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Original Research Article

A prospective observational study on loop diuretic utilization in a tertiary care hospital setting

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ABSTRACT

Background: Loop diuretics are essential for managing fluid overload in conditions like heart failure and chronic kidney disease. However, data on their utilization and adverse outcomes in resource-limited settings are scarce. To evaluate utilization patterns, adverse drug reactions (ADRs), and outcomes of loop diuretic therapy in a tertiary care hospital.
Methods: A prospective observational study was conducted on 100 inpatients from January 2023 to October 2023. Data on demographics, clinical indications, ADRs, and prescription patterns were analyzed.
Results: Furosemide was most prescribed (70%), followed by torsemide (20%) and bumetanide (10%). Main indications included congestive heart failure (40%), hypertension (24%), and chronic kidney disease (20%). Common ADRs were hypokalemia (16%), hypotension (10%), and dehydration (6%). Symptomatic improvement was noted in 70% of cases, with 20% showing no change and 10% worsening. Economic costs exceeded ₹1,000/month for 30% of patients, despite high medication adherence (80%).
Conclusions: Furosemide remains the most used diuretic, but ADRs and economic burdens highlight the need for regular monitoring and cost-effective strategies. Personalized therapy can optimize outcomes, and further multicenter studies are required for broader insights.

Keywords: Loop diuretics, Furosemide, Adverse drug reactions, Prescription patterns, Economic cost, Therapeutic outcomes

INTRODUCTION

Loop diuretics are essential medications widely utilized for managing fluid overload conditions, including heart failure, nephrotic syndrome, cirrhosis, hypertension, and edema.[1] These drugs function by reducing sodium (Na+) reabsorption in the thick ascending limb of the loop of Henle, where approximately 25% of Na+ in the glomerular filtrate is reabsorbed.

This inhibition leads to increased urinary excretion of sodium and water, effectively alleviating fluid overload.[2] Additionally loop diuretics decrease calcium (Ca++) and magnesium (Mg++) reabsorption while enhancing potassium (K+) excretion, contributing to their complex electrolyte-modulating effects.[3] Commonly used loop diuretics, including furosemide, torasemide, bumetanide, and piretanide, share a mechanism of action but differ in metabolism, pharmacokinetics, and potency.

Furosemide is glucuronidated, while bumetanide and torasemide undergo metabolism via cytochrome P450 pathways, influencing their clinical profiles. Torasemide's longer half-life allows for once-daily dosing and relatively potassium-sparing effects, making it a potential alternative to furosemide in specific patient populations.[4,5] Bumetanide's rapid onset and marked diuretic effect make it suitable for conditions requiring acute fluid removal.

Ethacrynic acid, another loop diuretic, is especially useful in patients allergic to sulfa drugs but has notable side effects, including ototoxicity.[6,7] In clinical practice, loop diuretics are pivotal in managing acute decompensated heart failure, controlling hypervolemia, and preventing complications such as pulmonary edema.

However, their use can lead to significant adverse drug reactions (ADRs), including electrolyte imbalances and diuretic resistance, particularly in elderly patients or those with chronic kidney disease (CKD) or hepatic cirrhosis.[8,9] Resistance mechanisms include pharmacokinetic alterations affecting drug access to the urine and pharmacodynamic changes that blunt diuretic efficacy.[10]

This prospective observational study aims to assess the utilization of loop diuretics in a tertiary care hospital. The objectives include analyzing demographic details of patients, ADRs associated with loop diuretic therapy, and understanding their role in various clinical conditions. The findings will provide insights into optimizing loop diuretic use, minimizing ADRs, and improving therapeutic outcomes.

Objectives

Primary objective

To assess the drug utilization study on loop diuretics

Secondary objectives

To describe the potential adverse effects of loop diuretics. To study the prescription pattern of loop diuretics. Examining relationships between variables, such as medication adherence and economic cost or therapeutic outcomes

METHODS

Study type

This was an insightful prospective observational study.

Study place

The study was carried out at a leading tertiary care hospital in Bangalore.

Study duration

The study was conducted over a period of ten months, from January to October 2023.

Study population

The study population comprised 100 inpatients admitted to a tertiary care hospital, selected based on predefined inclusion and exclusion criteria to ensure the reliability and relevance of the research findings.

Inclusion criteria

The inclusion criteria for the study were as follows, patients diagnosed with fluid overload conditions such as heart failure, nephrotic syndrome, cirrhosis, or hypertension; patients prescribed loop diuretics (e.g., furosemide, bumetanide, piretanide, or torasemide) as part of their treatment regimen; adults aged 18 years and older who are capable of giving informed consent; patients with stable renal function at the time of study enrollment; and those willing and able to comply with study procedures and follow-up.

Exclusion criteria

The exclusion criteria for the study were as follows: patients with a history of hypersensitivity or allergic reactions to loop diuretics; pregnant or breastfeeding women, due to potential risks to the fetus or infant; patients with severe renal impairment (e.g., end-stage renal disease requiring dialysis) at the time of study enrolment, patients currently participating in another clinical trial that may interfere with the study results, patients with acute kidney injury or any condition that could interfere with the metabolism of loop diuretics; and patients with uncorrected electrolyte imbalances (e.g., severe hypokalemia or hyperkalemia) prior to study inclusion.

Sources of data and materials

Sources of data and materials included patient case sheets, encompassing initial assessment charts, laboratory parameters (primarily electrolytes), medication charts, identification of loop diuretics administered, documentation of any ADRs caused by loop diuretics, and analysis of the prescription patterns of loop diuretics.

Method of collection of data

Data were collected through a prospective observational study conducted in the General Medicine, Cardiology, and Nephrology departments, as well as in the wards.

Patients meeting the criteria were enrolled, and their demographic details, presenting complaints, past history, laboratory parameters, and medications (specifically loop diuretics) were recorded.

Data on drug interactions, adverse drug reactions (ADRs), and medication adherence and cost were collected.

Prescription patterns, including medication type, frequency, dose, and route, were monitored. All data were documented in a designated collection form and tracked until patient discharge.

Ethical considerations

Participants were provided with detailed information about the study and were required to give written informed consent before enrolment.

To ensure confidentiality, all data were anonymized and stored securely, safeguarding the privacy and integrity of the participants' information.

Statistical analysis

Statistical analysis was performed using IBM SPSS version 22 (Armonk, NY, USA) for both descriptive and inferential statistics. Regression analysis was employed to examine relationships between variables, including medication adherence, economic cost, and therapeutic outcomes, providing insights into the factors influencing these aspects within the study population.

RESULTS

In the study of 100 patients using loop diuretics, 58% were males, and 42% were females. The most represented age group was 61-70 years (30%), followed by 51-60 years (24%) and 41-50 years (16%).

Smaller proportions were observed in the 30-40 years (8%), below 30 years (6%), 71-80 years (6%), and above 80 years (10%) age groups. The mean age was 57.2 years, with a standard deviation of 15.53, reflecting a moderate spread across a wide age range from below 30 to above 80, details are depicted in Table 1.

In the study of 100 patients, the most common clinical indication for loop diuretics was congestive heart failure, accounting for 40% of cases, followed by hypertension (24%) and chronic kidney disease (20%). Non-cardiac edema and liver cirrhosis were less common, representing 10% and 6% of cases, respectively.

Drug interactions were frequently noted, including ACE inhibitors and ARBs for congestive heart failure and NSAIDs for chronic kidney disease. Oral administration was the preferred route, with a daily frequency for all conditions. These details are summarized in Table 2.

In the study of 100 patients, furosemide was the most commonly prescribed loop diuretic, used by 70% of patients, with 64% receiving it intravenously and 48% on a twice-daily regimen. Torsemide was prescribed to 20% of patients, predominantly orally, and bumetanide to 10%, exclusively orally. Common drug interactions included aminoglycosides and lithium with furosemide and antidiabetic agents with torsemide. Therapeutically, 70% of patients reported improved symptomatic relief, while 20% experienced no change, and 10% saw their condition worsen. These details are summarized in Table 3.

In a study of 100 patients, ADRs were observed, with hypokalemia being the most common (16%), followed by hypotension (10%) and dehydration (6%), each presenting varying clinical implications such as muscle weakness, dizziness, and dry mouth.

Medication adherence was high among 80% of patients, while 16% demonstrated moderate adherence, and only 4% exhibited low adherence. Regarding economic costs, 20% of patients incurred expenses of less than ₹500 per month, half spent between ₹500 and ₹1000, and 30% faced costs exceeding ₹1000 monthly, reflecting diverse financial impacts. These details are summarized in Table 4.

Regression analysis revealed no statistically significant relationships between medication adherence and either economic cost or therapeutic outcomes. For adherence and economic cost, the intercept (2.049) aligns with the average cost category (~₹500-₹1000), while the coefficient (0.025) suggests a negligible increase in cost with adherence ($p=0.853$, $R^2=0.00035$).

Similarly, for adherence and therapeutic outcomes, the intercept (2.924) reflects high average outcomes, but the coefficient (-0.120) indicates a weak, negative association ($p=0.370$, $R^2=0.0082$). These findings suggest adherence does not significantly impact economic costs or therapeutic outcomes in this model, details depicted in Table 5.

Table 1: Socio-demographic characteristics.

Category	Subcategory	No. of patients	%	Mean age	Standard deviation
Gender	Male	58	58	57.2	15.53
	Female	42	42	-	-
Age group (years)	Below 30	6	6	-	-
	30-40	8	8	-	-
	41-50	16	16	-	-
	51-60	24	24	-	-
	61-70	30	30	-	-
	71-80	6	6	-	-
	Above 80	10	10	-	-

Table 2: Clinical indications and loop diuretics prescribed (100 patients).

Clinical indications	Patients (n=100)	%	Drug interactions	Route of administration	Frequency
Congestive heart failure	40	40	ACE inhibitors, ARBs	Oral	Daily
Hypertension	24	24	Beta-blockers, calcium channel blockers	Oral	Daily
Chronic kidney disease	20	20	NSAIDs, ACE inhibitors	Oral	Daily
Edema (non-cardiac)	10	10	None	Oral	Daily
Liver cirrhosis	6	6	Anticoagulants, hepatotoxic drugs	Oral	Daily

Table 3: Loop diuretics prescribed and therapeutic outcomes (100 patients).

Loop diuretics prescribed	Patients (n=100)	%	Drug interactions	Route of administration	Frequency
Furosemide	70	70	Aminoglycosides, lithium	IV (64%), PO (18%)	OD (26%), BID (48%)
Torsemide	20	20	Antidiabetic agents	PO (18%)	BD (4%), OD (14%)
Bumetanide	10	10	Digitalis, aminoglycosides	Oral	Daily
Therapeutic outcomes					
Improved symptomatic relief	70	70	-	-	-
No change	20	20	-	-	-
Worsening condition	10	10	-	-	-

Table 4: ADRs, medication adherence, and economic cost (100 patients).

ADRs	Patients (n=100)	%	Details
Hypokalemia	16	16	Decreased potassium levels, muscle weakness, arrhythmias
Hypotension	10	10	Low blood pressure, dizziness, fainting
Dehydration	6	6	Excessive fluid loss, dry mouth, low blood pressure
Medication adherence			
High adherence	80	80	-
Moderate adherence	16	16	-
Low adherence	4	4	-
Economic cost			
<₹500 per month	20	20	-
₹500-₹1000 per month	50	50	-
>₹1000 per month	30	30	-

Table 5: Regression analysis.

Variable	Intercept	Coefficient	P value	R squared
Adherence-economic cost	2.049	0.025	0.853	0.00035
Adherence-therapeutic outcomes	2.924	-0.12	0.37	0.0082

DISCUSSION

This prospective observational study on loop diuretic utilization in a tertiary care hospital setting provides critical insights into prescription patterns, ADRs and therapeutic outcomes. The findings are compared with existing research to highlight similarities, differences, and implications for clinical practice.

Furosemide was the most frequently prescribed loop diuretic, accounting for 70% of prescriptions, followed by torsemide (20%) and bumetanide (10%). The preference for furosemide aligns with its widespread use due to cost-effectiveness and ease of intravenous administration. Studies have demonstrated similar trends, with furosemide being the most utilized diuretic in hospitalized patients with acute decompensated heart failure.[11,12]

However, torsemide's longer half-life and better pharmacokinetic profile have been shown to improve patient adherence and outcomes in chronic heart failure compared to furosemide.[13] The relatively low usage of torsemide in this study may reflect physician familiarity or cost considerations, as observed in other developing countries.[14] The primary indications for loop diuretics in this study were congestive heart failure (40%), hypertension (24%), and chronic kidney disease (20%). These findings are consistent with previous reports highlighting the essential role of loop diuretics in managing fluid overload conditions in heart failure and chronic kidney disease.[15,16]

However, the utilization in hypertension appears lower in high-income countries, where newer antihypertensive agents are preferred.[17] This suggests regional differences in practice patterns, possibly influenced by resource availability. Hypokalemia (16%), hypotension (10%), and dehydration (6%) were the most common ADRs observed. These results are consistent with known pharmacological effects of loop diuretics. Hypokalemia remains a significant concern, particularly in elderly or chronic kidney disease patients.[18] A systematic review reported similar ADR profiles, underscoring the need for regular electrolyte monitoring during therapy.[19] Innovative strategies, such as combining loop diuretics with potassium-sparing diuretics, have been recommended to mitigate these effects.[20]

Symptomatic improvement was noted in 70% of patients, while 20% showed no change, and 10% experienced worsening conditions. These outcomes are similar to those reported in large-scale trials evaluating diuretic efficacy in heart failure and chronic kidney disease.[21,22] The lack of improvement in some patients could be attributed to diuretic resistance, a phenomenon frequently observed in chronic conditions.[23] Resistance mechanisms, including decreased drug delivery to renal sites and adaptive responses, have been extensively documented.[24]

High adherence (80%) was observed among most patients, reflecting the relatively simple dosing regimens. However, 30% of patients faced economic costs exceeding ₹1,000 monthly, indicating financial strain. Studies in high-income settings have demonstrated improved adherence and outcomes with fixed-dose combinations and patient education programs.[25] Implementing such interventions could alleviate cost burdens and enhance adherence in similar settings. However, regression analysis revealed no statistically significant relationships between medication adherence and either economic cost or therapeutic outcomes. The findings underscore the importance of tailoring loop diuretic therapy to individual patient profiles, considering clinical indications, ADR risk factors, and economic constraints. Regular monitoring of electrolytes and kidney function is critical to minimize ADRs. The adoption of torsemide in appropriate cases and the implementation of educational programs for patients and healthcare providers could optimize outcomes.

This study provides valuable data on loop diuretic utilization in a tertiary care hospital in India, contributing to the limited literature from low- and middle-income countries. However, the single-centre design and relatively small sample size may limit generalizability. Future multicentre studies with larger populations are warranted to validate these findings.

CONCLUSION

This study provides valuable insights into the utilization patterns, adverse effects, and therapeutic outcomes associated with loop diuretics in a tertiary care setting. Furosemide remains the most prescribed diuretic, while adverse effects such as hypokalemia highlight the need for vigilant monitoring. Regional variations in prescribing practices underscore the importance of local guidelines and cost-effective strategies. Optimizing diuretic use requires personalized approaches, adherence support, and addressing economic barriers to improve overall patient outcomes. Further multicenter research is essential to confirm these findings and guide clinical practice in diverse settings.

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