

# A Comprehensive Review of the Renal Safety And Stability of Torsemide in Patients with Chronic Kidney Disease and Heart Failure

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## ABSTRACT

Loop diuretics are commonly used in clinical practice for the treatment of fluid overload states associated with chronic kidney disease, congestive heart failure, and liver cirrhosis. These diuretics exert their action by inhibiting the reabsorption of sodium and chloride ions in the thick ascending limb of the loop of Henle, thus inducing diuresis and reducing extracellular fluid volume. Among all loop diuretics, torsemide and furosemide are commonly used in clinical practice. These two drugs, although belonging to the same pharmacological class, have shown significant differences in their pharmacokinetics, bioavailability, action, and clinical effects. Despite all the above-mentioned beneficial effects of torsemide, there is limited prospective clinical data on the effects of torsemide on various parameters of renal function, including GFR, serum creatinine, and BUN.

This review article aims to summarize the existing evidence of the efficacy of torsemide therapy and its effect on renal function in patients with CKD and heart failure. It also aims to present a prospective interventional study that will assess the effect of torsemide on renal function parameters, such as GFR, serum creatinine, and BUN. In addition, the study will also assess the renal safety of the drug, including acute kidney injury and electrolyte imbalance. In conclusion, this review article presents the potential role of torsemide as a safe and effective loop diuretic that may help maintain a stable renal function while effectively treating fluid overload in patients with cardiovascular and renal diseases.

**Keywords:** Torsemide, Loop diuretic, Chronic kidney disease, Heart failure, Glomerular filtration rate, Renal function, Diuretic therapy.

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## Introduction

Fluid overload is a condition frequently encountered in patients with chronic kidney diseases, heart failure, and liver cirrhosis. Fluid overload causes complications such as respiratory edema, peripheral edema, hypertension, and heart failure in patients. Loop diuretics are considered the first-line drugs for the treatment of fluid overload because of their potent natriuretic and diuretic properties.<sup>2,16</sup>

Loop diuretics work by inhibiting the sodium-potassium-chloride cotransporter located in the thick ascending limb of the loop of Henle of the nephron. This mechanism of action prevents sodium and chloride reabsorption, resulting in increased sodium and chloride excretion in the urine. This makes these drugs effective in reducing fluid volume within the body and relieving symptoms of fluid retention.<sup>1,37</sup>

Among all the loop diuretics, furosemide has been used most commonly as a drug of choice.

However, torsemide has received considerable attention in recent times because of its promising pharmacokinetic profile and potential clinical benefits. It has been observed that torsemide has a high bioavailability of 80–100%, whereas furosemide has variable bioavailability, ranging from 10% to 90%. This variable bioavailability of furosemide may lead to unpredictable clinical responses in patients.<sup>14, 15</sup> Besides, torsemide has been observed to have a longer half-life and prolonged duration of action compared with furosemide, which may be advantageous for controlling fluid overload states. In addition, torsemide may have additional clinical benefits by modulating neurohormonal systems, including the renin-angiotensin-aldosterone system (RAAS). It has been observed that torsemide may inhibit myocardial fibrosis mediated by aldosterone, leading to improved clinical outcomes.<sup>7,14</sup>

The maintenance of renal function is of particular interest in patients who have received diuretic treatment, especially in patients who have CKD. Excessive diuresis and changes in the

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hemodynamic of the kidneys have the potential to cause impairment of the kidneys or AKI.

However, the assessment of the effect of diuretic treatment on various renal functions such as GFR, creatinine, and blood urea nitrogen is crucial in the management of the patients.<sup>12,36</sup>

Although interest in torsemide has been rising, little prospective clinical data are available on its effects

### Pharm

### ecological Profile of Torsemide Mechanism of Action

Torsemide belongs to the class of diuretics known as loop diuretics. It works by inhibiting the  $\text{Na}^+/\text{K}^+/\text{2Cl}^-$  co-transporter in the thick ascending limb of the loop of Henle. Inhibiting this transporter reduces the reabsorption of sodium and chloride, resulting in increased loss of these ions, along with potassium, calcium, and magnesium, in the urine, thus decreasing the volume of extracellular fluid.<sup>1,37</sup>

### Pharmacokinetics

Torsemide demonstrates several pharmacokinetic advantages over other loop diuretics:

- **High oral bioavailability (80–100%)**
- **Longer half-life (approximately 3–6 hours)**
- **Longer duration of action (6–8 hours)**
- **Predictable dose–response relationship**
- **Pharmacodynamic Effects**

Torsemide

has a potent effect of increasing sodium and water excretion in urine. It also has the effect of decreasing venous pressure and symptoms of congestion in patients with heart failure. Other research has indicated that torsemide has the potential effect of inhibiting aldosterone- induced fibrosis, which could be beneficial for patients with cardiovascular and kidney diseases.<sup>2,7</sup>

### Literature Review

#### Study by Mohammad Al Mamun et al., 2025

The real-world observational study by Mohammad Al Mamun et al. examined the clinical outcomes of heart failure patients who are taking loop diuretics such as torsemide, furosemide, and bumetanide. The study has a large number of patients and examined mortality rates, hospitalization rates, and renal function parameters.<sup>4,9</sup>

The results showed that patients treated with torsemide had slightly better clinical outcomes compared to those treated with other loop diuretics. The mortality rate was lower among patients treated with torsemide, and no worsening of renal function was observed. This implies that torsemide could be effective in fluid management without impairing renal function..<sup>4,8</sup>

#### TRANSFORM-HF Trial, 2023

The TRANSFORM-HF trial is a randomized clinical trial aimed at evaluating the effectiveness of torsemide and furosemide in patients who were hospitalized due to heart failure. The main

on renal function parameters, with most studies focusing on cardiovascular outcomes, including mortality and hospitalization rates. Therefore, further studies are needed to determine whether torsemide could preserve renal function and adequately manage fluid overload in patients with CKD and heart failure.<sup>4,8</sup>

endpoint of the trial was all-cause mortality.<sup>1,8</sup>

### Discussion

The management of fluid overload in patients with CKD and heart failure demands the selection of diuretic therapy that balances fluid removal with renal function preservation. Torsemide has a number of pharmacological advantages that may contribute to better clinical outcomes compared with traditional loop diuretics.<sup>14,15</sup> Torsemide has a higher bioavailability and longer duration of action, resulting in more consistent diuretic responses that may reduce the need for dose adjustments. Furthermore, the potential for torsemide to exert anti-fibrotic effects may also contribute to better outcomes in patients with heart failure.<sup>7</sup>

### Impact on Glomerular Filtration Rate

One of the most important parameters for assessing kidney function is the glomerular filtration rate (GFR). Diuretic therapy affects the glomerular filtration rate because it affects renal blood flow and intraglomerular pressure. Excessive diuresis caused by diuretic therapy results in hypovolemia, which affects the glomerular filtration rate.<sup>22</sup>

Torsemide, when used in the right dosage, is effective in maintaining stable GFR in patients with heart failure or mild to moderate renal impairment. Torsemide is effective in increasing cardiac output and relieving venous congestion; these effects improve perfusion of the kidneys

and GFR.<sup>21</sup> In practice, serum creatinine levels may rise transiently in patients receiving diuretic therapy due to alterations in intravascular volume; however, these effects may not always be permanent and may be reversible. Monitoring of these parameters ensures that the benefits of diuretic therapy outweigh the risks to the kidneys.

<sup>31</sup>Torsemide in Heart Failure Management Role in Managing Fluid Overload

Fluid retention is one of the major characteristics of heart failure and is responsible for the occurrence of the symptoms. Fluid retention in the lungs leads to pulmonary congestion and breathlessness, while retention of excess fluids in the peripheral tissues leads to peripheral edema. Torsemide facilitates the process of diuresis and natriuresis, helping to get rid of excess fluids from the body.<sup>2</sup>

By reducing the volume of circulating blood, torsemide reduces the workload of the failing heart. This results in a relief of symptoms such as shortness of breath and fatigue. In most cases, diuretics such as torsemide are used for the relief of symptoms in patients with heart failure who show signs of fluid retention.<sup>16</sup>

#### Use in Patients with Coexisting Kidney Disease

patients with heart failure also have underlying compromised renal function. This situation is termed cardiorenal syndrome. The management of fluid balance in patients with cardiorenal syndrome may be problematic. Excessive diuretic use may compromise renal function further, and inadequate diuretic use may exacerbate heart failure symptoms.<sup>21</sup>

In this method, torsemide may be beneficial due to its predictable absorption and long duration of action. This enables the practitioner to achieve diuretic effects while limiting fluctuations in drug levels. Torsemide may be useful in maintaining a stable fluid balance in patients with both heart failure and renal impairment.<sup>14</sup>

#### Combination Therapy in Heart Failure

Torsemide is not often employed as a single agent for heart failure treatment. It is normally employed as part of a multi-faceted approach that also involves other agents like angiotensin- converting enzyme inhibitors, beta blockers, mineralocorticoid receptor antagonists, and sodium-glucose cotransporter-2 inhibitors. Although the first three agents are thought to influence the pathophysiology of heart failure, torsemide has a more symptomatic effect by managing fluid overload.<sup>34,35</sup>

#### Monitoring Parameters in Patients Receiving Torsemide

The monitoring parameters include the assessment of renal function, electrolytes, fluid balance, cardiovascular parameters, metabolic changes, and

possible interactions of the drug. These monitoring parameters play a crucial role in the optimization of treatment outcomes.

#### 1. Renal Function Monitoring

Monitoring renal function is one of the most important parameters in the management of torsemide. As the diuretic action of torsemide involves the renal system, there is a potential effect on the renal system, especially in those with underlying renal impairment.<sup>12</sup> Parameters that need to be checked for the assessment of renal function include creatinine, blood urea nitrogen, and the estimated glomerular filtration rate. The assessment of these parameters is essential in determining whether the kidneys are filtering the metabolic waste products appropriately. In the case of chronic kidney diseases, the renal function should be checked before the administration of the drug.<sup>36</sup>

Rise in serum creatinine and BUN levels may be a sign of deteriorating renal function or over- diuresis resulting in dehydration. eGFR levels need to be monitored to assess the progression of kidney disease and titrate the dosage of Torsemide accordingly. In patients with advanced stages of CKD, close monitoring is required as the drug response is altered due to decreased clearance of drugs by the kidneys.<sup>46</sup>

#### 2. Electrolyte Monitoring

Electrolyte disturbances are among the most common complications associated with loop diuretic therapy. Torsemide promotes the excretion of sodium, potassium, chloride, calcium, and magnesium through urine. Therefore, regular monitoring of electrolyte levels is essential.<sup>1</sup> Serum potassium levels are particularly important because hypokalemia is a frequent adverse effect of loop diuretics. Low potassium levels can lead to muscle weakness, cardiac arrhythmias, and fatigue.<sup>11</sup> Magnesium and calcium levels should also be assessed because long-term diuretic therapy may lead to deficiencies that contribute to neuromuscular and cardiovascular complications.

#### <sup>37</sup>Fluid Balance and Hydration Status

Monitoring fluid balance is essential to evaluate the therapeutic effectiveness of torsemide and to prevent complications associated with excessive diuresis. Accurate measurement of fluid intake and urine output helps clinicians determine whether the diuretic effect is appropriate.

<sup>1</sup>Assessment of clinical signs such as edema, pulmonary congestion, and jugular venous distention also helps determine the effectiveness of torsemide therapy.<sup>2</sup> Signs of dehydration, including dry mucous membranes, decreased skin turgor, and hypotension, should be evaluated to avoid complications from excessive fluid loss.

### 3. Blood Pressure Monitoring

The drug can have a significant impact on blood pressure as it is a diuretic and natriuretic. This is in the sense that the drug can reduce the volume of blood in the body. This can lead to a reduction in the pressure of the blood. Blood pressure needs to be monitored regularly, especially in patients with hypertension.<sup>1,41</sup>

Hypotension is a possible side effect of over-diuresis and may cause symptoms such as dizziness, fainting, or weakness. Monitoring both systolic and diastolic blood pressure will ensure that the drug is effective while at the same time preventing a fall in blood pressure.<sup>1</sup> Orthostatic measurements of blood pressure may also be needed in the elderly or patients with autonomic dysfunction. A fall in blood pressure when a patient stands up may show volume depletion and require adjustment of the dosage of torsemide.<sup>28</sup>

### 4. Cardiac Monitoring

Cardiac monitoring plays a crucial role in patients with heart failure who are undergoing treatment with torsemide. Alterations in the levels of certain electrolytes, e.g., low levels of potassium (hypokalemia) and magnesium (hypomagnesemia), may predispose a patient to the occurrence of cardiac arrhythmias. In this case, electrocardiography may be used to detect certain abnormalities, e.g., QT interval prolongation, ventricular arrhythmias, and conduction abnormalities. Patients with existing cardiovascular diseases and those on cardiac glycosides should be monitored closely to prevent any complications that may arise from arrhythmias. The heart rate and rhythm are constantly monitored to detect any imbalances or drug interactions that may affect the heart.<sup>27</sup>

### 5. Metabolic Parameter Monitoring

The metabolic parameters are also altered during torsemide treatment. Therefore, it is imperative to monitor them. It is known that loop diuretics can cause alterations in glucose metabolism, uric acid, and lipid levels.<sup>11</sup> Uric acid level in the blood is also to be regularly monitored during torsemide treatment. This is because torsemide can cause hyperuricemia by reducing uric acid excretion in the urine. Gout attacks may also be precipitated. Therefore, in patients with a history of gout, it is imperative to monitor uric acid levels and take appropriate measures to prevent gout attacks.<sup>28</sup> Glucose level in the blood is also to be monitored during torsemide treatment. This is particularly applicable in diabetic patients. In diabetic patients, it is known that loop diuretics can cause hyperglycemia. In addition, it can also cause impaired glucose tolerance. Therefore, it is imperative to monitor blood glucose levels in

diabetic patients. In addition, it is known that loop diuretics can cause alterations in lipid levels. However, these alterations are less significant compared to other antihypertensives.<sup>1</sup>

### Conclusion

Torsemide is a well-established loop diuretic that is effective in the treatment of fluid overload conditions in patients with chronic kidney disease and heart failure. Its favorable pharmacokinetic profile, which includes high bioavailability and longer duration of action, enables the drug to provide sustained diuretic activity. Evidence of the effectiveness of torsemide in the maintenance of stable renal function has been established, and its potential benefits are demonstrated in comparison to other loop diuretics. However, the available body of research is limited, and more prospective studies are required to fully elucidate its potential benefits in the maintenance of renal function. The proposed study aims to provide more evidence regarding the impact of torsemide on the most important renal function parameters, namely glomerular filtration rate, serum creatinine, and blood urea nitrogen. This would be helpful in making appropriate clinical decisions regarding the choice of diuretics in the treatment of CKD and heart failure, which would improve patient outcomes.

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