Effectiveness of Patient Education on Reducing Non-Adherent Behaviours among Patients Undergoing Hemodialysis: A Scoping Review

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Abstract

Background. Non-adherence to treatment, medications, dietary requirements, and fluid restrictions are common issues among in-center hemodialysis patients leading to an increased risk for hospitalization and mortality. Non-adherent behavior is difficult to manage when patients do not have a clear understanding of their disease process. The purpose of this study is to review the literature on the effectiveness of patient education on nonadherence in End Stage Renal Disease (ESRD) patients undergoing in-center hemodialysis.
Methods. Using a scoping review approach, three databases were searched including PubMed, CINHAL Plus and MEDLINE. A total of 95 articles were retrieved. After titles and abstracts screening 15 articles were relevant and selected for full-text reviews. A total of 8 articles met the inclusion and exclusion criteria for data extraction.
Results: Of the eight included articles, five studies investigated adherence to dietary phosphate and phosphate binders, two examined adherence to treatment, and one explored diet and fluid restrictions. All eight of the articles focused on effectiveness of education interventions on nonadherent behaviour in patients. The findings of this review indicate that patient education has improved patient's adherence.
Conclusion. The scoping review indicated that patient education in an in-center hemodialysis setting has a positive impact in improving adherence to diet, medication use, fluid restrictions, and treatment. These findings highlight the critical role of nephrology nurses in delivering structured education interventions and support the development of nurse-led education frameworks to improve patient outcomes. Future research is needed to establish a standardized framework for the implementation of patient education programs and to further identify the influence on patient education provided by all members of a multidisciplinary team.
Keywords: noncompliance or nonadherence, hemodialysis, patient education

End Stage Renal Disease (ESRD) is a demanding chronic illness often resulting in hemodialysis. Hemodialysis is a renal replacement therapy in which the patient's blood is cleaned of excess toxins and fluid by using an arteriovenous (AV) access or central venous catheter (CVC) (Fernandes & Dsouza, 2022). Hemodialysis treatment can be disruptive to patients' lives, requiring many treatment hours, usually ordered for four hours, three times per week, and attention to diet and medications (Ok et al., 2019). Adherence in hemodialysis is defined as the agreed parallel between patient behavior and the recommendations provided by a variety of healthcare professionals (Nowicka et al., 2021; Ozen et al., 2019). Adherence with hemodialysis orders, diet, medication, and lifestyle changes is critical for ensuring life expectancy and quality of life (Fernandes & Dsouza, 2022; Nowicka et al., 2021; Sultan et al., 2022; Sukartini et al., 2022). Non-adherence to hemodialysis has been reported as a significant risk for hospitalization and mortality among patients (Nowicka et al., 2021). Nonadherence with diet and fluid restrictions can lead to consequences such as bone demineralization, pulmonary edema, development and/or worsening of cardiovascular disorders, and death (Ozen et al., 2019). However, to increase adherence, patients need a better understanding and motivation to attend treatment which may be accomplished with patient education (Miyata et al., 2017). Nurses play a central role in the delivery of care and education in hemodialysis settings. Understanding the effectiveness of educational interventions is essential to inform evidence-based nursing practice and improve patient outcomes.

Background

Nonadherent behaviours among patients include missed treatments, decreased care of vascular access, poor dietary restrictions, large interdialytic weight gain (IDWG), late arrivals for treatment, or disruptive behavior during treatment (Parsons et al., 2021). Al Salmi et al. (2018) link nonadherence with poor education about ESRD, illness management, patient's desire for more control, age, and travel time to the nearest hemodialysis treatment center. In some countries, up to 24% of patients are missing at least one hemodialysis session in a 4-month period (Al Salmi et al., 2018). Patients may also experience barriers to healthcare facility access due to the financial burden of transportation, medication, mistrust of the medical system, psychological stress, and poor understanding of treatment benefit (Sawinski et al., 2022).

Transitioning to in-center hemodialysis can be an overwhelming process for patients. Miyata et al. (2017) emphasize that patients cannot be expected to effectively manage their health without a clear understanding of the progression and obligation of End Stage Renal Disease (ESRD) and hemodialysis. A lifelong commitment to food, fluid restrictions, medications, and hemodialysis orders are required to ensure quality of life (Sukartini et al., 2022). Patients and family assisting in their care must adjust their lifestyle and availability to meet the requirements associated with hemodialysis treatment to achieve optimal outcomes (Ok et al., 2019). However, non-adherent behavior is common for hemodialysis patients as it is difficult to adapt to the required lifestyle changes (James et al., 2021).

Mishel's Uncertainty in Illness theory focuses on the cognitive processes that an individual may face when coping with stress due to an uncertain health-related situation (Zhang, 2017). When patients and their families are experiencing uncertainty, it is necessary for all healthcare professionals to recognize and acknowledge psychological consequences and identify coping

strategies and interventions to manage stressors (Zhang, 2017). Patients often lack adequate knowledge about chronic kidney disease and are unaware of the serious consequences associated with nonadherent behaviors (James et al., 2021). Therefore, providing education and resources to patients from healthcare professionals may improve adherence, thus enhancing patients' quality of life (Fernandes & Dsouza, 2022). The purpose of this study is to review existing literature on the effectiveness of patient education provided by healthcare providers on reducing nonadherent behaviours among patients undergoing in-center hemodialysis.

Method/Design

This scoping review followed the methodological framework proposed by Arksey and O'Mally (2005). A scoping review helps identify what is known and not known about the causes and interventions for nonadherence for in-center hemodialysis patients. Arksey and O'Malley's (2005) framework identifies the following 5 stages to map relevant literature and are as follows: Stage 1 identifying the research question, Stage 2 identifying relevant studies, Stage 3 study selection, Stage 4 charting the data, Stage 5 collating, summarizing, and reporting the results.

Stage 1: Identifying the Research Question. The research question for this project is 'What is known from the existing literature about the impact of patient education provided by healthcare professionals on the adherence behaviours of patients receiving in-center hemodialysis?' For the purpose of this scoping review the terms non-compliance and non-adherence are used interchangeably. Nonadherence regarding hemodialysis treatment, medication regimens, interdialytic weight gain, and diet restrictions were all considered valid topics. In this review healthcare professionals include nephrologists, nurses, dietitians, and pharmacists.

Stage 2: Identifying relevant studies. Electronic databases, Pubmed, Medline, and CINHAL Plus were used to search peer-reviewed publications within the last ten years. The search terms and inclusion/exclusion criteria were developed by examining relevant articles. Inclusion criteria included: relates to the research question, focuses on in-center hemodialysis patients, clear connection to any healthcare profession associated with hemodialysis patients, adults ages eighteen plus, published after January 1, 2012, peer-reviewed literature using any research design, printed in English, and full-text available online. Only in-center hemodialysis patients are included due to the requirement of consistent attendance to a healthcare facility, usually three times weekly, and dependance on healthcare staff to provide hemodialysis treatment. Exclusion criteria included: articles specific to home hemodialysis, peritoneal dialysis, or kidney transplant, pediatric patients under eighteen years of age, and articles published before January 1, 2012.

Stage 3: Study Selection. Databases were searched using the keywords 'noncompliance' or 'nonadherence', 'hemodialysis', and 'patient education'. Literature was selected after screening titles and abstracts, and full-text review to ensure the inclusion criteria were met. A study selection flow diagram is presented in Figure 1.

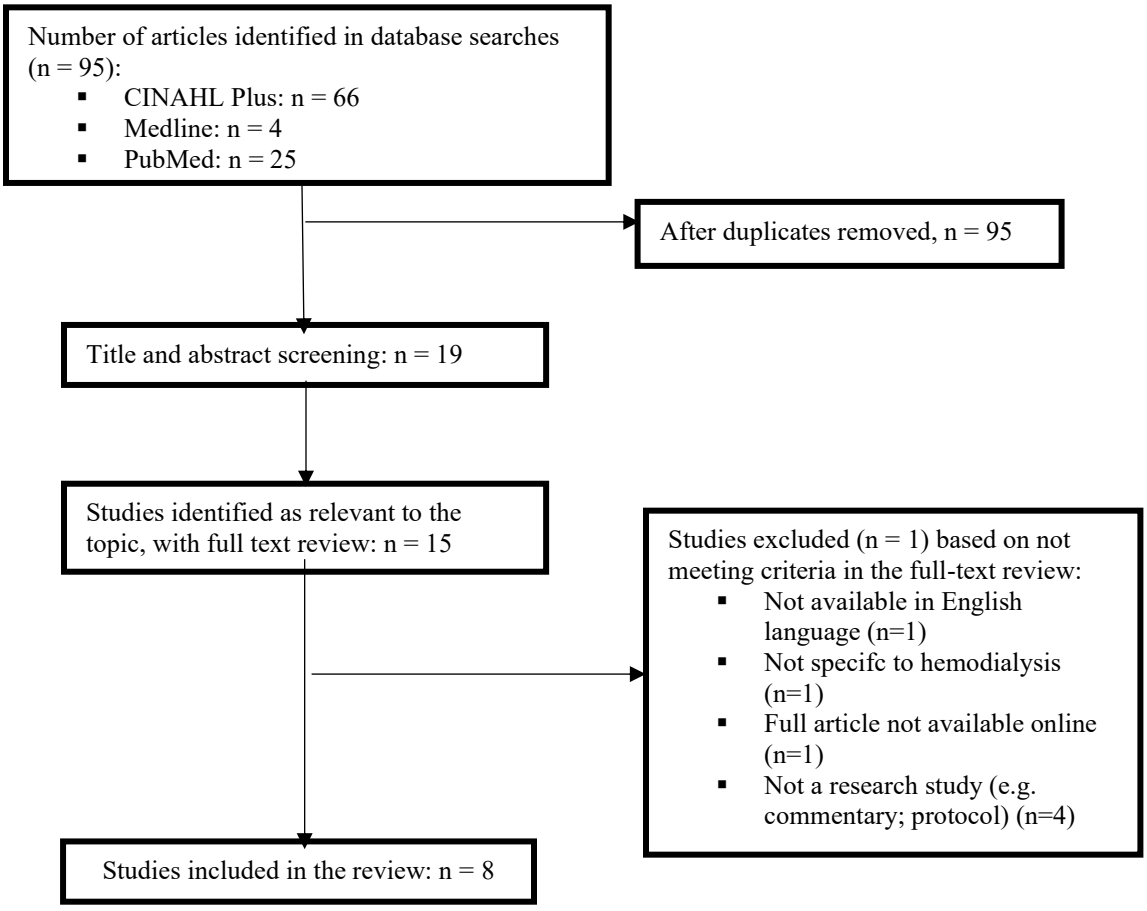
Stage 4: Charting the Data. Selected articles are organized in a summary table including author, date, country, study design, study aim, sample, interventions, and major findings (Table 1, p. 13).

Stage 5: Collating, summarizing, and reporting the results. The results were organized by common topics and collated in relation to phosphate control through diet and medication adherence, and fluid and treatment adherence.

Results

A total of 95 articles were retrieved. There were no duplicates, therefore, 95 articles underwent title and abstract screening. Of these 95 articles, 15 met the inclusion criteria and proceeded to full text review. After full-text review, a total of 8 were relevant and selected for data extraction. All selected articles had a focus on patient education to reduce nonadherent behaviours among in-center hemodialysis patients. See study selection flow diagram below.

FIGURE 1. STUDY SELECTION FLOW DIAGRAM



Summary of Study Characteristics

The included studies were quantitative and published in a variety of dates and countries. Of these studies, three were published in 2013, one in 2018, two in 2019, and two in 2021. The studies were conducted one each in the following countries: Iran, Turkey, USA, Norway, Korea, India, Australia, and China. Of the eight included articles, five studies focused primarily on

adherence to dietary phosphate and phosphate binders, two focused on adherence to treatment, and one focused on diet and fluid restrictions. A total of 781 hemodialysis patients were involved in the selected studies. A summary of the studies is presented in Table 1 (p.14), which consists of the following pages.

Four primary factors of hemodialysis adherence including dietary requirements, medication use, fluid restrictions, and attendance to dialysis treatment had been found to be the focus on the patient education interventions in this review.

Phosphate Control through Diet and Medication Adherence

Hyperphosphatemia is common among hemodialysis patients as phosphorus can only be partially removed by hemodialysis treatment (Lim et al., 2018). Uncontrolled hyperphosphatemia can lead to mineral bone disorder, vascular stiffening and calcification leading to a higher risk of cardiovascular mortality (Hjemas et al., 2019; Lim et al., 2018). Serum phosphorus levels can be controlled by medication or diet but is often best managed by following diet restrictions and utilizing phosphate binder medication.

Five articles focused on phosphorus control, including education on diet and medication use, and other interventions. Brogdon's (2013) study provided educational brochures to patients and individualized information regarding self-care and showed an increase in patient knowledge and understanding to high phosphorus foods and symptoms of hyperphosphatemia. Hjemas et al. (2019) reviewed patients' bloodwork before and after the intervention, provided pharmacist led counselling during dialysis sessions, provided educational leaflets to patients, and showed a statistically significant increase in patient knowledge post intervention. Lim et al. (2018) provided 30-minute education sessions with leaflets, assessed laboratory values before and after the intervention, and the education was provided by dieticians and pharmacists. Lim et al. (2018) study showed improvement in dietary phosphate intake, phosphate to protein ratio, and patient knowledge, however, was not statistically significant. In Sandin et al. (2013) study, the dialysis nurses were provided with two 30-minute education sessions to ensure education consistency, nurses then provided individualized patient education at each dialysis session. Patients were awarded points when laboratory values were desirable, and when they brought their phosphate binders to treatment (Sandin et al., 2013). Sandin et al. (2013) study showed a statistically significant improvement in patients taking phosphate binders correctly. Lastly, the Yin et al. (2021) study provided several interventions including the First Principles of Instruction Model, educational booklet for patients, group-based lectures for patients and their families, question and answer sessions, individualized patient education at the bedside, and a bulletin board, multimedia videos, and social media to emphasize patient education topics. The results showed a significant improvement in patient's knowledge of phosphate, serum phosphate levels, and adherence to phosphate binders (Yin et al., 2021). The First Principles of Instruction Model has traditionally been used in school education, however, as shown in Yin et al. (2021) study it can be successfully applied to patient education in the hospital setting.

All five studies focusing on phosphate control showed an increase in patient knowledge and adherence to phosphorus medication post intervention, however not all were statistically significant. Likewise, all studies that provided patient education showed an improvement in

adherence to diet, fluid, and treatment in general. Interventions lasted anywhere from 3 months to 6 months and follow-up occurring up to 5 months post intervention in the Hjemas et al. (2019) study.

Fluid and Treatment Adherence

The primary focus of Arad et al. (2021) was to increase adherence to hemodialysis treatment by providing an educational booklet about diet, medication use, and fluid restrictions. Adherence to all these factors are important to improve quality of life and avoid complications. In this study, nurses provided a telephone follow-up twice weekly, lasting approximately twenty minutes, and a daily text message to discuss an adherence topic. Interventions were measured using questionnaires and monitoring patient's laboratory results, which revealed a significant improvement in medication adherence, fluid restriction, hemodialysis attendance, and dietary restrictions (Arad et al., 2021). Baser and Mollaglu's (2019) interventions included four education sessions delivered by the researcher, a nutrition education booklet, patient interviews, and follow up on interdialytic weight gain and blood pressure to monitor fluid restrictions, which showed statistically significant in enhancing adherence. Nair and Edison's (2013) article focused on improving knowledge and psychological well-being to increase adherence to hemodialysis treatment by utilizing semi-structured interviews including questions about the hemodialysis procedure, dietary restrictions, care of vascular access, and prevention of complications. The results indicated a significant improvement in knowledge and psychological distress post-intervention (Nair & Edison, 2013).

Discussion

This review focused on research that examined reducing hemodialysis nonadherence through educational interventions. The findings of eight articles demonstrated that educational interventions can be an effective way to improve adherence among patients who receive hemodialysis.

Patient Education delivered by Multidisciplinary Care Team

Education provided by a variety of healthcare professionals prior to the initiation of hemodialysis and before treatment at each dialysis session can improve patient understanding of fluid restrictions (Miyata et al., 2017; Sukartini et al., 2022). Frequent face-to-face education regarding fluid and dietary requirements is more likely to facilitate discussion and allow healthcare professionals to provide the opportunities to interact with patients and family, and provide additional resources (e.g., food lists, recipe ideas, and discussing initial patient and family concerns) (Fernandes & Dsouza, 2022; Sukartini et al., 2022).

Reasons for noncompliance may change over time, it is essential for healthcare professionals to establish a trusting and collaborative relationship with patients to provide adequate support and individualized patient care to meet their needs (Ozen et al., 2019; Parsons et al., 2021). Information and resources provided should also be consistent between the multidisciplinary team to decrease the risk of patient confusion and potential mistrust of team members (Sukartini et al., 2022). For example, to increase patients' involvement of their care, an

online system where patients can easily view their own bloodwork results, which showed increased adherence to care as patients may be more motivated to learn and understand the treatment progress (Miyata et al., 2017). While patients are being educated on understanding their laboratory results, it can be rewarding for the patients when they see the improved results (Gilad et al., 2020).

The benefits of utilizing a multidisciplinary care team to provide patient education have been discussed in some studies. Milazi et al. (2021) describe in a hemodialysis center that nurses provide educational support, dietitians encourage dietary restrictions and education, and pharmacists provide education regarding how and when to take medications. Sandin et al. (2013) suggest that nurses are in the strongest position to provide education and influence change as they are in daily contact with patients, while the same study also emphasizes that nurses lack the time to provide the amount of education needed to manage compliance issues, therefore, the support of a multidisciplinary team would be beneficial. Additionally, transfer of knowledge into behavior change requires collaboration between multidisciplinary team members and patients and families (Yin et al., 2021).

Influences of Mental Health on Adherence Behaviour

A lifelong commitment to diet and fluids can be challenging. Patients may feel hopelessness and decide to give up, which results in failure to adhere to dietary recommendations leading to further deterioration of kidney disease (Fernandes and Dsouza, 2021; Sukartini et al., 2022). Depression and anxiety are common for hemodialysis patients often caused by ineffective coping mechanisms, which has been associated with impaired quality of life due to withdrawal from hemodialysis treatment, diet restrictions, and education (Kim & Kim, 2019; Skoumalova et al., 2020). In addition, anxiety and depression also decrease self-management behaviour and can impede engagement with healthcare professionals (Skoumalova et al., 2020).

It is important to integrate a psychological support program into patient's treatment plan in addition to education programs to reduce depression and anxiety among hemodialysis patients (Kim & Kim, 2019). For example, in James et al. prospective study (2021), providing counselling before and after dialysis treatment showed improvement in adherence to treatment sessions, diet, and fluid, and increased quality of life (James et al., 2021). Furthermore, during counselling sessions, healthcare providers assessed patient and families' satisfaction with their hemodialysis experience, which provided opportunity to determine appropriate interventions and resources for improvement (James et al., 2021).

Cognitive Behavioral Intervention (CBI) can also be an effective strategy to increase hope and manage anxiety and depression for hemodialysis patients since changing a patient's behavior and response to negative feelings is the most effective way to improve their mindset (Saki et al., 2022). In Saki et al. (2022) randomized control trial study, after an eight week trial of CBI, the intervention group demonstrated significantly increased level of hope, and improvement of anxiety symptoms, while the control group did not show any changes in terms of hope and anxiety.

Family Support and Adherence

Incorporating family members into education sessions is beneficial as they are often assisting with daily care and provide psychological support (Brogdon, 2013; Yin et al., 2021; and Hiemas et al., 2019). It is common for family members to assist with meal preparation, provide medication, and fluids (Baser & Mollaoglu, 2019; Hjemas et al., 2019). The family can discuss any concerns and emotions associated with hemodialysis treatment and increase patient certainty in following diet and fluid restrictions, and medication regimens (Sukartini et al., 2022).

For instance, phosphorus control is often difficult to maintain due to phosphorus being widely used as a food preservative. When patients have a high phosphorus level, it may be due to a lack of ability for the patient and their family to read food labels and understand the impact of the ingredients (Sawinski et al., 2022). Adherence to diet can be improved by providing education to patients and their family through nutritional counselling and education provided by a variety of healthcare professionals including nursing, nephrologists, pharmacists, and dieticians (Fernandes and Dsouza, 2021). When families are able to assist in caring for their loved one they are likely to monitor food and fluid intake, and provide emotional support through the preparation and encouragement of a renal diet (Sukartini et al., 2022). Family support has indicated increased confidence, emotional well-being, and improved self-care among patients (Kim & Kim, 2019; Sukartini et al., 2022).

Future Research

First, to reduce hemodialysis nonadherence, Pierratos (2013) suggested to develop a standardized framework for patient education in all dialysis centers to ensure that patients are provided with up-to-date information and is consistent between healthcare teams and facilities. Second, the patient's behaviour and stage of change can influence the effectiveness of education programs, thus psychological assessment is necessary to understand patient needs. Third, given that each member of a multidisciplinary team has specialized renal knowledge in their profession, it is important to include all members of a multidisciplinary team to study the effectiveness of patient education in hemodialysis. Finally, more longitudinal studies are required to determine the long-term effectiveness of the educational interventions (Murali et al., 2019).

Limitations

There are several limitations in this review. First, there were limited research articles specific to patient education in in-center hemodialysis. Second, many of the studies had small sample sizes which may affect the internal and external validity (Faber & Fonseca, 2014). Third, there were no longitudinal studies to determine whether the educational interventions are sustainable long term. Fourth, the interventions in the included articles were provided by different health care professionals, such as, pharmacists, dietitians, or nurses, however, none of them was implemented by a multidisciplinary team.

Conclusion

This study reviewed literature on the effectiveness of patient educational interventions on nonadherence in in-center hemodialysis. The findings indicated that educational interventions could improve knowledge and reduce nonadherent behaviours among patients who receive in-center hemodialysis. These findings are relevant to nursing practice as nephrology nurses play a crucial role in delivering patient education in hemodialysis settings. Implementing evidence-based practice guidelines may enhance patient outcomes and reduce complications associated with nonadherence. Future research is needed to develop a standardized framework for the implementation of patient education programs delivered by multidisciplinary teams. Further research is also needed to investigate the effectiveness of this approach to patient education programs and to overall patient health outcomes.

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Conflicts of Interest

The Authors declare that there is no conflict of interest.

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Table 1. SUMMARY OF SELECTED STUDIES

Author (year), country	Study Design	Study Aim	Sample	Measures	Interventions	Major Findings
Arad et al., (2021), Iran	Randomized Control Trial	To Determine the effects of patient education and nurse-led telephone follow up on adherence to treatment in hemodialysis	• 66 patients • 33 in Control group	• Demographic questionnaire • Laboratory results record • ESRD Adherence Questionnaire (ESRD-AQ) • Assessed four dimensions of hemodialysis compliance: attendance, medication use, fluid restrictions and diet recommendations. • Intervention for 3 months	• Patient education program on four factors: diet, medication use, and fluid restrictions using education booklet. • Nurse-led follow up by telephone twice weekly, each call lasting 20 minutes, and a daily text message regarding an adherence topic • Questionnaire pre and post intervention • Assessed before intervention and immediately, 1 month, and 3 months after intervention	• Difference in HD attendance was not statistically significant ($P = 0.269$), before the intervention, however, was statistically significant immediately, 1 month, and 3 months post intervention, ($P < 0.001$). • Difference in medication adherence was statistically significant immediately, 1 month, and 3 months post intervention, ($P < 0.001$). • Difference in adherence to fluid restrictions was statistically significant immediately, 1 month, and 3 months post intervention, ($P < 0.001$). • Difference in adherence to diet restrictions was statistically significant immediately, 1 month, and 3 months post intervention, ($P < 0.001$). • Difference in total treatment adherence was statistically significant immediately, 1 month, and 3 months post intervention, ($P < 0.001$). • Limitations: small sample size and short-term follow up period.

Baser & Mollaoglu (2019), Turkey	Prospective Cohort study	To investigate the effect of the training program on hemodialysis patients' adherence to diet and fluid restrictions	• 78 patients • 40 in control group	• Sociodemographic questionnaire • Dialysis diet and fluid nonadherence questionnaire (DDFQ) • Fluid control in hemodialysis patients scale (FCHPS)	• Four education sessions across 4 months by researcher. • Nutrition education booklet • Patients interviewed four times, once at each month. • Clinical parameters were recorded including interdialytic weight, UF volume and blood pressure	• Significant improvement in interdialytic weight gain, pre SBP, and post DBP, ($P < 0.05$). • No statistical significant in dry weight and UF volume. • statistically significant difference ($P < 0.05$) between the mean scores obtained from the FCHPS ($t = 6.505$ $P = 0.000$) and its knowledge ($t = 5.271$ $P < 0.05$), behavior ($t = 4.608$ $P = 0.000$) and attitude ($t = 4.299$ $P < 0.05$) • The patients in the 35-50 age group had statistically significant higher scores from the frequency of nonadherence to diet and fluid restriction than other age groups. ($P < 0.05$) • participants in the 65 and over age group obtained higher scores from the attitude and behavior subscales ($P < 0.05$)
Brogdon (2013), USA	Quasi-experimental study	To provide an overview of the use of self-care education to improve knowledge of dietary phosphorus control in hemodialysis patients	10 patients (6 male, 4 female) recruited from one nephrology practice	• Pre-test/post-test • Brochures	• Pretest/ post test with 'The Diet Education and Hemodialysis Patients' Knowledge Test' • A brochure 'The Renal Diet: Phosphorus Control' was given to patients after the pre-test	• On the knowledge test the average score change was increased by 38% on post-test when compared to pre-test scores • Average score increased by 32.5% on post-test when identifying signs and symptoms of increased phosphorus. • Average score increased by 58.3% on post-test when identifying foods high and low in phosphorus.

					• Self-care education reviewed by nurse with each individual patient	
Hjemas et al., (2019), Norway	Quasi-experimental study	To investigate patient knowledge, beliefs about adherence to phosphate binders and assess whether one-to-one pharmacist-led education and counselling enhance adherence and lead to changes in phosphate levels	• 69 patients	• Medication Adherence Report Scale (MARS) • Beliefs about Medicines Questionnaire (BMQ)	• Serum phosphate levels were collected 5 months prior to intervention and 5 months after • A semi-structured counselling guide • Educational leaflet provided. • Interventions were during dialysis treatment and provided by a pharmacist.	• The type of phosphate binder used was not associated with having serum phosphate at target level. • Serum phosphate for patients below target had no statistical change post intervention ($P = 0.593$) • Serum phosphate for patients above target had a positive change, however, not statistically significant ($P = 0.218$). • No statistical change was seen after using MARS-5 ($P = 0.258$). • Statistically significant increase in patient knowledge post intervention, (CI: 2.165, 3.570; $P = 0.001$)
Lim et al., (2018), Korea	Randomized control trial	To evaluate the efficacy of education on low-phosphate diet and proper phosphate binder intake.	70 patients 22 in control group	• Collected monthly lab results. • One Face-to-Face education session with each patient • Morisky Medication Adherence Scale-8 (MMAS-8) • Drug Compliance Questionnaire	• Education sessions with leaflets for 30 minutes • Laboratory profiles assessed at 1 month after intervention and 2 or 3 months after intervention. • Dietitians and pharmacists provided teaching to education group then met with each patient individually	• Education increased patients' knowledge of when to take phosphate binders, but not statistically significant (P = 0.087). • Information on phosphate-to-protein ratios in different foods should be included in education and focus on reducing processed foods. • Polypharmacy is one of the primary factors for medication noncompliance. • Improvement in calcium phosphorus product was not significant ($P = 0.430$).

				• Patient Generated Subjective Global Assessment (PG-SGA) • Dietary assessment by 3 day recall		• For dietary phosphate intake, both groups showed slightly reduced intakes ($P = 0.851$). • For dietary phosphate-to-protein ratio, the education group showed a lower ratio, but not statistically significance ($P = 0.193$). • Providing education on phosphate restriction did not affect dietary protein intake ($P = 0.569$) or PG-SGA score ($P = 0.363$). • MMAS-8 Score improved in education group (P=0.445)
Nair & Edison (2013), India	Quasi experimental study	To assess the effect of planned nursing interventions on compliance among hemodialysis patients	• 60 patients • Control group n=30	• Compliance assessment tool (CAT) • Assessment of bloodwork • Psychosocial assessment tool (PAT-5)	• Pre-test/post-test • Semi-structured interviews	• A focus of improving knowledge and psychological well-being is crucial for hemodialysis patients • Mean post-test knowledge score is significantly higher than pre-test knowledge ($P = 0.001$), for experimental group. • Mean post-test score of psychological distress is significantly improved from pre-test score, ($P = 0.000$), for experimental group • No significant changes for control group.
Sandin et al., (2013), Australia	Quasi experimental study	To examine the impact of a nurse-led education intervention on bone disorder markers, adherence to	• 62 patients	• Bloodwork • Pre-test/post-test Interview survey	• All nursing staff were provided two 30-minute education sessions prior to the patient intervention to ensure consistency, and refresh knowledge of phosphate binders.	• Statistically significant improvement post intervention of patients who took their phosphate binders correctly (44% to 72%, $P = 0.016$) • Moderate effect size for serum phosphorus but no statistical significance

		phosphate binder medication and medication knowledge			• 12 week program • Individualized education provided by nursing staff at each dialysis session	• No significant change for PTH • Moderate effect size for serum calcium but no statistical significance • A decrease in patients feeling they need help to understand how to take phosphate binders (50% to 29%) • Increase in patient's understanding the importance of taking phosphate binder with food (50% to 72%)
Yin et al., (2021), China	Non-randomized, single-arm, single-center trial	To develop an intensive education program focusing on phosphate control among hemodialysis patients	• 366 patients	• Patient Questionnaire on phosphate control knowledge • Medical adherence report scale (MARS) • Demographic questionnaire	• 6 month program using First Principles of Instruction model • Patient booklet on phosphate control • Patients are required to demonstrate what is learned. • Group-based lectures to patients and family members before dialysis treatment by healthcare team (3 Nephrologists, 8 RNs) • Individualized patient education at the bedside • Bulletin board, multimedia videos and social media were used to continue patient education	• Average scores of phosphate knowledge were significantly increased after the education program: 59 +/- 18.9 to 80.6 +/- 12.4 ($P < 0.001$). • Adherence to phosphate binders increased from 21.9% before education program to 44.5% after the program. • Controlled serum phosphate significantly increased from 43.5% to 54.9%, $P < 0.001$). • First Principles of Instruction model can be successfully applied to patient education. • The average scores of adherence to phosphate binders significantly increased from 18.8 +/- 3.7 to 22.5 +/- 2.9, ($P < 0.001$).

