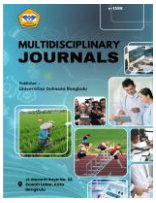

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Application of 30° Upper Extremity Elevation for Edema Reduction in Patients with Hypervolemia: A Case Study

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Abstract. Patients with Diabetes Mellitus (DM) and hypertension are at high risk of impaired renal function and fluid retention, leading to hypervolemia and peripheral edema. This condition reduces comfort and physical function. Non-pharmacological interventions, such as limb elevation, are important nursing actions to reduce interstitial fluid accumulation. This case study aimed to analyze the effect of 30° hand elevation on reducing edema grade in a patient with hypervolemia due to chronic disease. A qualitative descriptive case study design was used with a single subject (Mrs. E, 53 years old) in the inpatient ward of RSUD Welas Asih. The intervention was performed for 15 minutes, four times daily, over three days, alongside collaborative therapy including furosemide infusion and fluid restriction. Results showed a progressive reduction in edema from grade 4 to grade 2 by the third day, indicating improved venous and lymphatic return. These findings suggest that 30° hand elevation is a simple, safe, and effective independent nursing intervention to reduce upper extremity edema in hypervolemic patients and can be integrated with pharmacological therapy under proper supervision.

Keywords: *Hand Extremity Elevation, Hypervolemia, Edema Reduction.*

INTRODUCTION

The complexity of chronic non-communicable diseases has become a significant global health burden. Two major contributors to high morbidity and mortality are Diabetes Mellitus (DM) and hypertension, which frequently coexist and have synergistic effects in accelerating systemic organ damage, particularly in the heart, kidneys, and vascular system. This combination can lead to myocardial remodeling and left ventricular hypertrophy, ultimately resulting in cardiomegaly and reduced cardiac pumping function (Savarese & Lund, 2017).

Patients with chronic comorbidities often experience impaired fluid balance, leading to hypervolemia and peripheral edema due to interstitial fluid accumulation caused by disrupted osmotic regulation, lymphatic flow, and kidney function (Hansen, 2021). Clinical manifestations such as high-grade pitting edema in the extremities not only indicate systemic fluid overload but also contribute to decreased mobility, pain, and reduced quality of life (Mollaelahi & Shahali, 2022).

In nursing practice, edema management typically focuses on collaborative interventions such as fluid restriction and diuretic therapy. However, independent non-pharmacological interventions, particularly mechanical approaches like extremity elevation, also play an important role in reducing edema (Miller et al., 2017). Physiologically, elevating the extremities by 20° reduces capillary hydrostatic pressure and enhances venous and lymphatic return, thereby decreasing interstitial fluid accumulation and promoting reabsorption (Purwanty et al., 2021). This intervention has been shown to reduce swelling, relieve pain, and improve patient comfort (Yodchareon & Sathiyamas, 2024).

Several studies support its effectiveness. Purwanty et al. (2021) found that 20° lower extremity elevation reduced swelling and pain after orthopedic surgery. Ahmadinejad et al. (2022) reported that upper extremity elevation in ICU patients reduced edema, although its effectiveness depends on duration and positioning. Additionally, Miller et al. (2017) found in a systematic review that various hand elevation techniques can reduce sub-acute edema, although the evidence remains heterogeneous.

Ahmadinejad et al. (2022) further provided evidence-based support by demonstrating that 30° hand elevation using a support pillow, performed five times daily for 30 minutes over five days, reduced average hand circumference from 18.64 cm to 17.82 cm (a decrease of 0.82 cm) in ICU patients with bilateral upper extremity edema. The study also highlighted that hand elevation is more practical and non-invasive compared to pneumatic compression, making it feasible for independent nursing implementation across clinical settings.

These findings indicate that extremity elevation is an evidence-based intervention that can be integrated into nursing care for patients with comorbid DM, hypertension, and cardiomegaly complications accompanied by edema due to hypervolemia. Further study of this intervention is important to improve fluid management effectiveness and patient quality of life.

LITERATURE REVIEW

Extremity elevation is a non-pharmacological intervention widely used to reduce edema through mechanical and physiological mechanisms. Scientifically, elevation is used to reduce hydrostatic pressure by raising the limb above the level of the heart, thereby overcoming gravitational hydrostatic forces and increasing venous return (Du Pont et al., 2016). Studies emphasize that elevation allows gravity to assist in draining edema from distal extremities, and in some cases, elevation alone can significantly reduce hand edema volume by up to 6.6% (Ujjainwala et al., 2019). In addition, changes in body position significantly affect venous hemodynamics, such as blood flow velocity and volume flow (VF), which are key factors influencing the risk of edema (Wang et al., 2024).

The mechanism of edema reduction through elevation is based on the utilization of gravitational force to decrease local capillary hydrostatic pressure. This reduction alters the filtration–reabsorption balance according to Starling's Law, in which plasma oncotic pressure becomes more dominant in drawing fluid back from the interstitial space into the vascular lumen (Adi et al., 2024).

Furthermore, the elevation position has been shown to enhance lymphatic drainage by reducing external pressure that may inhibit lymphatic vessel function (Adi et al., 2024). The venous return generated from extremity elevation flows through major veins into the right atrium, increasing preload, which subsequently affects stroke volume and systemic blood pressure (Madhavaram et al., 2025; White & Soos, 2023; Nemoto et al., 2016).

However, the effectiveness of elevation must be considered carefully, particularly regarding the degree and duration of elevation. Elevation performed at excessive angles or durations may increase central venous pressure (CVP) and systemic blood pressure due to the mobilization of blood volume from the peripheral to central circulation (Nemoto et al., 2016; Serhiyenko et al., 2022). As a physiological response to increased preload and atrial wall stretch, the body releases natriuretic peptides (ANP and BNP), which promote diuresis and vasodilation as compensatory mechanisms to reduce blood pressure (Serhiyenko et al., 2022; Adi et al., 2024).

Clinical studies support the effectiveness of extremity elevation as a routine and practical intervention for reducing edema. Elevation has been identified as an effective method to reduce swelling by facilitating venous and lymphatic return (Seo et al., 2020). Other studies also indicate that extremity elevation is an important non-pharmacological strategy that mechanically

reduces edema by enhancing lymphatic fluid drainage (Larasati et al., 2024). However, research also shows that the effects of elevation are temporary and may dissipate rapidly (in less than 5 minutes) once the limb is returned to a gravity-dependent position, highlighting the importance of intermittent and consistent application (Seo et al., 2020).

In addition to mechanical interventions, pharmacological therapy such as diuretics is commonly used to manage fluid overload. Furosemide, a loop diuretic, works by inhibiting sodium and chloride reabsorption in the loop of Henle, thereby promoting water excretion. However, its effectiveness may be limited in certain conditions due to diuretic resistance.

Factors contributing to this resistance include impaired renal function, which reduces drug delivery to its site of action (Cox et al., 2022), active infection that induces inflammatory responses and renal vasoconstriction (Escudero et al., 2022), and electrolyte imbalances such as hyponatremia, which reflect relative fluid excess and affect diuretic efficacy (Wilcox et al., 2020). Prolonged use of loop diuretics may also trigger compensatory mechanisms such as distal tubular hypertrophy, leading to increased sodium reabsorption and fluid retention (Assen et al., 2020). In such cases, a Sequential Nephron Blockade strategy may be required to enhance diuretic effectiveness by targeting different segments of the nephron (Assen et al., 2020).

Previous studies have demonstrated that extremity elevation alone can reduce edema, but combined interventions may provide more optimal outcomes. For instance, Ahmadinejad et al. (2022) reported that 30° hand elevation performed five times daily for 30 minutes over five days resulted in a measurable reduction in hand circumference, equivalent to a decrease in clinical edema grade. This suggests that extremity elevation is an effective, non-invasive, and practical intervention that can be implemented independently in clinical settings, while also being potentially enhanced when combined with systemic therapies.

METHODS

This study employed a descriptive qualitative design using a case study approach. The study focused on comprehensive nursing care, covering all stages from assessment to evaluation, to explore the effectiveness of a specific non-pharmacological intervention—hand elevation—in reducing edema in a hypervolemia case.

The subject was a 53-year-old female (Mrs. E) hospitalized with hypervolemia due to chronic comorbidities, including type 2 diabetes mellitus, hypertension, and a history of stroke. Inclusion criteria included the presence of pitting edema in the upper extremities and willingness to participate. The study was conducted in the inpatient ward of RSUD Welas Asih, West Java, over three days (September 29 – October 1, 2025).

The intervention design was adapted from Ahmadinejad et al. (2022), involving 30° hand elevation using a pillow as support. In this study, the intervention was applied four times daily for 15 minutes per session over three days. Additional nursing care included fluid restriction, monitoring of vital signs and fluid balance (intake–output), and collaboration in diuretic therapy (furosemide infusion).

Data were collected through structured interviews, physical examination, and observation, particularly assessing pitting edema using a +0 to +4 scale. Supporting data were obtained from medical records, including laboratory results and fluid balance documentation. Data analysis was conducted descriptively by comparing daily changes in edema degree to evaluate intervention effectiveness.All procedures followed ethical principles, including obtaining informed consent from the patient and family prior to the intervention, ensuring voluntary participation, and maintaining the confidentiality of all patient data.

RESULTS

Based on the study by Ahmadinejad et al. (2022), the researcher adapted the intervention according to the patient's clinical condition and the duration of hospitalization in a non-ICU inpatient setting. In this study, 30° hand elevation was performed on both upper extremities for 15 minutes, with the hands positioned above heart level using a sterile support pillow. The intervention was carried out in four sessions per day, each lasting 15 minutes. It was implemented hourly at 16:00, 17:00, 18:00, and 19:00 on days 1 and 2, and at 09:00, 10:00, 11:00, and 12:00 on day 3.

Adjustments in the duration and frequency of the intervention from the previous study were made based on several contextual considerations. First, the patient's clinical condition and tolerance were the primary factors, as the subject was treated in a general ward rather than an intensive care unit (ICU) with continuous monitoring. Therefore, the intervention intensity was modified to ensure safety and patient comfort. Second, the relatively short hospitalization period of three days influenced the scheduling adjustments to allow optimal implementation within the available timeframe. Third, the context of independent nursing practice was also considered; thus, a duration of 15 minutes per session was selected as it was more realistic, safe, and feasible to be implemented by nurses in clinical settings without interfering with other nursing activities.Evaluation was conducted to assess the effectiveness of nursing interventions aimed at managing hypervolemia related to sodium and water retention due to impaired kidney function. The assessment focused on signs and symptoms of hypervolemia, particularly the degree of edema.After consistent implementation of nursing interventions, including 30° hand elevation for 15 minutes per session and diuretic therapy (furosemide infusion), the following results were obtained:

Table 1. Evaluation of Intervention Outcomes

Date	Day of Care	Intervention Time	Measurement Time	Edema Degree	Notes
Monday, 29 September 2025	Day 1	16.00 – 16.15 17.00 – 17.15 18.00 – 18.15 19.00 – 19.15	19.15	4	Persistent edema despite prior maintenance furosemide therapy (drip) for two days.
Tuesday, 30 September 2025	Day 2	16.00 – 16.15 17.00 – 17.15 18.00 – 18.15 19.00 – 19.15	19.00	3	Reduction in edema degree began to be observed after day 2 intervention.
Wednesday, 01 October 2025	Day 3	09.00 – 09.15 10.00 – 10.15 11.00 – 11.15 12.00 – 12.15	12.00	2	Significant reduction in extremity edema; skin appeared more elastic.

The 30° hand elevation combined with collaborative diuretic therapy and fluid restriction demonstrated effectiveness in reducing interstitial fluid accumulation in the upper extremities.

DISCUSSION

The evaluation results showed a progressive decrease in the degree of edema in both hands of Mrs. E from grade 4 on day 1 to grade 2 on day 3. This reduction reflects the success of an integrated intervention. The hand elevation intervention provided a rapid and significant local effect, while diuretic therapy (furosemide infusion) and fluid restriction worked systemically to achieve a negative fluid balance. Although the edema focus was only on the hands, the reduction in the degree of pitting edema achieved is a direct indicator of the success of nursing interventions aimed at mobilizing interstitial fluid from the third space. This local success is inseparable from the biomechanical principles underlying the elevation intervention.

In this case, hand elevation was established as the main non-pharmacological nursing intervention based on the focus of complaints and nursing diagnosis (hypervolemia with manifestations of upper extremity edema). The application of 30° hand elevation for 15 minutes in 4 daily sessions (every hour within a specified time range) alternately has shown clear efficacy, as evidenced by the improvement in edema degree. This intervention is highly rational because it directly targets the local symptoms complained of by the patient and can be independently performed by nurses.

Scientifically, elevation is used to reduce hydrostatic pressure by raising the limb above the heart, overcoming gravitational hydrostatic forces, thereby increasing venous return (Du Pont et al., 2016). Studies emphasize that elevation allows gravity to assist in draining edema from distal extremities, and even in some studies, elevation alone was able to significantly reduce hand edema volume by up to 6.6% (Ujjainwala et al., 2019). In addition, changes in body position significantly affect venous hemodynamics such as blood flow velocity and volume flow (VF), which are key factors in edema risk (Wang et al., 2024).

By placing the hands higher than the heart, this intervention specifically reduces capillary hydrostatic pressure in the upper extremities, which is the main trigger for excessive fluid filtration into the interstitial space. The significant reduction in edema degree is a direct validation of the effectiveness of implementing extremity elevation nursing intervention in Mrs. E's case.

The mechanism of edema reduction is based on the utilization of gravitational force to reduce local capillary hydrostatic pressure (Adi et al., 2024). This reduction changes the filtration-reabsorption dynamics according to Starling's Law; in this condition, plasma oncotic pressure becomes more dominant in drawing fluid back from the interstitial space into the vascular lumen (Adi et al., 2024).

The elevation position is also proven to increase fluid drainage through the lymphatic pathway by reducing external pressure that inhibits lymphatic vessel function (Adi et al., 2024). The venous return generated from upper extremity elevation flows through the Superior Vena Cava and directly enters the Right Atrium of the heart (Madhavaram et al., 2025; White & Soos, 2023). This increased return automatically increases cardiac filling volume or preload, which subsequently increases stroke volume and systemic blood pressure (Madhavaram et al., 2025; Nemoto et al., 2016).

This condition needs attention, especially in patients with a history of lower extremity amputation (LEA), due to the loss of venous reservoir or large blood storage capacity in the legs, resulting in massive redistribution of blood volume to central circulation and upper extremities (Madhavaram et al., 2025). This causes the upper extremities to receive a higher hydrostatic load, while the lymphatic transport capacity in the superior area is anatomically not as strong as the mechanisms present in the lower extremities (Madhavaram et al., 2025; Partsch et al., 2004). However, elevation performed at too high an angle or for excessive

duration has the potential to trigger hypertension because mobilization of blood volume from the periphery to the center significantly increases Central Venous Pressure (CVP) and blood pressure (Nemoto et al., 2016; Serhiyenko et al., 2022). In response to the surge in volume and stretching of the atrial walls due to increased preload, the body releases natriuretic peptide hormones (ANP and BNP) to trigger diuresis and vasodilation as a compensatory effort to reduce blood pressure (Serhiyenko et al., 2022; Adi et al., 2024).

The implementation of 30° hand elevation for 15 minutes in four scheduled daily sessions (at 16:00, 17:00, 18:00, and 19:00 on days 1 and 2; and at 09:00, 10:00, 11:00, and 12:00 on day 3) proved effective by utilizing gravitational principles. When the hands are elevated above heart level, local capillary hydrostatic pressure decreases, which automatically increases venous and lymphatic return from the extremities to central circulation. This mechanism accelerates the transfer of interstitial fluid back into blood vessels and the lymphatic system, thereby reducing fluid accumulation and swelling. Studies confirm that elevation is a routine and effective method to reduce swelling (Seo et al., 2020).

Other studies also show that extremity elevation is an important non-pharmacological strategy that mechanically helps reduce swelling by increasing lymphatic fluid drainage (Larasati et al., 2024). However, the effectiveness of this intervention must be evaluated by considering daily variations in patient symptoms. Research also shows that the effect of elevation dissipates quickly (less than 5 minutes) after the limb is returned to a gravity-dependent position (Seo et al., 2020).

This provides a strong scientific basis for why elevation in Mrs. E was performed intermittently and regularly (4 sessions per day) to maintain fluid reabsorption results without causing discomfort due to prolonged static positioning. The phenomenon of patient complaints that edema is worse at night is a common occurrence due to fluid redistribution when the body is in a horizontal (lying) position.

Fluid that was previously accumulated in lower areas due to gravity returns to central circulation, causing an increase in central blood volume and subjectively making swelling (including in the upper extremities and face) more apparent. This fluid redistribution indicates that hypervolemia is systemic and requires strong pharmacological intervention.

The clinical correlation of this mechanism is clearly seen in Mrs. E's condition, where this independent intervention provided an effect that could not be achieved by pharmacological therapy alone. It should be emphasized that before the elevation intervention began, the patient had received maintenance-dose Furosemide therapy for 48 hours, yet the edema condition remained static at grade 4.

The fact that the reduction to grade 2 occurred when the patient experienced diuretic resistance—evidenced by urine output reaching only 50 cc/hour from a target of 100 cc/hour—indicates that hand elevation was the main determining variable in local fluid mobilization. Clinically, this validates that mechanical intervention through elevation can overcome local hydrostatic pressure that cannot be addressed by systemic therapy alone, allowing fluid from the third space to be reabsorbed into the vascular system despite suboptimal renal excretory function.

Further analysis regarding the limitations of pharmacological roles in this case shows systemic barriers. Although strong diuretic therapy (furosemide infusion) was administered, the urine output target of 100 cc/hour was not achieved, with an average output of only around 50 cc/hour (based on a negative balance of 100 ml in 8 hours). Furosemide is a loop diuretic that works by inhibiting sodium and chloride reabsorption in the loop of Henle, forcing water excretion. However, the failure to achieve optimal urine output in Mrs. E is most likely due to diuretic resistance as a consequence of complex comorbidities.

Factors triggering this resistance include: (1) impaired renal function (ureum 54 mg/dL and creatinine 2.21 mg/dL), which reduces furosemide secretion into the tubular lumen where the

drug acts (Cox et al., 2022); (2) active infection (leukocytes 19,940 and bronchopneumonia), where inflammatory and septic conditions can cause renal vasoconstriction and fluid retention opposing diuretic effects (Escudero et al., 2022); and (3) hyponatremia (126 mmol/L), which indicates relative water excess that can affect diuretic efficacy (Wilcox et al., 2020).

Additionally, physiologically, prolonged furosemide use can trigger compensation in the form of distal tubular hypertrophy that increases sodium reabsorption and induces retention (Assen et al., 2020). Although the furosemide dose was increased from 5 mg/hour, it had not reached the effectiveness threshold required to overcome diuretic resistance in this multi-pathology patient. This condition highlights the need for a Sequential Nephron Blockade strategy through the addition of diuretics that work in distal nephron segments to overcome this compensatory mechanism (Assen et al., 2020).

The results of this study are also consistent with findings from Ahmadinejad et al. (2022), who conducted a randomized controlled trial in ICU patients with upper extremity edema. In that study, 30° hand elevation was performed 5 times per day for 30 minutes over 5 consecutive days, without additional pharmacological therapy such as diuretics.

The results showed a reduction in hand circumference from 18.64 cm to 17.82 cm, or a decrease of 0.82 cm. When converted to the clinical pitting edema scale, this is equivalent to a reduction of approximately 1–2 edema grades, depending on the condition of subcutaneous tissue. The results obtained in Mrs. E, namely a reduction from grade 4 to grade 2 within three days, indicate relatively faster effectiveness.

This is presumably because the intervention applied was not only hand elevation but also combined with diuretic therapy and fluid restriction, which provided systemic effects on reducing body fluid volume. This combination produced a synergistic effect because elevation facilitates venous and lymphatic drainage, while diuretics provide systemic effects on fluid volume reduction, although natriuresis did not reach optimal targets due to diuretic resistance (Goyal et al., 2025). The results in Mrs. E strengthen that a combination of mechanical (elevation) and pharmacological (furosemide) interventions can produce more optimal outcomes compared to single interventions as in Ahmadinejad et al. (2022).

Overall, nursing interventions focusing on the upper extremities proved locally successful in reducing edema. However, the management of systemic hypervolemia still faces serious challenges due to diuretic resistance associated with impaired renal function, infection, and patient comorbidities. This condition emphasizes the need for continuous evaluation in subsequent nursing care plans to address systemic root causes more comprehensively.

The effectiveness of this intervention is also inseparable from the implementation context in the field, which presents several barriers. Limitations of this case study include restricted monitoring outside working hours, so the consistency of independent elevation performed by the patient outside scheduled interventions could not be fully observed.

Additionally, the presence of intravenous access (infusion) in the edematous hand potentially affected the optimization of elevation positioning. Patient compliance in maintaining the position also became an external factor that was difficult to fully control. Finally, the duration of nursing care, which lasted only three days, limited the evaluation of long-term outcomes, unlike literature studies conducted over longer durations in intensive care settings.

CONCLUSION

The results of the case study on Mrs. E showed that the nursing intervention of 30° hand elevation for 15 minutes in four scheduled daily sessions was effective in reducing the degree of upper extremity edema from grade 4 to grade 2 within three days of care. This success indicates that a simple intervention based on gravitational principles can produce a significant clinical impact by reducing capillary hydrostatic pressure and improving venous return.

Despite the presence of systemic diuretic resistance, the hand elevation intervention still contributed significantly to the mobilization of interstitial fluid. These findings are consistent with Ahmadinejad et al. (2022) regarding the effectiveness of elevation in reducing edema. However, in this case, the combination of independent nursing intervention (elevation) and medical collaboration (furosemide and fluid restriction) produced a synergistic effect that accelerated clinical recovery in patients with hypervolemia and complex comorbidities.

LIMITATION

Although the intervention showed positive outcomes, the effectiveness observed in this case may be influenced by the combined use of pharmacological therapy and fluid restriction, making it difficult to isolate the sole effect of hand elevation. Additionally, the short duration of care (three days) limits the evaluation of long-term outcomes, particularly in patients with complex comorbid conditions and systemic fluid imbalance.

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