Medical Research Archives

European Society of Medicine

OPEN ACCESS

Published: June 30, 2024

Citation: Charra C, Haboubacar ID, et al., 2024. The Prescribing Patterns of Diuretics in Intensive Care Retrospective Study About 64 Cases, Medical Research Archives, [online] 12(6). https://doi.org/10.18103/mra.v12i6.5247

DOI
https://doi.org/10.18103/mra.v12i6.5247

ISSN: 2375-1924

CASE REPORT

The Prescribing Patterns of Diuretics in Intensive Care Retrospective Study About 64 Cases

Boubakar Charra*, Idi Djibadjé Haboubacar, Tougar Sanaa, Nijimbere Roselyne

***Corresponding author:** Head of Department of Medical Intensive Care, Ibn Rochd University Hospital, Faculty of Medicine and Pharmacy of Casablanca, Hassan 2 University, Casablanca, Morocco. Email: boubaker.ch68@gmail.com

ABSTRACT:
Diuretics are commonly recommended in medical practice, utilized for both chronic management and emergency interventions in intensive care units., due to their powerful pharmacological effect. However, their use in the intensive care setting is sometimes inappropriate and excessive, leading to errors in indication and significantly increased iatrogenic harm.
Our study aims to evaluate the use of diuretics in intensive care units by examining the indications for prescription as well as their clinical and biological impacts, in order to elucidate practical guidelines for optimal use ensuring relevant and safe employment while eliminating harmful practices that could have serious consequences for the health of intensive care patients.
To achieve this, we conducted a retrospective descriptive case series study involving patients hospitalized in the medical intensive care unit of CHU Ibn Rochd in Casablanca from January 1, 2022, to December 31, 2022. Demographic, clinical, paraclinical, therapeutic, and evolutionary data were collected.
Out of the 292 patients hospitalized in the medical intensive care unit during the year 2022, 64 cases of diuretic use were collected, with an incidence of 21.91%. The most frequent indications for diuretic use in our series were acute renal failure and inadequate diuresis, followed by acute respiratory distress syndrome and heart failure. Furosemide was the only diuretic prescribed in our series. Following diuretic administration, hemodynamic, metabolic, and organic complications were observed. The most frequently encountered complications were arterial hypotension requiring the use of vasoactive drugs in some cases, hypokalemia, and impaired renal function. Mortality was high in our series, with death occurring in 77% of our patients.
The indications for diuretics in intensive care have changed over the last decade. They are no longer recommended in cases of acute renal failure to maintain diuresis or to preserve renal function, nor in hepatorenal syndrome as this can worsen renal perfusion and acute renal injury. However, as part of fluid balance regulation by the intensivist, diuretic administration may be considered in organ congestion, particularly pulmonary, and in various situations such as ventilatory weaning, acute heart failure, and acute respiratory distress syndrome, provided that this use is carefully evaluated and associated with precise administration modalities, in addition to appropriate compensatory treatments to prevent their adverse effects.

Keywords: Diuretics, metabolic disorders, Body hydration states, Hemodialysis

Introduction

Diuretic compounds are therapeutic substances widely and successfully used in the treatment of a variety of medical conditions throughout the world. All diuretic agents act primarily by altering Na+ reabsorption in the renal tubules, thereby increasing iso-osmotic urinary hydro sodium excretion [1].

However, they differ considerably in their chemical derivation and mechanism of action, i.e. the specific tubular ion transport systems they interfere with. The latter determines the site of action along the nephron where each class of diuretic acts, and because of physiological differences in the amount of Na+ reabsorbed between different segments of the nephron, it also determines the natriuretic efficacy, pharmacological effects and specific clinical indications of each diuretic [2,3].

Diuretics are commonly used in medical practice, both as chronic treatment for conditions such as hypertension, heart failure, chronic renal failure and cirrhosis, or in emergency treatment in intensive care settings, where they are widely prescribed for oedematose states, and more specifically for acute lung oedema, acute renal failure, hyperkaliemia, oedemato-ascitic decompensation and many other uses aimed at regulating the fluid balance [4,17,18]. Furthermore, iatrogenic effects induced by diuretics are certain and frequent[19]. It may be of moderate severity, such as hypokalemia which is detected and compensated for in time, or it may be more severe, as some studies have suggested, with the possibility of increased mortality when diuretics are used [5] , as well as excessive diuresis leading to a significant reduction in circulating volume, with the associated risk of reduced tissue perfusion.

Given their significant and powerful pharmacological effect, diuretics are often used inappropriately and abused, particularly in intensive care[26,27]. Errors of indication are common, underlining the complexity of the use of this seemingly innocuous and dangerous treatment and the need for a considered approach that raises the following questions:

- ✓ Are hemodynamic and renal physiology not adversely affected by the administration of the diuretic?
- ✓ Is the benefit obtained relevant?
- ✓ Is the benefit obtained preferable to the inconvenience caused?

This dilemma highlights the paradox in the use of diuretics, where the expected benefits must be carefully weighed against the risks, calling for careful consideration of their relevance in clinical management.

The aim of our study is to evaluate the use of diuretics in the ICU by examining the indications for their prescription and their clinical and biological impact. The aim is therefore to elucidate the practical guidelines for optimal use of diuretics in the ICU, based on established scientific data, and to specify, for each prescription, the objectives and monitoring required to ensure appropriate and safe use, while eliminating harmful practices that could have adverse consequences for the health of ICU patients.

Patients and methods

This is a retrospective descriptive study of patients hospitalized in the medical intensive care unit of the Ibn Rochd University Hospital, Casablanca, over a one-year period from 1 January 2022 to 31 December 2022 who received diuretic treatment during their stay in the unit, in order to evaluate the use of diuretics in intensive care.

A clinico-biological summary was carried out for each patient enrolled in order to identify the various indications that justified the use of diuretics, their methods of use, including the choice of drug, the route of administration, the dosage and the duration of treatment, on the basis of an operating form that collected relevant clinical and paraclinical data. Pathological histories were collected, in particular pre-existing cardiovascular, renal, hepatic, respiratory, neurological or metabolic pathologies. Initial data on admission for the assessment of hemodynamic, respiratory and neurological status were also collected. At the paraclinical level, the data collected included imaging results (chest X-ray, echocardiogram and renal ultrasound) and biological parameters, in particular: natremia, kaliemia, calcaemia, magnesemia, plasma urea and creatinine were collected as appropriate.

Lastly, the progress of each patient was analyzed: improvement and/or clinico-biological deterioration, secondary improvement or death. Thus, of the 292 patients hospitalized that year in the department, 64 cases of diuretic use were identified and analyzed.

Exclusion criteria: These were patients who had received osmotic diuretics.

We used Microsoft Excel software and SPSS version 24.0 to perform univariate analysis, which examined the mean or median, standard deviation, and range for quantitative variables, and proportions (%) for qualitative variables.

Results

- ✓ Among the 292 patients admitted to the medical intensive care unit during the year 2022, there were 64 cases in whom diuretics were used, representing an incidence of 21.91%.
- ✓ The mean age of our patients was 51.3 ± 17.6 years, ranging from 17 to 80 years. There was a slight male predominance (56%), with a sex ratio M/F = 1.285.
- ✓ History Of the 64 patients, 26 (40.62%) had a history of cardiovascular disease, mainly hypertension, 23 (35.9%) were diabetics, and 12 (18.75%) had a history of respiratory disease, including respiratory insufficiency, 7 (10.93%) had a history of kidney disease, in particular glomerulopathy and chronic renal failure, 4 (6.3%) had a neurological history, 3 (4.8%) had systemic diseases and 1 (1.6%) had liver failure.
- ✓ The reasons for hospitalization are summarized in Table I below.

Reasons of hospitalization	workforce	Percentage%
ARDS	17	26.56
Diabetic acidocetosis	14	21.87
Septic shock	5	7.81
Leptospirosis	5	7.81
Meningitis and meningoencephalitis	4	6.25
Drug intoxication	3	4.68
Status epilepticus	3	4.68
Haemorrhagic shock	2	3.12
Hypercalcemia	2	3.12
Cardiac decompensation and PAO	2	3.12
Tetanus	2	3.12
Acute renal failure	1	1.6
Acute fulminant hepatitis	1	1.6
Ischaemic stroke	1	1.6
Anaphylactic shock	1	1.6
Malaria	1	1.6

Table 1: the reasons for hospitalization

- ✓ **hemodynamic** status on admission was assessed as stable in 42 patients, representing 65.6% of the group studied. Total diuresis was maintained in 43 patients (67.18% of cases). 13 patients were oliguric, i.e. 20.31% of cases, and 8 were anuric, i.e. 12.5% of cases. Vasoactive drugs were used in 20 patients, i.e. 31.3% of cases, while 68.8% of cases did not require vasoactive hemodynamic support.

- ✓ **Biological parameters on admission:**
  - Kaliemia: the median value was 4.4 meq/l, with extremes, minimum of 2.3 meq/l and maximum of 8.8 meq/l.
  - Natremia: the median value was 139 meq/l, with extremes of a minimum of 110 meq/l and a maximum of 171 meq/l.
  - Calcaemia: the median value was 89 mg/l, with extremes of a minimum of 20 mg/l and a maximum of 183 mg/l.
  - Magnesemia: the median value was 89 mg/l, with extremes of a minimum of 25 mg/l and a maximum of 92 mg/l.
  - Plasma urea: The median value was 1.34 g/l, with a minimum of 0.23 g/l and a maximum of 5.04 g/l.
  - Creatinine: The median value was 26.5 mg/l, with a minimum of 5.1 mg/l and a maximum of 261 mg/l.

- ✓ **Glomerular filtration according to the MDRD formula**

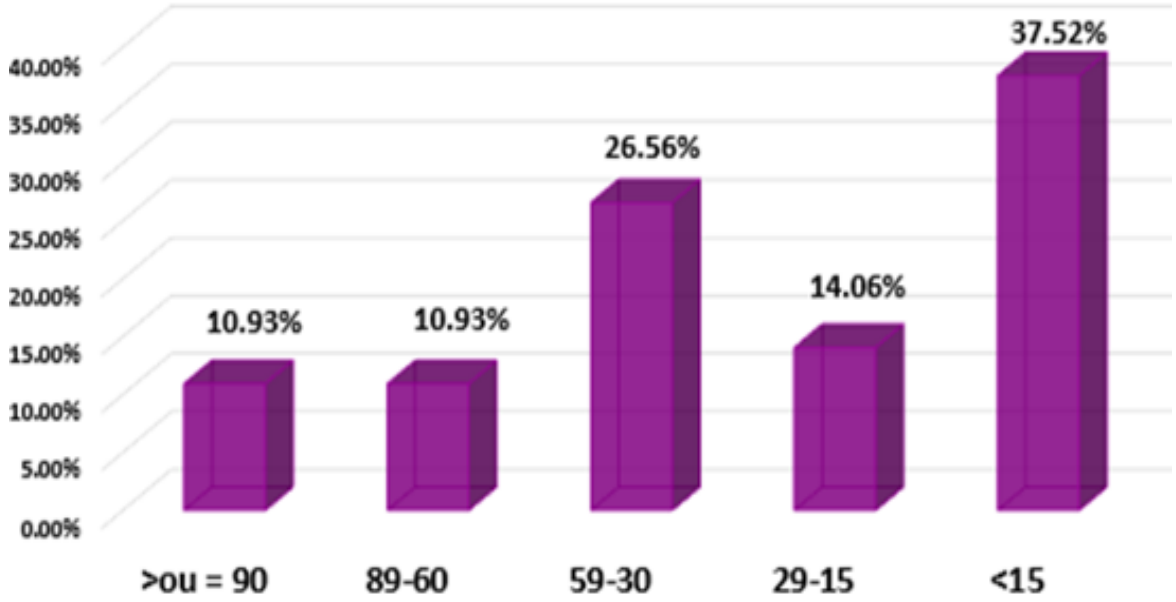

Figure 1: distribution of patients according to glomerular filtration rate

Reasons of hospitalization	workforce	Percentage%
ARDS	12	18.75
Diabetic acidocetosis	9	14.06
Septic shock	5	7.81
Leptospirosis	5	7.81
Meningitis and meningoencephalitis	4	6.25
Drug intoxication	3	4.68
Cardiac decompensation and PAO	2	3.12
Haemorrhagic shock	2	3.12
Tetanus	2	3.12
Acute fulminant hepatitis	1	1.56
Hypercalcemia	1	1.56
Malaria	1	1.56
Status epilepticus	1	1.56
Anaphylactic shock	1	1.56

Table 2: Breakdown of patients who died according reason for hospitalization

✓ Indications for use of diuretics

The indications justifying the use of diuretics, mainly included acute renal failure, identified in 45 patients, representing 70.31% of cases, and diuresis deemed insufficient in 34 patients, or 53.12%. Respiratory distress syndrome was present in 14 patients, or 21.87% of cases. Cardiac failure was observed in 11 patients (17.18% of cases). Other indications included peripheral oedema and oedema of the lower limbs in 11 patients (17.18% of cases), acute lung oedema in 8 patients (12.5% of cases), chronic renal failure in 5 patients (7.81%

of cases), hepatocellular insufficiency in 5 patients (7.81% of cases), and arterial hypertension in only 1 patient (1.6% of cases). It should be noted that in some cases, several indications were combined in the same patient.

- ✓ In our study, furosemide was the only diuretic used, and the IV route of administration was used in all patients. The median dose of furosemide used per 24 hours was 240 mg, with extremes of a minimum of 40 mg and a maximum of 1000 mg.
- ✓ The median duration of administration was 3 days, with extremes of a minimum of one day and a maximum of 13 days.
- ✓ The complications encountered in our patients and to which the use of diuretics could contribute or give rise are summarized in Table 3.

Sides effects	Workforce	Percentage %
	➢ Hemodynamic complications	
Low blood pressure (PAS <or= 90 mmhg)	34	53.12
Hemodynamic instability and use of vasoactive drugs	32	50
	➢ Metabolic complications:	
Hyperkaliemia	13	20.31
Hypokalemia	10	16.1
Hyponatremia	8	12.5
Hypernatremia	2	3.1
Hypocalcemia	15	23.43
Hypomagnesaemia	6	9.37
Metabolic alkalosis	12	18,75
	➢ Organic complications:	
Impaired renal function	20	31,25
Ototoxicity	0	0
Anti-androgenic effect	0	0

Table 3: Distribution of patients according to their evolution

✓ **Distribution of patients according to outcome.** Following use of the diuretic, hemodynamic optimization was achieved in 53 patients (82.8% of cases). A clinico-biological improvement was observed in 12 patients (18.8% of cases), a clinico-biological deterioration with alteration of renal function, necessitating recourse to dialysis, was observed in 24 patients (37.5%), 3 of whom subsequently improved (4.68% of cases), while 21 patients died after recourse to hemodialysis (32.8% of cases in our study group). However, 28 patients in our study series who received diuretic treatment died initially without recourse to hemodialysis, i.e. 43.8% of cases.

Discussion

➢ ANATOMOPHYSIOLOGY OF THE KIDNEYS

The kidneys are solid organs, the main function of which is the formation of urine thanks to the nephron, which is the functional unit. Each kidney weighs on average 150 g and is shaped like a bean, containing between 400 and 800,000 nephrons. Each nephron contains a glomerulus and a tubule that follows it. Each tubule is made up of different specialized segments, which enable the composition of the glomerular ultrafiltrate to be modified (by secretion and reabsorption phenomena between the tubular fluid and the capillaries), culminating in the final urine. Through its exocrine and endocrine properties, the kidney plays an essential role in the homeostasis of the internal environment [4].

➢ CLASSIFICATION OF DIURETICS ACCORDING TO THEIR SITES AND MECHANISMS OF ACTION [22].

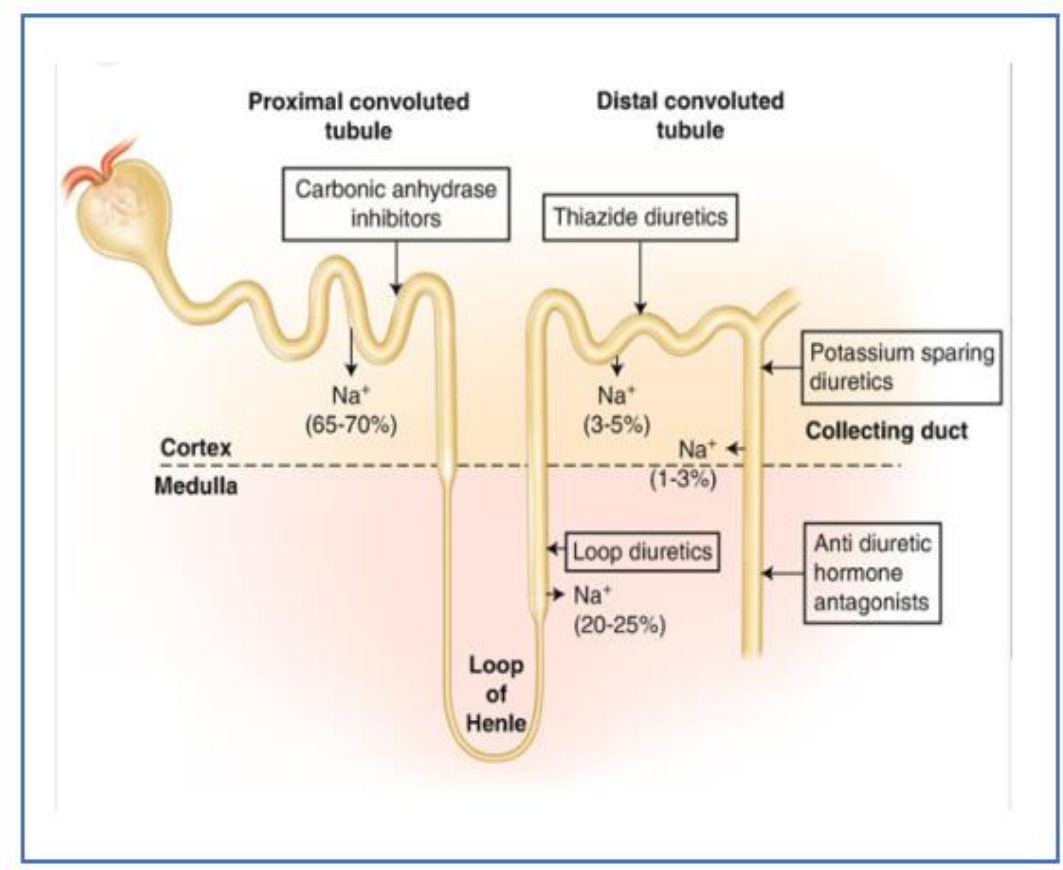

Figure 2: Classification of diuretics according to their sites and mechanisms of action[22].

A distinction is made between:

- Carbonic anhydrase inhibiting diuretics
- Loop diuretics: Na+/K+/2Cl- cotransporter inhibitors
- Thiazides and related diuretics: Na+/Cl- cotransporter inhibitors
- Potassium-sparing diuretics:
- Aquaretic: vasopressin receptor antagonists

The use or initiation of diuretic treatment requires a number of precautions, including in particular:

✓ Assessment of the freedom of the excretory tract
✓ Assessment of absolute hydration
✓ Assessment of relative hydration
✓ Assessment of systemic hemodynamics
✓ Assessment of renal risk
✓ Assessment of the risk of hypokalemia
✓ Diuretic titration

➢ INDICATIONS FOR DIURETIC TREATMENT

❖ **Diuretics and heart failure in intensive care:**

Decompensated heart failure is one of the most frequent causes of admission in patients over the age of 65, and is responsible for more than one million hospital admissions each year in the United States[6]. The vast majority of episodes of acute heart failure are characterized by an increase in symptoms and signs of congestion accompanied by volume overload. In this case, chronic sodium and water retention further increases intravascular volume, leading to excessive accumulation of extravascular fluid. The aim of treatment in these

patients is to relieve congestion by achieving a state of euvolemia.

The diuretics most commonly used in acute heart failure are loop diuretics, particularly furosemide. These are the most potent diuretics, which is why they are also known as high ceiling diuretics[7 ,21].
A Cochrane review of 7 clinical trials compared the outcomes and adverse effects of continuous infusion of loop diuretics with those of intravenous bolus administration in patients with acute heart failure. This review demonstrated that higher diuresis and a better safety profile were achieved when loop diuretics were administered via continuous infusion[23].

- **Diuretics and acute renal failure and inadequate diuresis in intensive care:**

ARF is characterized by a sudden and sustained decrease in glomerular filtration rate. The KDIGO international working group has defined ARF according to 3 stages of severity (stages 1, 2 and 3).

As diuresis is a major criterion of good hemodynamics in intensive care, some practitioners frequently resort to diuretics to maintain it, but this attitude is open to criticism in many respects. It is crucial to note that furosemide increases urine output without improving creatinine clearance or renal function. A temporary increase in urine output induced by furosemide may create false confidence that the drug has solved the problem or altered the course of acute renal failure [8].

In a cohort study of 552 patients in 4 intensive care units, Mehta et al. reported that diuretics were used in 59% of patients with AKI. A statistical analysis taking into account confounding factors showed that the use of diuretics was associated with higher mortality but also with poorer recovery of renal function.

Interestingly, the absence of an increase in diuresis after administration of diuretics (> 400 ml.d-1) was associated with a poorer prognosis.

Several randomized studies show that diuretics have not altered the natural course of renal function in acute renal failure. Therefore, they are considered ineffective and even harmful in the prevention and treatment of this condition, having no effect on the duration of renal failure, the need for dialysis, the number of sessions required for renal recovery, or hospital mortality[24,25].

Dans notre série, les diurétiques étaient principalement utilisés pour traiter l'insuffisance rénale aiguë, mais seulement 13,7% des cas ont montré une amélioration sans hémodialyse. Une diminution de plus de 30% du débit de filtration glomérulaire a été observée chez 31,25% des participants après le traitement diurétique, remettant en question leur effet bénéfique et soulignant leur potentiel nocif sur la fonction rénale et l'évolution clinique des patients

Diuretics are therefore no longer recommended in the treatment of ARF to maintain diuresis and/or preserve renal function [9].

- **Diuretics and respiratory failure in intensive care:**

Acute lung injury and acute respiratory distress syndrome are a major cause of acute respiratory failure in critically ill patients.

The multicenter, controlled, randomized, single-blind IRIHS study confirms that diuretics could easily reduce fluid balance, with good cardiac and renal safety in ARDS[10].

In our study, ARDS was also an indication for the use of diuretics, particularly furosemide, in 21.87% of cases.

- **Diuretics and hepatocellular failure in the intensive care unit:**

Hepatocellular failure, frequently triggered by decompensated cirrhosis, represents an extremely serious clinical condition in the intensive care unit, marked by a very poor prognosis in the absence of emergency liver transplantation[11].Hepatorenal syndrome is therefore a functional renal failure that occurs in cirrhotic patients at the stage of end-stage hepatocellular failure.

Excessive prescription of diuretic therapy in the management of ascites can lead to impaired renal function (by increasing effective hypovolemia, which in turn increases the activity of vasoconstrictor systems). A randomized study compared ascites puncture alone with the combination of spironolactone and furosemide in the treatment of ascites, and showed that the occurrence of renal failure was more frequent in the group treated with diuretics (27.1% versus 3.4%). It is therefore recommended that all diuretics be discontinued at the time of initial assessment and diagnosis of SHR, and even that vasodilators and NSAIDs be withdrawn [12,13] .

- **Diuretics and hypertensive emergencies in intensive care:**

Hypertensive emergencies are defined as situations where severely elevated blood pressure, typically

a systolic value greater than 180 mmHg and/or a diastolic value greater than 120 mmHg, is associated with acute and potentially life-threatening organ damage in one of the following key organs: brain, arteries, retina, kidney and/or heart [14].

Specific clinical presentations of hypertensive emergencies include:

Malignant hypertension (hemorrhages, cottony nodules, papilledema) Hypertensive encephalopathy, Hypertensive thrombotic microangiopathy.

The most effective drugs listed for the treatment of hypertensive emergencies include nicardipine, labetalol, esmolol and clevidipine.

Diuretics are of no use in the emergency treatment of BP. Their effect on blood pressure is highly unpredictable and most patients do not experience hypervolemia but rather volume depletion, particularly in patients with malignant hypertension, and the administration of a diuretic in combination with an anti-hypertensive agent may lead to a sudden drop in blood pressure[15]. Diuretics should be avoided unless specifically indicated in cases of volume overload, as occurs in coexisting renal parenchymal disease or pulmonary oedema.

❖ **Osmotic diuretics in neuro-resuscitation:**

The blood-brain barrier has permeability properties similar to those of an isolated cell, exhibiting higher permeability to water than to ions such as sodium (Na+), potassium (K+), or chloride (Cl-). Because of these properties, brain tissue is extremely sensitive to changes in plasma osmolarity. Thus, a variation in blood sodium concentration can, at any time, alter the water content of the brain and lead to sudden and harmful fluctuations in intracranial pressure [16].

➢ THE ADVERSE EFFECTS OF DIURETIC TREATMENT ARE:

- ✓ Hemodynamic: arterial hypotension
- ✓ Hydro electrolytic: hypovolemia, hypokalemia, hyperkaliemia, hyponatremia,
- ✓ Metabolic side effects include hyperuricemia, carbohydrate intolerance, dyslipidemia, metabolic alkalosis, metabolic acidosis.
- ✓ Other adverse effects include renal dysfunction, anti-androgenic effects, ototoxicity, etc.

Diuretics have been incriminated in the aggravation of pre-existing renal failure during treatment of acute heart failure, and more generally in the development or aggravation of cardio-renal syndrome[7].

In our study, glomerular filtration rate fell by more than 30% after diuretic treatment in 31.25% of our patients. Consequently, care should be taken to detect situations where the administration of diuretics and the occurrence of their well-known side-effects (reduced venous return, dehydration) could have more serious consequences. Indeed, the onset of renal dysfunction, generally diagnosed by oliguria and elevated creatinine levels, is a late sign of renal damage.

There were no cases of ototoxicity in our study, but its presence means that its association with ototoxic antibiotics such as aminoglycosides is contraindicated [8].

➢ RECOMMENDATIONS FOR GOOD PRACTICE IN THE ADMINISTRATION OF DIURETICS IN INTENSIVE CARE UNITS

Diuretics, particularly loop diuretics when prescribed outside of chronic treatments, are among the most difficult treatments to administer correctly.

✓ **Recommended indications and contraindications for the use of diuretics:**

In the light of all that has been said, it is suggested that the use of diuretics in the resuscitation setting may be recommended, tolerated or inadvisable. In view of these aspects, the following recommendations are proposed:

▪ **INDICATIONS ENCOURAGED:**

- Cardiogenic and non-cardiogenic pulmonary oedema
- Acute heart failure with signs of fluid overload
- Threatening hyperkaliemia

▪ **INDICATIONS TOLERATED:**

- Acute respiratory distress syndrome and ventilatory weaning
- Regulation of fluid balance in cases of hydrosodal inflation, provided there is a reason for anti-diuresis and the circulating volume is able to tolerate subtraction.
- Threatening hypercalcemia

▪ **CONTRAINDICATIONS :**

- Acute rénal Failure
- Hépatorénal syndrome
- Hypernatremia
- Reduced venous return in a preload-dependent patient
- Hydro sodium depletion

Diuretic	Clinical Uses	Contraindication	Adverse Effects
Loop Diuretic	Edematous disorders (congestive heart failure, hepatic cirrhosis, and nephrotic syndrome), hypertension with glomerular filtration rate <30 mL/min, hypercalcemia, SIADH given with NaCl, and renal tubular acidosis	Hypersensitivity to sulfa agents, gout, pregnancy, nonreversible anuria	Volume depletion, decreased serum K^+, Na^+, Mg^+, and H^+. Increased uric acid, glucose, cholesterol, LDL, and triglycerides. Nausea, ototoxicity, and allergic interstitial nephritis
Thiazides	Nephrogenic diabetes insipidus, mild edema, and renal calcium stones.	Hypersensitivity to sulfa agents, gout, hepatic failure, and renal failure	Orthostatic hypotension. Decreased serum Na^+, K^+, Mg^+, and H^+. Modest increases in Ca^{2+}. Increases in serum uric acid, glucose, cholesterol, LDL, and triglycerides. Erectile dysfunction, impotence, and lithium accumulation
"Thiazide-like" agents (eg, chlorthalidone and indapamide)[a]	Hypertension and resistant hypertension	Ditto	Ditto
Potassium Sparing Pteridines: Triameterene & amiloride.	Pteridine derivatives: Hypertension with K+ &/or Mg+ loss, Liddle's syndrome	Hyperkalemia, concomitant use of ACEIs or ARBs, & renal failure, hepatic failure, pregnancy (particularly triamterene)	Increase serum K+, Cl-, & H+. Nausea, flatulence & skin rash with amiloride or triamterene, nephrolithiasis with triamterene. Gynecomastia & decreased libido in men with spironolactone
Aldosterone antagonists: Spironolactone & Eplerenone.	Aldosterone antagonists: Hypertension with K &/or Mg loss, resistant hypertension, Primary aldosteronism and other mineral corticoid excess,[b] CHF[c]		
Carbonic anhydrase inhibitors	Glaucoma, metabolic alkalosis, altitude sickness, and diuretic resistance	Hypersensitivity to sulfonamides, metabolic acidosis, pregnancy, hepatic failure, and renal failure	Volume depletion, hypokalemia, hyperchloremic metabolic acidosis, light-headedness, circumoral paresthesias, weakness, and confusion
Osmotic agents	Cerebral edema	CHF, volume depletion, and nonreversible anuria	Low volume, K^+, and H^+. CHF, headache, nausea, vomit, fever, confusion, and lethargic state
Arginine vasopressin antagonists	Short-term use in euvolemic or hypervolemic hyponatremia, syndrome of inappropriate antidiuretic hormone.		Increased thirst, dry mouth, hypokalemia, hypernatremia. EVEREST trial shows small but statistically significant increase in risk of stroke

Abbreviations: SIADH, syndrome of inappropriate antidiuretic hormone secretion; LDL, low-density lipoprotein; CHF, congestive heart failure; ACEIs, angiotensin-converting enzyme inhibitors; ARBs, Angiotensin II receptor blockers; EVEREST, efficacy of vasopressin antagonism in heart failure outcome study with tolvaptan.

[a] Like thiazides, these agents act on the distal convoluted tubule. However, they lack the benzothiadiazine ring framework of the thiazides and are more potent in lowering of blood pressure.

[b] Familial hyperaldosteronism type I (glucocorticoid remedial hyperaldosteronism) and familial hyperaldosteronism type 2 (apparent mineral corticoid excess).

[c] Spironolactone in CHF with New York Heart stages 3 or 4. Eplerenone in CHF with New York Heart stage 2 and in those with decreased ejection fraction following myocardial infarction.

Table 4: Summarizing the properties, indications and adverse effects of each class of diuretic[20]

Conclusion

When diuretics are prescribed outside of chronic treatment, they are among the most difficult treatments to manage correctly.

The use of diuretics is no longer indicated in acute renal failure to maintain diuresis or preserve renal function, or in hepatorenal syndrome, since they do not alter the natural course of glomerular filtration and may even become harmful by causing excessive diuresis that is insufficiently compensated by the transfer of fluid from the extravascular to the intravascular sector. This entails a risk of renal hypoperfusion, which aggravates the ARF.

However, as part of the resuscitator's efforts to regulate the fluid balance, the administration of diuretics may be considered, subject to careful consideration and repeated and thorough verification of the prerequisites for the use of this pharmacological class, combined with scrupulous administration procedures in addition to treatments which compensate for some of their known and controlled effects.

References:

1. Sarafidis PA, Georgianos PI, Lasaridis AN. Diuretics in clinical practice. Part I: mechanisms of action, pharmacological effects and clinical indications of diuretic compounds. *Expert Opinion on Drug Safety*. 2010;9(2):243-257. Doi:10.1517/14740330903499240
2. Brater DC. Pharmacology of Diuretics. *The American Journal of the Medical Sciences*. 2000;319(1):38-50. Doi:10.1016/s0002-9629(15)40678-0
3. Greenberg A. *Primer on Kidney Diseases E-Book*. Elsevier Health Sciences; 2009.
4. Hausfater P. Effets indésirables des diurétiques
5. Mehta R, Pascual M, Soroko S, Chertow G. Diuretics, mortality, and nonrecovery of renal function in acute renal failure. *ACC Current Journal Review*. 2003;12(2):68-69. Doi:10.1016/s1062-1458(03)00064-3
6. Felker GM, Lee KL, Bull DA, Redfield MM, Stevenson LW, Goldsmith SR, LeWinter MM, Deswal A, Rouleau JL, Ofili EO, Anstrom KJ, Hernandez AF, McNulty SE, Velazquez EJ, Kfoury AG, Chen HH, Givertz MM, Semigran MJ, Bart BA, Mascette AM, Braunwald E, O'Connor CM. Diuretic Strategies in Patients with Acute Decompensated Heart Failure. *New England Journal of Medicine*. 2011;364(9):797-805. Doi:10.1056/nejmoa1005419
7. Carles Trullàs J, Morales-Rull JL, Formiga F. Tratamiento con diuréticos en la insuficiencia cardíaca aguda. *Medicina Clínica*. 2014;142:36-41. Doi:10.1016/s0025-7753(14)70081-8
8. Ho KM, Power BM. Benefits and risks of furosemide in acute kidney injury. *Anaesthesia*. 2010;65(3):283-293. Doi:10.1111/j.1365-2044.2009.06228.x
9. Richard C, Saudan P, Ernandez T. Utilisation des diurétiques : ce que le praticien doit connaître. Rev Médicale Suisse. 2015; Doi: 10.53738/revmed.2015.11.463.0482
10. Seitz KP, Caldwell ES, Hough CL. Fluid management in ARDS: an evaluation of current practice and the association between early diuretic use and hospital mortality. J Intensive Care. 12 oct 2020;8(1):78. Dio:10.1186/s40560-020-00496-7
11. Cheyron D du, Bouchet B, Charbonneau P. Insuffisance rénale aiguë chez les patients cirrhotiques en réanimation : incidence et pronostic. Réanimation. 1 nov 2007, Doi:10.1016/j.reaurg.2007.08.006
12. New Consensus Definition of Acute Kidney Injury Accurately Predicts 30-Day Mortality in Patients with Cirrhosis and Infection. Gastroenterology. 1 déc 2013; Doi:1053/j.gastro.2013.10.016
13. Moore KP, Wong F, Gines P, Bernardi M, Ochs A, Salerno F, et al. The management of ascites in cirrhosis: Report on the consensus conference of the international Ascites club. Hepatology. 2003; Doi:10.1053/jhep.2003.50315
14. Papadopoulos DP, Sanidas EA, Viniou NA, Gennimata V, Chantziara V, Barbetseas I, et al. Cardiovascular Hypertensive Emergencies. Curr Hypertens Rep. 27 janv 2015; Doi: 10.1007/s11906-014-0515-z.
15. Varon J, Marik PE. clinical review: the managment of hypertensive crises. Crit Care. 2003;7(5):374. Doi: 10.1007/978-1-4757-5551-0_77
16. Vigué B. L'hypernatrémie contrôlée est-elle utile en neuroréanimation? Ann Fr Anesth Réanimation. sept 2010;29(9):e189-92. Doi:10.1016/j.annfar.2010.06.009
17. Klouche, K., Sandapa, D., Barrau, H., *et al*. Insuffisance rénale aiguë en réanimation—Prévention et traitement. *Médecine Intensive Réanimation*, 2011, vol. 20, no Suppl. 2, p. 552-559 Doi: 10.1007/s13546-010-0030-4.
18. Hedin E, Bijelić V, Barrowman N, Geier P. Furosemide and albumin for the treatment of nephrotic edema: a systematic review. Pediatr Nephrol Berl Ger. août 2022;37(8):1747-57 Doi: 10.1007/s00467-021-05358-4.
19. Tran, P., & Banerjee, P. (2020). Iatrogenic decompensated heart failure. *Current Heart Failure Reports*, *17*, 21-27. Doi: 10.1007/s11897-020-00452-4
20. Roush, G.C., Kaur, R., & Ernst, M.E. (2014). Diuretics. *Journal of Cardiovascular Pharmacology and Therapeutics, 19*, 13 - 5.
21. Friocourt, P. (2011). Traitement de l'insuffisance cardiaque du sujet âgé. *NPG Neurologie-Psychiatrie-Gériatrie*, *11*(63), 114-123 Doi: 10.1016/j.npg.2011.01.001.
22. Kuppachi, S., Fraer, M. (2018). Diuretics in Heart Failure. In: Desai, C., Cotts, W., Lerma, E., Rudnick, M. (eds) Ventricular-Assist Devices and Kidney Disease. Springer, Cham. Doi:10.1007/978-3-319-74657-9_4
23. Allen LA, Turer AT, DeWald T, Stough WG, Cotter G, O'Connor CM. Continuous Versus Bolus Dosing of Furosemide for Patients Hospitalized for Heart Failure. Am J Cardiol. juin 2010;105(12):1794-7. Doi:10.1016/j.amjcard.2010.01.355
24. Mehta RL, Pascual MT, Soroko S, Chertow GM. Diuretics, Mortality, and Nonrecovery of Renal Function in Acute Renal Failure. Doi: 10.1016/s1062-1458(03)00064-3

25. Ejaz AA, Mohandas R. Are diuretics harmful in the management of acute kidney injury? Curr Opin Nephrol Hypertens.mars2014;23(2): 155-60. Doi:10.1097/01.mnh.0000441150.17202.be

26. Bartoli, E., Rossi, L., Sola, D., Castello, L., Sainaghi, P. P., & Smirne, C. (2017). Use, misuse and abuse of diuretics. European Journal of Internal Medicine, 39, 9-17. Doi:10.1016/j.ejim.2017.01.016

27. Harrois, A. Y A-T-Il Encore Une Indication Aux Diurétiques En Réanimation?.Mapar 2015