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Kanyanat Ummee
Faculty of Public Health, Chiang Mai University, kanyanat.f1@gmail.com

Kittipan Rerkkasem
Department of Surgery, Faculty of Medicine, Chiang Mai University; Research Institute of Health Science, Chiang Mai University, rerkase@gmail.com

Jukkrit Wungrath
Faculty of Public Health, Chiang Mai University, jukkrit.w@cmu.ac.th

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The Effect of Fluid Overload Control Program on Knowledge and Behavior Among Caregivers of End-Stage Renal Disease Patients on Hemodialysis

Kanyanat Ummee[1], Kittipan Rerkkasem[2,3], Jukkrit Wungrath[1*]

[1]Faculty of Public Health, Chiang Mai University, Chiang Mai, Thailand, [2]Department of Surgery, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand, [3]Research Institute of Health Science, Chiang Mai University, Chiang Mai, Thailand

Abstract

End-stage renal disease (ESRD) is a pressing health issue, and patients on hemodialysis frequently grapple with fluid overload. In Chiang Mai, Thailand, from September to November 2022, this study was conducted to assess the impact of an educational program on the knowledge and behavior of caregivers managing fluid overload in ESRD patients. Using a quasi-intervention design, participants were categorized into two groups: the intervention group, which underwent the educational intervention, and the control group, which continued with standard care. The educational content was grounded in existing studies and insights from healthcare professionals, caregivers, and patients. Post-intervention results revealed a significant enhancement in the knowledge and behavior of caregivers in the intervention group regarding fluid overload control compared to the control group (p-value<0.05). This study emphasizes the potential benefits of structured and evidence-based educational initiatives in equipping caregivers with the tools they need to better manage fluid balance, ultimately leading to improved patient outcomes.

Keywords: caregivers, end-stage renal disease, fluid overload, hemodialysis

Introduction

End-stage renal disease (ESRD) is a global public health concern affecting millions of people worldwide.[1] In Thailand, the prevalence of ESRD has risen significantly over the past five years (2018-2023).[2] According to the Thai Renal Registry, the number of ESRD patients in Thailand has increased from approximately 48,000 in 2018 to more than 58,000 in 2020.[3] In Chiang Mai, a major city in the Northern Thailand, the number of ESRD patients has also shown a steady increase, with over 3,000 patients currently receiving life-sustaining hemodialysis treatment.[4] The health status and quality of life of ESRD patients are often compromised due to the progressive nature of the disease and the burden of ongoing hemodialysis treatment.[5] Patients with ESRD frequently experience debilitating symptoms, such as fatigue, muscle cramps, and insomnia, significantly impacting their daily functioning and overall well-being.[6]

Furthermore, these patients often suffer from multiple comorbidities, such as cardiovascular disease, diabetes, and anemia, which exacerbate the challenges they face in managing their health.[7] Hemodialysis removes waste products from the blood and helps manage fluid balance, but it also presents challenges, such as fluid overload, which is a common complication among ESRD patients.[8] Fluid overload in ESRD patients can have severe consequences on their health and overall well-being. The impacts and effects of fluid overload include increased blood pressure, additional strain on the heart, and exacerbation of existing cardiovascular conditions.[9-11] This can lead to life-threatening complications, such as congestive heart failure, pulmonary edema, and even death.[12,13]

One of the critical factors contributing to fluid overload in ESRD patients is the lack of suitable knowledge and practice among caregivers who are responsible for the care and treatment of these patients.[14,15] Many caregivers, often family members, lack the necessary understanding of the complexities of ESRD and the skills to effectively manage fluid balance in patients undergoing hemodialysis.[16] As a result, patients may experience fluid overload, leading to further health complications and reduced quality of life.[17,18]

Despite several attempts to improve the knowledge and practice of caregivers of ESRD patients, previous studies and interventions focusing on fluid overload

Correspondence*: Jukkrit Wungrath. Faculty of Public Health, Chiang Mai University, Chiang Mai, Thailand 50200, Email: jukkrit.w@cmu.ac.th, Phone: +66 81-595-9638*

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control have been limited and insufficient. This gap in the literature highlights the need for a more comprehensive and targeted approach to address the specific needs of caregivers in managing fluid balance in ESRD patients.[19,20] This study aimed to bridge this gap by developing and implementing a tailored education and self-management program for caregivers of ESRD patients undergoing hemodialysis in Thailand. This program will be designed based on the existing literature's findings and input from healthcare professionals, caregivers, and patients to ensure that it effectively addresses the unique challenges faced by this population.[21] Equipping caregivers to better control fluid balance can significantly improve patient health outcomes and optimize resource utilization in public healthcare. Learnings from this comprehensive caregiver education program could inform future public health policies and practices globally.[22]

Furthermore, this study would employ a rigorous evaluation framework to assess the impact of the intervention on caregivers' knowledge and practice, as well as patient health outcomes related to fluid overload control. This will help determine the program's effectiveness and provide valuable insights for future studies and practice in this area.[23,24] Ultimately, this should result in improved patient health, reduced risk of fluid overload, and an enhanced quality of life for both patients and caregivers.[25] Moreover, the study would investigate the effectiveness of the adapted fluid overload control program by evaluating the changes in caregivers' knowledge, attitudes, and practices related to ESRD and fluid management.[21]

Additionally, this study would assess the program's impact on patient health outcomes, such as blood pressure, interdialytic weight gain, and hospitalization rates related to fluid overload complications.[26,27] This study offered a tailored educational program for caregivers of ESRD patients, aiming to enhance their skills and knowledge. By doing so, it not only promises improved health outcomes for patients on hemodialysis but also suggests a model that could be replicated globally, potentially leading to significant reductions in healthcare costs and elevating the quality of care for ESRD patients worldwide.

Method

This cross-sectional study was conducted at Hospital A in Chiang Mai Province, Thailand. The sample size was calculated using G*Power software, a free program, considering an alpha level of 0.05, a power of 0.80, and a medium effect size. The calculated sample size was 100 participants, equally divided into the intervention group (n = 50) and the control group (n = 50). Inclusion criteria were patients aged 18 years or older diagnosed with ESRD and receiving hemodialysis for at least three months prior to participating in the study. Exclusion criteria included patients with severe cognitive impairment, active malignancy, or requiring palliative care.

Purposive sampling was used to recruit caregivers meeting inclusion criteria. The authors approached eligible caregivers at dialysis centers and enrolled interested participants who consented. Once the target sample size was reached, participants were matched into pairs based on key characteristics. The matched sample was then randomly divided into intervention and control groups. Simple randomization was then used to allocate each pair to the intervention or control group. Matched pairs were assigned random numbers using computer software. Based on the numbers, one participant from each pair was allocated to the intervention and the other to the control groups. This random allocation after matching ensured comparable intervention and control groups, reducing selection bias.

The study tools used in the study were divided into three parts, which were developed based on a comprehensive literature review and expert consultations, including the authors team's physicians.

Part 1: Demographic data collection involved gathering information on the participants' age, sex, education level, occupation, duration of hemodialysis, and any comorbidities. Part 2: The Fluid Overload Control Knowledge Test was a 21 true-false multiple-choice questions test that assessed the participants' understanding of fluid overload control for caregivers of ESRD patients on hemodialysis. This test was developed by the authors based on the literature review. Part 3: The Fluid Overload Control Behavior Questionnaire was developed following the literature review. It contained 22 items, and a 5-point Likert scale was used to evaluate participants' fluid overload control habits and adherence to recommended practices. The scale ranged from "Never" to "Always," and participants rated their agreement with each statement or indicated the frequency of behaviors. This approach comprehensively captured participants' fluid overload control behaviors and adherence.

The Content Validity Index values for both research tools were found to be above the acceptable threshold of 0.86. Additionally, Cronbach's alpha coefficients for the fluid overload control knowledge test and fluid overload control behavior questionnaire were 0.803 and 0.807, respectively, demonstrating internal reliability.

The intervention group received a six-week education program through the Line application and telephone consultations from September to November 2022, while the control group received no intervention. Control participants were requested not to share study information, and authors team only interacted with the intervention group. Analyses comparing baseline character-

istics throughout the six-week study duration identified any contamination across groups. Communication via private Line groups and calls prevented sharing the educational intervention with controls. With measures including separate recruitment, limited interactions, supervised interventions, and baseline comparison, the study effectively prevented contamination of the control group.

The six-week intervention program for the intervention group combined on-site health education and telephone consultations to provide education, address challenges, and offer solutions to help participants effectively manage fluid overload.

Week 1 (26-30 September 2022): This week aimed to help participants identify unhealthy behaviors and set goals for changing them. Topics included identifying behavior triggers, developing action plans, and practicing self-monitoring. Week 2 (3-7 October 2022): This week focused on enhancing knowledge and self-awareness about controlling fluid excess. Topics covered the importance of controlling fluid intake, signs of excess fluid, and strategies for managing intake effectively.

Week 3 (10-14 October 2022): This week focused on experience sharing between caregivers and patients in managing excess fluid. Topics facilitated knowledge sharing and problem-solving related to the challenges faced in managing fluid, effective communication strategies, and ways caregivers can support patients. Week 4 (17-21 October 2022): This week reviewed knowledge on controlling excess fluid and focused on motivating and building confidence in practicing the skills learned. Topics reinforced previous knowledge and encouraged practicing fluid management techniques.

The telephone consultations were conducted by a qualified researcher using the "Brief Intervention Advice" technique during Week 5 (24-28 October 2022). The focus was on advising caregivers to increase their knowledge and skills in helping patients manage their fluid overload condition. Each consultation lasted approximately 5-10 minutes. Week 6 (31 October 2022) was a review of all the knowledge that had been taught, and a post-test was conducted.

During the 6-week study period, no specific intervention was given to the control group. Instead, they continued to receive regular care and followed standard fluid overload control recommendations from healthcare providers.

The data collected were analyzed using SPSS software (IBM Corp. 2021. IBM SPSS Statistics for Windows, Version 29.0). Descriptive statistics summarized baseline characteristics. In contrast, inferential statistics, including paired t-tests and independent t-tests, compared caregivers' knowledge and behavior regarding fluid overload within and between groups. Statistical significance was set at p-value<0.05.

Results

Demographic data analysis (Table 1) indicated that

Table 1. The Characteristics of Samples

Variable	Category	Intervention Group (n = 50)		Control Group (n = 50)		p-value
		n	%	n	%	
Sex	Male	19	38	12	24	0.13[a]
	Female	31	62	38	76	
Age (years)	<41	11	22	11	22	
	41-50	11	22	11	22	
	51-60	13	26	15	30	0.98[b]
	61-70	12	24	11	22	
	71-80	3	6	2	4	
Marital status	Single	13	26	11	22	
	Married	37	74	30	60	0.67[b]
	Divorced/Separated	0	0	9	18	
Education	Primary school	19	38	13	40.6	
	High school	19	38	19	47.1	0.64[b]
	Vocational/University	12	24	18	60	
Occupation	Employed	13	26	23	46	0.85[b]
	Unemployed	37	74	27	54	
Duration of hemodialysis (years)	<3	6	12	8	16	
	3-5	11	22	9	18	0.30[b]
	>5	33	66	33	66	
Any comorbidities*	Diabetes	25	50	23	46	
	Hypertension	43	86	40	80	0.11[b]
	Other	6	12	12	24	

Notes: [a] = Fisher's exact test (p-value<0.05), [b] = Chi-square test (p-value>0.05), *The respondent can choose to answer more than one disease that they have, so the total can add up to more than 50.

Table 2. Effectiveness of Fluid Overload Control Program on the Fluid Overload Control Knowledge Among Caregivers of End-Stage Renal Disease Patients on Hemodialysis

Fluid Overload Control Knowledge	Intervention Group		Control Group		p-value[a]
	Mean	Standard Deviation	Mean	Standard Deviation	
Before	14.82	1.64	14.36	2.02	0.21
After	17.80	2.79	15.10	2.52	p-value<0.05
p-value[b]	p-value<0.05				

Notes: [a] = Independent t-test, [b] = Paired t-test

Table 3. Effectiveness of Fluid Overload Control Program on the Fluid Overload Control Knowledge Among Caregivers of End-Stage Renal Disease Patients on Hemodialysis

Fluid Overload Control Behavior	Intervention Group		Control Group		p-value[a]
	Mean	Standard Deviation	Mean	Standard Deviation	
Before	4.11	0.72	3.95	0.62	0.25
After	4.54	0.37	4.15	0.58	p-value<0.05
p-value[b]	p-value<0.05				

Notes: [a] = Independent t-test, [b] = Paired t-test

the control and intervention groups had similar attributes. The control group comprised 12 men (24.0%) and 19 women (38.0%), with an average age of 2.64+1.17 years, while the intervention group included 19 men (38.0%) and 31 women (62.0%) with an average age of 2.70+1.23 years. The main causes of ESRD in both groups were diabetes (control: 46.0%; intervention: 50.0%) and hypertension (control: 80.0%; intervention: 86.0%). Both groups had comparable durations of hemodialysis treatment (control: 3.06±1.34 years; intervention: 3.36±1.42 years).

Mean pre-test and post-test scores to evaluate fluid overload control for the intervention group were 14.82 (SD = 1.64) and 17.80 (SD = 2.79), respectively, with the post-test average score significantly higher than the pre-test average score (p-value<0.05). Post-test mean scores for fluid overload control in the intervention and control groups were 17.80 (SD = 2.79) and 15.10 (SD = 2.52), respectively. The average fluid overload control knowledge score in the intervention group was significantly higher than in the control group (p-value<0.05), as shown in Table 2.

Mean pre- and post-test scores of fluid overload control behavior in the intervention group were 4.11 (SD = 0.72) and 4.54 (SD = 0.37), respectively, with the post-test average score significantly higher than the pre-test average score (p-value<0.05). Post-test mean scores for fluid overload control behavior in the intervention and control groups were 4.54 (SD = 0.37) and 4.15 (SD = 0.58), respectively, with average fluid overload control behavior score in the intervention group significantly higher than in the control group (p-value<0.05), as shown in Table 3.

Discussion

Results demonstrated significant improvements in fluid overload control knowledge in the intervention group after the intervention, consistent with related up-to-date field studies. Educational interventions are crucial to enhance knowledge and self-management skills for patients with chronic conditions such as heart failure or kidney disease. Previous studies showed that targeted educational programs led to better patient self-care behaviors and improved health outcomes.[28] McNaughton, *et al.*, found that a nurse-led education and support intervention significantly improved the self-care behaviors of patients with heart failure by focusing on fluid management, medication adherence, and symptom recognition.[29]

Similarly, Sbolli, *et al.*, demonstrated that tailored educational interventions that included individualized fluid management plans led to significant improvements in self-care behaviors and reduced hospital readmissions related to fluid overload.[30] Peng, *et al.*, conducted a systematic review and concluded that educational interventions, including fluid management education, improved self-management, reduced hospitalizations, and improved clinical outcomes for patients with chronic kidney disease.[31] This result was supported by the findings of a randomized controlled trial which found that a struc-

tured education program on fluid control inheart failure patients led to better adherence to fluid restrictions and improved fluid overload control knowledge.[32]

A previous study demonstrated that a web-based self-management program that included fluid control education improved knowledge, self-management skills, and clinical outcomes for patients with chronic kidney disease.[33] Post-test scores in the intervention group were significantly higher than in the control group, aligning with the consensus that well-designed interventions led to meaningful improvements in knowledge and self-management skills. These related studies reinforced the importance of implementing evidence-based educational interventions in clinical practices to help patients better understand and manage their health conditions, ultimately leading to improved health outcomes and quality of life.[34]

This study's findings aligned with a previous study indicating that comprehensively tailored educational intervention significantly improved caregivers' knowledge and practices related to fluid overload management.[34] A multi-modal delivery workshop combining take-home materials, Line group sharing, and telephone consultations facilitated knowledge acquisition and behavioral change by integrating interactive learning with ongoing support, with positive effects stemming from enhanced perceived self-efficacy, improved observational learning, and increased motivation through the intervention.[35]

Significant improvements in fluid overload control behavior were recorded in the intervention group, further emphasizing educational interventions' critical role in enhancing self-management skills and promoting better health behaviors. This is especially important for patients with chronic conditions such as heart failure or kidney disease, where effective fluid overload control is essential.[35] Several related studies supported these findings and reinforced the positive impact of educational interventions on fluid overload control behavior.[33,35] A tailored, self-management intervention for heart failure patients by Ha Dinh, *et al.*, demonstrated significant improvements in self-care behaviors, including fluid overload control.[36] The intervention was designed to address individual patient needs and involved teaching the patients to recognize and respond to changes in their symptoms. Dierckx, *et al.*, assessed the effects of a telephone-based self-management support program for patients with heart failure.[37] Their intervention included education on fluid management, with results leading to improved self-care behaviors and decreased hospital readmissions.

Another previous study investigated the effects of individualized educational intervention on self-management for patients with chronic kidney disease.[38] The intervention included fluid management, and results showed improved self-care behaviors, better fluid control, and reduced complications related to fluid overload. A randomized controlled trial by Huang, *et al.*, evaluated the impact of a nurse-led patient education program on self-care behaviors in heart failure patients.[39] This intervention focused on fluid management, with results demonstrating improved adherence to fluid restrictions and reduced hospital readmissions. At the same time, a previous systematic review and meta-analysis investigated the effectiveness of self-management interventions in heart failure patients.[40] This review concluded that fluid management education interventions improved self-management, reduced hospitalizations, and improved clinical outcomes.[40]

The post-test scores of the intervention group were significantly higher than the control group, aligning with the general understanding that well-designed interventions improved self-management skills and health behaviors. These related study results further supported the importance of implementing evidence-based educational interventions in clinical practices to help patients better understand and manage their health conditions, ultimately leading to improved health outcomes and higher quality of life. The multi-modal educational program improved knowledge and practices by enhancing self-efficacy, observational learning, and motivation through reinforcement by overcoming barriers through greater nurse access, providing ongoing support, and imparting practical guidance focused on actionable skills.[35]

This study demonstrated how tailored, evidence-based educational interventions delivered through innovative modalities empowered patients and caregivers to improve self-management behaviors, highlighting the role of strategic public health education in driving positive behavior change for enhanced population health outcomes. This study's results supported the effectiveness of policies aimed at integrating similar educational interventions into standard ESRD care, increasing investments in scalable patient education programs, leveraging technology for accessible delivery, establishing standardized curriculums, fostering partnerships to disseminate education, strengthening the training of providers on teaching self-management skills, and reforming insurance policies to enable a greater focus on patient education.

This study has both strengths and limitations that must be considered when interpreting the results. The strengths included focusing on a clinically relevant issue of fluid overload control, which is critical when managing chronic conditions such as heart failure and kidney disease. By targeting this issue, this study contributed valuable insights into improving patient outcomes and quality of life. This study expanded existing study in this field and strengthened the argument for the effectiveness of educational interventions in improving fluid overload

control knowledge and behavior among patients with chronic conditions.

However, some study limitations should also be noted. First, the participants might not represent the broader patient population with chronic conditions, affecting the results' generalizability. Second, this study only focused on short-term outcomes, with long-term results possibly providing a more comprehensive understanding of intervention effectiveness. Last, this single-center study did not account for variability in patient populations, practices, and resources, which would be better addressed through multi-center studies.

Conclusion

This study underscores the potential of tailored educational interventions to enhance the self-management capabilities of caregivers for ESRD patients on hemodialysis. Drawing parallels with existing literature, the study reaffirms the universal significance of such programs in chronic disease management. As the healthcare landscape evolves, integrating evidence-based educational strategies remains vital to ensuring optimal patient outcomes and quality of life. While promising, the findings also highlight the need for broader, multi-center study to further validate and expand upon these insights, ensuring a holistic understanding of the intervention's long-term efficacy and applicability.

Abbreviations

ESRD: End-stage Renal Disease.

Ethics Approval and Consent to Participate

The Ethics Research Committee of the Faculty of Medicine, Chiang Mai University, approved this study (approval code: SUR-2563-07657).

Competing Interest

The authors declared no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Availability of Data and Materials

Data used in this study is available from the corresponding author upon reasonable request.

Authors' Contribution

KU and JW were responsible for conceptualization and methodology. KU collected data and performed an investigation. JW wrote the original draft. JW and KR critically reviewed the manuscript. JW supervised the study. All authors read and approved the final manuscript.

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