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# Non-Pharmacological Nursing Management of Edema in Acute Kidney Injury: A Case Study of Ankle Pump Exercises and 30° Leg Elevation

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**Abstract:**
Acute Kidney Injury (AKI) frequently induces sodium retention and hypoalbuminemia, precipitating severe peripheral edema that threatens cardiopulmonary and neurological stability. Non-pharmacological interventions are increasingly sought to safely and effectively manage this complex fluid overload in clinical settings. This case study aimed to evaluate the clinical efficacy of a combined nursing intervention, specifically structured ankle pump exercises and 30-degree leg elevation, in mitigating peripheral edema severity in an adult patient with AKI. A descriptive, single-subject case study design was employed within a regional hospital ward setting. The intervention was administered twice daily over a consecutive five-day period. Edema severity was quantitatively assessed at baseline and post-intervention utilizing a standardized pitting edema observation sheet to measure precise tissue depth and rebound time. The intervention yielded clinically meaningful improvements by the third day of implementation. Bilateral lower extremity edema successfully decreased from Grade III to Grade II, accompanied by a measurable reduction in pitting depth and improved tissue recoil time. These objective findings demonstrate enhanced venous return and successful mobilization of interstitial fluid. Ankle pump exercises combined with 30-degree leg elevation represent a highly viable, cost-effective, and independent nursing strategy for managing peripheral edema in AKI patients. This non-pharmacological approach safely complements standard medical management, empowering patient self-care while circumventing the iatrogenic risks associated with aggressive pharmacological diuresis.

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## INTRODUCTION

Acute Kidney Injury represents a critical global health burden characterized by a sudden, rapid decline in renal function (Cerda et al., 2026). This abrupt deterioration disrupts the body's ability to excrete nitrogenous waste products, leading to the dangerous accumulation of urea and creatinine, while severely compromising fluid and electrolyte homeostasis (Dainton, 2024). The etiology of this syndrome is broadly categorized into prerenal, intrinsic, and postrenal mechanisms, each presenting unique clinical challenges (Turgut et al., 2022). Patients frequently manifest with fatigue, altered urine output, hypertension, hyperkalemia, and significant fluid shifts (Menon et al., 2023). The global prevalence of AKI continues to rise, placing immense strain on healthcare systems and demanding comprehensive, multidisciplinary management strategies to prevent progression to chronic kidney disease or mortality (Bell et al., 2026).

A prominent and dangerous complication of this condition is severe peripheral edema, driven by complex pathophysiological mechanisms (Juncos et al., 2022). The renal dysfunction inherent in

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AKI directly causes sodium retention and elevated urea levels, frequently culminating in hypoalbuminemia (Xu et al., 2025). This decline in serum albumin drastically reduces plasma oncotic pressure, prompting a pathological shift of intravascular fluid into the interstitial spaces (Messina et al., 2025). Compensatory mechanisms for the resulting intravascular hypovolemia further increase sodium and water retention (Abe et al., 2023). This vicious cycle exacerbates the underlying hypoalbuminemia and accelerates extravascular fluid accumulation (Kwiatkowska et al., 2023). Untreated peripheral edema poses severe risks, potentially compromising respiratory function through pulmonary congestion, straining the cardiovascular system, and inducing neurological disturbances due to fluid shifts (Terrades et al., 2025).

Current clinical management of AKI-related edema relies heavily on pharmacological interventions and strict dietary modifications (Rroji et al., 2024). Physicians typically prescribe loop diuretics to promote fluid excretion, alongside rigorous fluid and sodium restriction protocols (Flamm et al., 2022). These foundational measures frequently present significant clinical limitations. Diuretic resistance is a common phenomenon in advanced AKI, rendering pharmacological approaches ineffective or necessitating dangerously high doses that risk ototoxicity and further renal insult (Nei et al., 2025). Strict fluid restriction also demands high patient compliance, which is often difficult to achieve and maintain (Argaiz et al., 2022). These limitations highlight the critical need for adjunctive, non-pharmacological strategies to safely manage fluid overload.

Non-pharmacological nursing interventions offer a promising physiological mechanism to enhance venous return and reduce interstitial fluid accumulation (Chowdhury & Kumar, 2023). Ankle pump exercises actively engage the calf muscle pump, generating mechanical pressure that facilitates the movement of stagnant interstitial fluid back into the venous circulation and toward the heart (Yu et al., 2024). Combining this active movement with passive leg elevation optimizes the gravitational advantage, further promoting lymphatic drainage and venous return. Elevating the legs to a precise 30-degree angle provides sufficient hydrostatic pressure reduction in the lower extremities without causing undue discomfort or compromising arterial perfusion (Putri et al., 2025). These combined actions directly counteract the dependent pooling of fluid characteristic of AKI-induced edema.

The existing literature reveals a substantial research gap regarding standardized, evidence-based nursing protocols for managing peripheral edema in patients with acute kidney injury. Previous studies have extensively documented the benefits of ankle pump exercises in preventing deep vein thrombosis or managing postoperative edema in orthopedic patients (Liu et al., 2025). Research focusing on chronic heart failure or lymphedema also supports the utility of leg elevation (Chadwick, 2022). The specific application, efficacy, and measurable outcomes of these combined mechanical interventions within the unique pathophysiological context of acute kidney injury remain severely underexplored.

This study introduces a novel approach by evaluating the precise, combined application of ankle pump exercises and 30-degree leg elevation as a targeted nursing strategy. Unlike broad fluid management studies, this research isolates the mechanical intervention to measure its direct impact on edema grading in a controlled clinical scenario (Rancu et al., 2024). The novelty lies in establishing a quantifiable, reproducible nursing protocol that addresses the specific hemodynamic and oncotic challenges presented by AKI. This focused methodology provides clear, actionable data for bedside nurses managing complex fluid shifts.

Establishing the efficacy of this non-invasive intervention is urgently required to optimize patient outcomes. Implementing this cost-effective strategy empowers providers to proactively address edema before systemic compromise occurs. This research aims to demonstrate that structured ankle pump exercises and 30-degree leg elevation significantly reduce edema severity in

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AKI patients. Validating this approach will ultimately enhance the quality of nursing care, reduce reliance on high-risk pharmacological agents, and improve the overall clinical trajectory of individuals with acute renal dysfunction (Zimmerman, 2025).

## METHOD

### Design

This study employed a pretest-posttest design without a control group. This case study approach focuses exclusively on evaluating the effects of the administered treatment on a single subject, eliminating the need for a comparative control group while isolating the impact of the specific nursing intervention.

### Setting and Time

The research was conducted in the Anthurium Ward of Dr. Soebandi Regional Hospital in Jember. The data collection period spanned five consecutive days, from December 12 to December 16, 2025.

### Population, Sample, and Sampling

The target population comprised all patients diagnosed with Acute Kidney Injury (AKI) receiving treatment in the Anthurium Ward. The sampling technique utilized was purposive sampling, resulting in the selection of a single respondent who strictly met the predetermined inclusion criteria for this specific case study.

### Intervention

The therapeutic intervention consisted of structured ankle pump exercises combined with a 30-degree leg elevation. This protocol was administered consistently over the five-day observation period to evaluate its direct physiological impact on peripheral edema reduction.

### Instrument and Measurement Properties

The primary instruments used included the Standard Operating Procedures (SOPs) for administering ankle pump exercises and 30-degree leg elevation. Additionally, a standardized pitting edema observation sheet was used to assess and document edema severity. These tools ensured a consistent, objective, and reproducible assessment of the clinical outcomes.

### Data Collection Procedure

Data acquisition involved both primary and secondary sources. Primary data were gathered directly through researcher-led interviews, direct clinical observations, and physical calculations. Specifically, the researcher measured the patient's edema grade using the observation sheet at baseline (pretest) and after the 5-day intervention (posttest). Secondary data were extracted from the patient's medical records to establish the definitive medical diagnosis and comprehensive health history.

### Data Analysis

The collected data were analyzed quantitatively using univariate descriptive statistics. This analytical method focused on comparing the numerical edema grade measurements recorded before and after the implementation of the ankle pump exercise and leg elevation protocol to determine the magnitude and direction of the clinical change.

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**Ethical Declaration**

Ethical approval for this study was granted by the Ethics Committee of the Faculty of Nursing, Universitas Jember. Written informed consent was obtained from the patient prior to data collection, ensuring full understanding of the study's purpose, procedures, and the right to withdraw. Patient confidentiality and anonymity were strictly maintained by de-identifying all personal health information throughout the research and reporting processes.

## RESULT

The intervention was implemented on Mr. S, a 42-year-old patient treated in the Anthurium Ward with Acute Kidney Injury. This section discusses the results of the case study on the implementation of the Ankle Pump Exercise and 30° Leg Elevation to reduce edema. The outcomes include the edema grade before and after the therapy over 5 days.

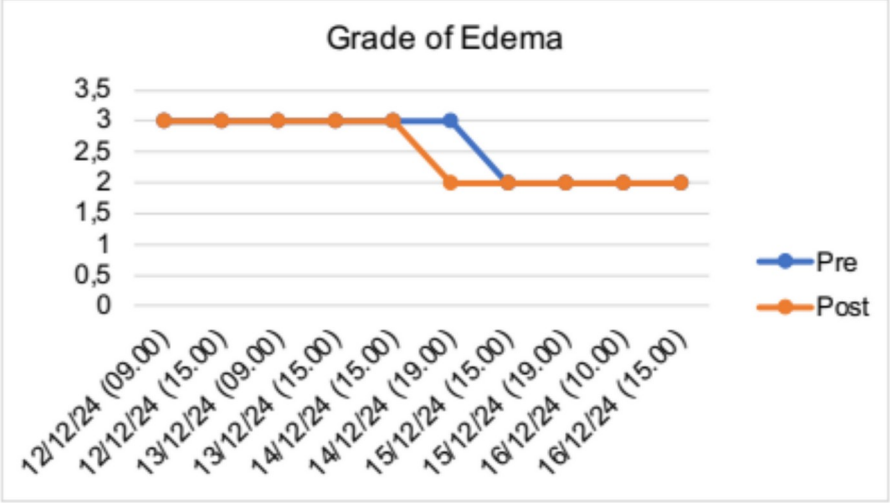


Diagram 1 Progression of Edema Grade – Right Leg (Pre and Post Intervention)

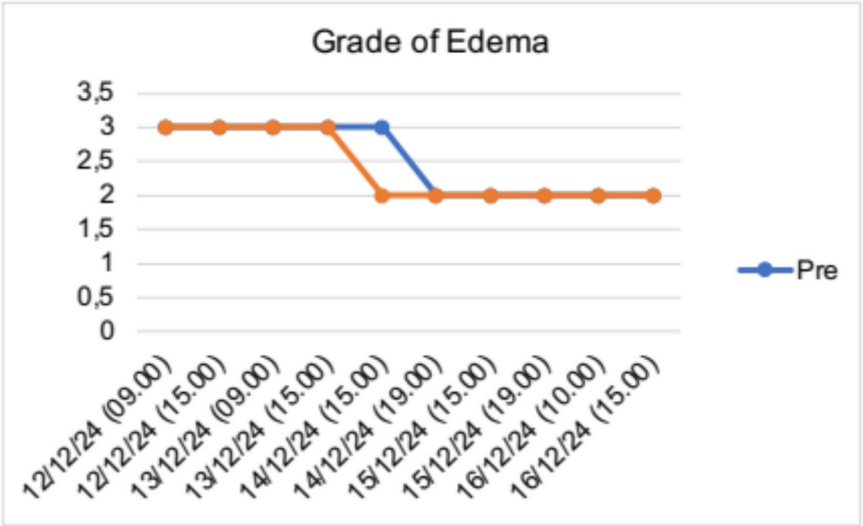


Diagram 2 Progression of Edema Grade – Left Leg (Pre and Post Intervention)

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The case study showed a significant decrease in Mr. S's edema grade from the first to the fifth day. For the right leg, the edema grade on Day 3 (19:00) was grade III, with a depth of 5 mm and a rebound time of 17 seconds. After the intervention, the edema grade decreased to grade II, with a depth of 4 mm and a rebound time of 14 seconds. Similarly, in the left leg, the edema decreased from grade III (depth 5 mm, rebound time 17 seconds) to grade II (depth 4 mm, rebound time 15 seconds) after the intervention.

## DISCUSSION

The primary finding of this case study demonstrates that the combined application of ankle pump exercises and 30-degree leg elevation effectively reduced peripheral edema from Grade III to Grade II in a patient with Acute Kidney Injury over five days. The intervention was administered twice daily, yielding measurable clinical improvements as early as the third day of implementation, which indicates a rapid therapeutic response. Baseline assessments revealed severe pitting edema characterized by a 5-millimeter depth and a prolonged 17-second rebound time in both lower extremities. Following the structured nursing intervention, the edema depth decreased to 4 millimeters, and tissue recoil improved to a 14- to 15-second rebound time. This quantifiable shift indicates a successful mobilization of trapped interstitial fluid back into the systemic circulation. The consistent bilateral improvement confirms that the intervention effectively countered the systemic fluid retention characteristic of acute renal dysfunction.

These clinical improvements align closely with existing literature examining non-pharmacological fluid management in patients with renal dysfunction. Previous research investigating patients with chronic kidney disease and fluid volume excess reported a dramatic reduction in edema severity (Chowdhury & Kumar, 2023). That specific study documented concurrent improvements in secondary clinical indicators, including increased urine output, stabilized blood pressure, normalized pulse rates, and enhanced skin turgor. Another relevant investigation reported a statistically significant decrease in average edema grade, from 2.83 to 1.92, with a p-value of 0.001 following structured lower limb interventions. The current case study mirrors these trajectories, suggesting that the pathophysiological response to mechanical fluid mobilization remains consistent across both acute and chronic renal impairment spectrums.

Similar positive outcomes have been documented in related cardiovascular and systemic fluid overload conditions, reinforcing the universal physiological benefits of this intervention. Research focusing on patients with congestive heart failure has consistently demonstrated that leg elevation therapy significantly reduces lower limb edema, often measured by precise reductions in ankle circumference (Chadwick, 2022). The underlying pathophysiology in heart failure involves impaired cardiac output leading to venous congestion, which parallels the fluid overload dynamics seen in Acute Kidney Injury. Studies evaluating postoperative orthopedic patients further confirm that ankle pump exercises prevent venous stasis and effectively mitigate dependent edema (Liu et al., 2025). The convergence of evidence across nephrology, cardiology, and surgical nursing underscores the robustness of mechanical venous return enhancement as a foundational clinical strategy.

The physiological mechanism driving this edema reduction relies on the biomechanical action of the calf muscle pump during active ankle movement. Ankle pump exercises involve rhythmic dorsiflexion and plantarflexion, which induce maximal contraction of the gastrocnemius and soleus muscles. These muscle contractions physically compress the deep venous blood vessels within the lower extremities. The compression generates a transient increase in intravenous pressure, effectively propelling stagnant venous blood and interstitial fluid proximally toward the heart. One-

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way venous valves prevent the retrograde flow of this mobilized fluid, ensuring unidirectional movement toward the central circulation. This mechanical action directly counteracts the hydrostatic pressure that forces fluid into the interstitial spaces during states of hypoalbuminemia and sodium retention (Rondhianto et al., 2025).

Concurrent 30-degree leg elevation synergistically amplifies this effect by leveraging gravity to optimize hydrostatic pressure gradients. Elevating the lower extremities above the level of the right atrium decreases the hydrostatic pressure within the distal venous system. This positional change facilitates passive lymphatic drainage and venous return without requiring additional metabolic energy from the patient. The specific angle of 30 degrees is clinically optimal, as it provides sufficient gravitational assistance while maintaining patient comfort and preserving adequate arterial perfusion to the distal tissues. The combination of active muscle pumping and passive gravitational drainage creates a comprehensive hemodynamic environment conducive to rapid fluid resorption (Nuraliffa et al., 2026).

The clinical implications of these findings strongly advocate for the integration of this dual-modality intervention into standard nursing care protocols for Acute Kidney Injury. Nurses possess the autonomy to implement these physical interventions independently, bypassing the delays and potential adverse effects associated with escalating pharmacological diuretic therapy. Incorporating structured ankle pump exercises and leg elevation into daily care plans provides a proactive, rather than reactive, approach to fluid management. This strategy empowers nursing staff to directly influence patient hemodynamics and comfort levels through evidence-based physical care. Hospitals and clinical wards can easily standardize these procedures through clear Standard Operating Procedures and dedicated staff training modules.

Implementing this non-invasive strategy offers substantial benefits regarding patient safety, comfort, and healthcare resource utilization. Pharmacological management of edema in Acute Kidney Injury frequently carries risks of electrolyte imbalances, ototoxicity, and further renal insult due to diuretic resistance (Menon et al., 2023). A mechanical intervention completely circumvents these iatrogenic risks, presenting a highly favorable safety profile for vulnerable renal patients. The financial cost of implementing ankle pump exercises and leg elevation is negligible, requiring no specialized equipment or expensive medications. This cost-effectiveness makes the intervention highly scalable and accessible, particularly in resource-limited healthcare settings or developing nations. Patients also report higher satisfaction and a greater sense of agency when actively participating in their own physical recovery protocols, which can improve overall adherence to broader treatment plans.

The interpretation of these promising results must be contextualized within the inherent methodological limitations of the current study design. The utilization of a single-subject case study design inherently restricts the generalizability of the findings to the broader Acute Kidney Injury population. The absence of a control group prevents the definitive isolation of the intervention's effect from other concurrent medical treatments, such as dietary sodium restriction or administered diuretics. Natural fluctuations in the patient's renal function or fluid balance over the 5 days could have contributed independently to the observed reduction in edema. Future research must employ randomized controlled trials with larger sample sizes to establish causal relationships and determine the intervention's statistical significance across diverse patient demographics.

Additional constraints include reliance on subjective clinical measurement tools and the relatively short observation period. Pitting edema assessment, while clinically standard, remains susceptible to inter-rater reliability issues and subjective interpretation of depth and rebound time. The use of more objective measurement tools, such as bioimpedance spectroscopy or volumetric water displacement, would yield more precise, quantifiable data on fluid shifts. A five-day observation

window is sufficient to demonstrate acute changes but fails to capture the long-term sustainability of the edema reduction or the potential for rapid fluid re-accumulation post-intervention. Subsequent studies should incorporate continuous monitoring technologies, such as wearable fluid sensors, and extend the follow-up period to evaluate the enduring efficacy and optimal frequency of this nursing care strategy.

## CONCLUSION

The implementation of ankle pump exercises combined with 30 ° leg elevation demonstrated clinical efficacy in mitigating peripheral edema severity in a patient with acute kidney injury. Clinically meaningful improvements were evident by the third day of the intervention, with bilateral lower extremity edema transitioning from severe to moderate pitting characteristics as documented through standardized observational assessments. This dual-modality approach represents a highly viable, independent nursing intervention that safely complements standard pharmacological fluid management protocols without introducing iatrogenic risks. The inherent simplicity and lack of specialized equipment requirements empower patients to actively participate in their own self-management, making this strategy highly accessible and cost-effective as a component of comprehensive renal care.

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