari J, Jahantigh. F Probing the relationship between treatment regimen compliance and the quality of life in hemodialysis patients: A descriptive-analytic study. Medical-Surgical Nursing Journal. 2019; 8: e95599.

Song YJ. Construction and testing of a self-management scale for hemodialysis patients. Kaohsiung Medical University: Kaohsiung. 2009. (In Chinese)

Ware JE Jr. SF-36 health survey update. Spine. 2000; 25: 3130–3139.

World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA. 2013; 310: 2191–2194. https://doi.org/10.1001/jama.2013.281053

Wang YN, Hu HH, Zhang DD, Wu XQ, Liu JL, Guo Y, et al. The Dysregulation of Eicosanoids and Bile Acids Correlates with Impaired Kidney Function and Renal Fibrosis in Chronic Renal Failure. Metabolites. 2021; 11: 127. https://doi.org/10.3390/metabo11020127

Yao J, He W, Chen H, Qi Y. Nursing effect of continuous nursing intervention based on "Internet Plus" on patients with severe adrenal tumor. Medicine. 2023; 102: e33187. https://doi.org/10.1097/MD.0000000000033187

Zhou X, Zhong X, Qian J, Wu X, Yin J, Jiang X. Influence of "Internet plus" based continuous nursing intervention on hemodialysis self-management ability of patients with uremia and its countermeasures. Urinary and Renal Research. 2021; 2: 2028.

Zhang M, Guo S, Gan S, Xu Q. "Internet Plus" continuous nursing for patients with advanced bladder cancer: A retrospective observational study. Medicine. 2024; 103: e37822. https://doi.org/10.1097/MD.0000000000037822