Comparative analysis of diuretic therapy and ultrafiltration in the efficacy of acute heart failure treatment

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Abstract.
This article examines the role of furosemide and ultrafiltration in the treatment of acute heart failure. Furosemide, a loop diuretic, is successfully employed to reduce circulating blood volume and arterial pressure while increasing urea and uric acid excretion. The study compares two methods of furosemide administration: continuous infusion and intermittent injections, highlighting their advantages and limitations. Ultrafiltration, a method for removing excess fluid from the body, presents a promising alternative to diuretic therapy in the treatment of acute heart failure. This method allows for more precise fluid removal, preservation of kidney function, reduction of patient deterioration risks, improvement in their quality of life, and a decrease in diuretic dosages. Data analysis underscores the efficacy of ultrafiltration in managing acute heart failure with fluid overload and offers a perspective for future therapeutic practices.

Keywords:
heart failure
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Introduction:  
Heart failure remains one of the most pressing and serious diseases in the modern medical world. With its increasing prevalence among the population, the development of effective treatment methods and the maintenance of patients' vital signs become increasingly crucial. In this context, two methods - the use of furosemide and ultrafiltration - have become subjects of intensive research and discussion in the field of medicine. Furosemide, a loop diuretic, has long established itself as a significant tool for managing fluid balance in patients with acute heart failure. However, questions regarding its effectiveness and application methods continue to be the subject of debate and investigation. In this article, we delve into the mechanisms of furosemide action and analyze various methods of its application in treating patients with heart failure, particularly considering continuous infusion and intermittent injections. On the other hand, ultrafiltration, as a method for removing excess fluid from the body, represents a promising alternative to diuretic therapy. Its advantages in precise fluid removal, preservation of kidney function, and improvement in the quality of life of patients make it a matter of special interest. In this article, we conduct an analysis of the advantages of ultrafiltration, its role in preserving kidney function, and reducing the risks of worsening acute heart failure. Studying these two treatment methods is a key element of modern medical practice, as it allows for improved treatment outcomes, reduced risks, and enhanced quality of life for patients with heart failure. As a result, this article aims to justify the relevance and significance of research in this field and to provide a clear understanding of the mechanisms and benefits of furosemide and ultrafiltration in the treatment of acute heart failure.

Materials and Methods:  
To conduct this literature review and systematize the gathered data, a search for scientific articles, reviews, and meta-analyses was performed in medical databases, including PubMed, Lancet, and other relevant sources. The studies included in the review covered the period from 2015 to 2023 and were limited to publications in the English language.
Keywords and phrases such as "Acute Heart Failure," "Contemporary Recommendations," "Therapy Methods," "Furosemide," and "Ultrafiltration" were used for the search and selection of suitable studies.

Results:

1. Methods of Furosemide Administration in the Treatment of Acute Heart Failure:

Furosemide belongs to the class of highly effective loop diuretics. Its mechanism of action is based on the inhibition of the activity of sodium-potassium-chloride cotransporters (NKCC2) in the loop of Henle, a part of the nephron in the kidneys. This cotransporter is responsible for the normal reabsorption of sodium, potassium, and chloride from the primary urine. Furosemide binds to NKCC2 and interferes with this process, resulting in a significant increase in the excretion of sodium, potassium, chloride, and water through the urine.

Due to this mechanism of action, furosemide effectively reduces circulating blood volume and arterial pressure, making it useful in the treatment of edema and hypertension. It is also worth noting that furosemide increases the excretion of urea and uric acid, which can be beneficial in certain conditions, such as hyperuricemia and hyperuricosuria.

In study [1], a comparison is made between two methods of furosemide administration in the treatment of heart failure - continuous infusion and intermittent bolus injections.

The advantages of prescribing Furosemide as Continuous Infusion include the following aspects:

1. Continuous diuretic effect: This method is particularly useful in critical cases where continuous monitoring and control of the patient's diuresis are required. In such situations, continuous furosemide infusion allows for maintaining the optimal fluid balance within the body, which is critically important for patients suffering from severe conditions.

2. Minimization of the risk of dehydration and restoration of hydration levels: The use of continuous furosemide infusion is vital in reducing the likelihood of dehydration and restoring normal hydration levels in the body.
This method allows for careful regulation of the fluid level in the patient's body, which is especially important when addressing medical issues related to fluid balance. However, it is important to note that this method may require more strict medical supervision and dosage regulation. It demands more meticulous monitoring and dosage regulation to avoid the potential risk of fluid overload. In some cases, patients may not adhere to a strict continuous infusion schedule.

The advantages of prescribing Furosemide as Intermittent Bolus Injection include the convenience of patients receiving Furosemide at intervals between doses, reducing the risk of fluid overload. Among the disadvantages, it should be noted that this method is not effective in reducing B-type natriuretic peptide (BNP) levels and the patient's body mass. This method requires more strict regulation and monitoring to ensure correct intervals between doses and effective treatment.

Continuous infusion of furosemide has shown higher effectiveness compared to intermittent bolus injections, resulting in greater weight loss, increased daily diuretic function, and decreased BNP levels. However, both methods did not demonstrate differences in terms of mortality, length of hospitalization, the incidence of increased creatinine levels, and hypokalemia [2,3]. The analysis of BNP levels indicated that continuous infusion reduced BNP levels more effectively, but these changes did not correlate with mortality and hospitalization duration [4, 5].

Furthermore, the study found that Intermittent Bolus Injection administration is generally suitable for patients with moderately severe heart failure who can follow the prescribed medication schedule and require less intensive medical supervision. Conversely, Continuous Infusion is prescribed for severe heart failure patients who require intensive medical observation.

2. Influence of Ultrafiltration in the Treatment of Acute Heart Failure:

Ultrafiltration is a medical procedure used to remove excess fluid and inadequately cleared metabolic waste products from a patient's body. This process is employed in the treatment of acute heart failure and other conditions
where fluid balance is disrupted. Based on articles [6, 7], ultrafiltration may be a better alternative to diuretic therapy for patients with acute heart failure, especially in cases where diuretics do not lead to sufficient improvement in the patient's condition. Ultrafiltration is carried out using specialized devices that filter the patient's blood, remove excess fluid, and return purified blood back to the body. This method allows for more precise control of fluid removal and the patient's dehydration level, which can be crucial in cases of acute heart failure where fluid balance plays a key role. Ultrafiltration can also help reduce the strain on the heart and improve the patient's condition.

Ultrafiltration (UF) and diuretic therapy (DT) represent two different approaches to managing acute heart failure (AHF) with fluid overload. From the analysis, several key advantages of UF compared to DT can be highlighted [8-10].

1. Effective fluid removal:
   Compared to DT, UF demonstrates the potential to remove a larger volume of fluid in patients with AHF. This improvement in dehydration efficiency is particularly important for patients suffering from fluid overload, where the removal of excess fluid from the body can have a decisive impact on their condition.

2. Preservation of kidney function:
   On one hand, UF helps reduce the risk of worsening kidney function in AHF patients with fluid overload. This is particularly important as maintaining kidney health plays a crucial role in the overall success of heart failure treatment. UF may even reduce the risk of developing cardiorenal syndrome, a serious complication in cases where heart failure and kidney function abnormalities are closely related.

3. Reduction in the risk of AHF exacerbation and rehospitalization:
   Research indicates that UF reduces the risks of AHF exacerbation and rehospitalization in patients with heart failure. This is a significant aspect, as preventing relapses and maintaining a stable condition in such patients contributes to an improved quality of life and reduces healthcare costs.
4. Improvement in the quality of life:
   One study [11] identified that UF contributes to the improvement of the quality of life for patients, specifically reducing symptoms of breathlessness and signs of congestive heart failure. This means that patients can feel better, which is important for their overall well-being.

5. Reduction in the required diuretic dose:
   UF may allow for a reduction in the dose of diuretics typically used in heart failure treatment. This not only reduces the risks of side effects associated with diuretics but can also lead to healthcare cost savings.

6. Long-term benefits:
   It is important to note that UF can provide long-term benefits, including a decrease in rehospitalization rates for a significant period after treatment. This sets it apart from diuretic therapy, which may not yield such stable results.

In conclusion, based on the analysis of articles, it can be concluded that UF represents a justified alternative to diuretic therapy in the treatment of patients with acute heart failure and fluid overload. It provides more effective fluid removal, preserves kidney function, reduces the risks of AHF exacerbation and rehospitalization, improves the quality of life, and may even reduce the need for diuretics. The long-term benefits of UF further confirm its effectiveness in treating acute heart failure with fluid overload.

Conclusion:
Based on the analysis of furosemide and ultrafiltration in the context of acute heart failure treatment, it can be concluded that these methods are essential components in medical practice aimed at improving the quality of life and prognosis for patients. Heart failure remains one of the major medical challenges in contemporary society, and effective management of fluid balance in this condition plays a crucial role. Furosemide, as a loop diuretic, demonstrates its effectiveness in reducing circulating blood volume and arterial pressure, as well as increasing the excretion of urea and uric acid. Research findings confirm that continuous furosemide infusion can be particularly useful in cases requiring constant monitoring of the patient's fluid balance. However, this method also demands careful monitoring and
dosage regulation to avoid potential fluid overload. Ultrafiltration, on the other hand, presents a promising alternative to diuretic therapy, offering more precise control of fluid removal, preservation of kidney function, and a reduction in the risks of worsening the patient's condition. This method also allows for a reduction in the dose of diuretics, which can have a positive impact on patients and healthcare cost savings. However, both methods have their limitations and require further research to determine the optimal indications and application strategies. Importantly, both methods do not have a significant impact on mortality and hospitalization duration. Nevertheless, they contribute to the improvement of patients' quality of life and overall condition, making them important tools in the management of heart failure. In the end, furosemide and ultrafiltration represent promising methods for managing acute heart failure and fluid overload. Further research and clinical studies will help delineate their roles and optimal application strategies, ultimately contributing to improved patient care and a reduction in the burden on the healthcare system in the treatment of heart failure.

References:


