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Recommended Citation
Ummee K, Rerkkasem K, Wungrath J. The Effect of Fluid Overload Control Program on Knowledge and Behavior Among Caregivers of End-Stage Renal Disease Patients on Hemodialysis. _Kesmas_. 2023; 18(4): -
DOI: 10.21109/kesmas.v18i4.6893
Available at: https://scholarhub.ui.ac.id/kesmas/vol18/iss4/7

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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

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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...
control have been limited and insufficient. This gap in
the literature highlights the need for a more comprehen-
sive and targeted approach to address the specific needs
of caregivers in managing fluid balance in ESRD
patients.\textsuperscript{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 pro-
gram will be designed based on the existing literature’s
findings and input from healthcare professionals, care-
givers, and patients to ensure that it effectively addresses
the unique challenges faced by this population.\textsuperscript{21} Equipp-
ing caregivers to better control fluid balance can signifi-
cantly 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.\textsuperscript{22}

Furthermore, this study would employ a rigorous
evaluation framework to assess the impact of the inter-
vention 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.\textsuperscript{23,24} Ultimately, this should result in impro-
ved patient health, reduced risk of fluid overload, and an
enhanced quality of life for both patients and care-
givers.\textsuperscript{25} Moreover, the study would investigate the
effectiveness of the adapted fluid overload control pro-
gram by evaluating the changes in caregivers’ knowledge,
attitudes, and practices related to ESRD and fluid mana-
gement.\textsuperscript{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.\textsuperscript{26,27} This
study offered a tailored educational program for care-
givers of ESRD patients, aiming to enhance their skills
and knowledge. By doing so, it not only promises im-
proved 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\textsuperscript{2}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 impair-
ment, 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 in-
terested 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 compre-
hensive literature review and expert consultations, in-
cluding the authors team’s physicians.

Part 1: Demographic data collection involved gather-
ing information on the participants’ age, sex, education
level, occupation, duration of hemodialysis, and any co-
morbidities. Part 2: The Fluid Overload Control Know-
ledge 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 state-
ment 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 inform-
ation, and authors team only interacted with the inter-
vention 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
behavior score in the intervention group significantly higher than in the control group (p-value<0.05), as shown in Table 2.

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

<table>
<thead>
<tr>
<th>Fluid Overload Control Knowledge</th>
<th>Intervention Group</th>
<th>Control Group</th>
<th>p-value^a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Standard Deviation</td>
<td>Mean</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>Before</td>
<td>14.82</td>
<td>1.64</td>
<td>14.36</td>
</tr>
<tr>
<td>After</td>
<td>17.80</td>
<td>2.79</td>
<td>15.10</td>
</tr>
<tr>
<td>p-value^b</td>
<td>p-value&lt;0.05</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: ^a Independent t-test, ^b Paired t-test

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 in heart 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.

Acknowledgment
The authors gratefully acknowledge the Faculty of Public Health, Chiang Mai University, and Maharaj Nakorn Chiang Mai Hospital, Chiang Mai Province, Thailand. The authors also appreciate the cooperation of all participants in this study.

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Saengyo S, Rerkkasem K, Wungrath J. Effectiveness of a Line Application Together with Telephone-Based Consultation and Education Program on The Dietary Knowledge and Behavior Among Caregivers of End-Stage Renal Disease Patients on Hemodialysis. Malays J Public Health Med. 2023; 23 (2): 282-90. DOI: 0.37268/mjphm/vol.23/no.2/art.2214


