

# A COMPARATIVE STUDY TO OBSERVE THE SAFETY AND EFFICACY OF ULTRAFILTRATION VERSUS INTRA VENOUS DIURETIC DURING VALVULAR HEART SURGERY

Dr. AshwanthPreddy<sup>1</sup>, Dr. VigneshRavikumar<sup>2</sup>, Theyjhovathi B<sup>3</sup>, S. George Miller<sup>4</sup>, Dr. J Ramkumar<sup>5</sup>, DrPeriyasamyThangavel<sup>6</sup>

<sup>1</sup>Assistant Professor, Department of Cardio Thoracic Vascular Surgery, Sri Ramachandra Medical College And Research Institute, Sri Ramachandra Institute of Higher Education and Research, Chennai

<sup>2</sup>Assistant Professor, Department of Cardio Thoracic Vascular Surgery, Sri Ramachandra Medical College And Research Institute, Sri Ramachandra Institute of Higher Education and Research, Chennai.

<sup>3</sup>Perfusionist, Department of Cardio Thoracic Vascular Surgery, Sri Ramachandra Medical College And Research Institute, Sri Ramachandra Institute of Higher Education and Research, Chennai.

<sup>4</sup>Perfusionist, Department of Cardio Thoracic Vascular Surgery, Sri Ramachandra Medical College And Research Institute, Sri Ramachandra Institute of Higher Education and Research, Chennai.

<sup>5</sup>Professor, Department of Cardio Thoracic Vascular Surgery, Sri Ramachandra Medical College And Research Institute, Sri Ramachandra Institute of Higher Education and Research, Chennai.

<sup>6</sup>Professor, Department of Cardio Thoracic Vascular Surgery, Sri Ramachandra Medical College And Research Institute, Sri Ramachandra Institute of Higher Education and Research, Chennai.

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## Abstract

To study the efficacy and safety of ultra filtration versus intravenous diuretics for patients undergoing valvular heart surgery.

## INTRODUCTION

### AIM

To study the efficacy and safety of ultra filtration versus intravenous diuretics for patients undergoing valvular heart surgery.

## MATERIALS AND METHODS

• This was a single-center retrospective study. From August 2021 to August 2022, thirty consecutive patients who underwent cardiac surgeries on cardiopulmonary bypass (CPB) at SRIHER were analyzed.

### METHODS:

GROUP-1: Randomized to conventional ultrafiltration GROUP-2:Randomized to peri-operativeLasixadministration

### INCLUSION CRITERIA

- Patients Age>30years
- Patients undergoing valvular heart surgery on cardiopulmonary bypass
- Ejection fraction>40%
- Excessive hemodilution

### EXCLUSIONCRITERIA

- Hypovolemic patients
- Sepsis
- Acute kidney injury
- Patients with Electrolyte imbalance

### CIRCUIT:

1/2\*3/8adult circuit

## DATA COLLECTION

- Arterial Blood sample was collected from patient during rewarming (28°C--33°C) and after rewarming (33°C-36°C) in CPB for ABG analysis.
- Patient's pre-operative and post-operative(POD-2ndday) RFT(serum creatinine, BUN, sodium, potassium, chloride, and bicarbonate) investigation were collected

## EQUIPMENT

- Heart lung machine (Stockert,sarns8000)
- Hemothem(Stockert,Cincinnati)
- Adult membrane oxygenator(Sorin-inspire)
- Cardioplegia reservoir(Spictra)
- Hemofilter

## RESULT AND STATISTICS

• **STATISTICAL ANALYSIS:** The statistical analysis was carried out using Levene's and T-test. Descriptive statistics, frequency analysis, percentage analysis, mean, and standard deviation were all used to describe the data. The significance difference between the paired groups was assessed using the T-test (PRE-OP, POST-OP, and PERI-OP). The significance of the data was evaluated using the Levene's test. The probability value P 0.05 is regarded as significant in all of the aforementioned statistical methods.

• This study consists of two groups (GROUP-1 and GROUP-2).

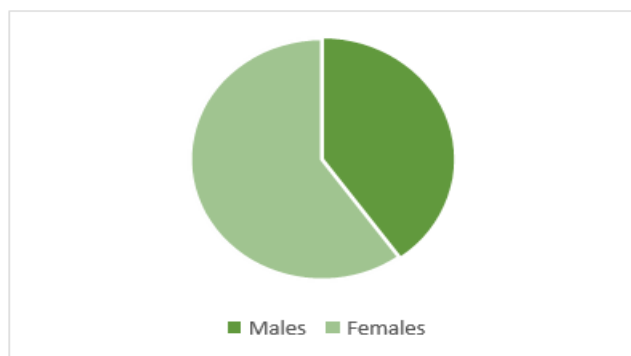
GROUP-1 was randomized to conventional ultra filtration while GROUP-2 was randomized to perioperative Lasix administration.

Significance level	specification
P>0.05	Not significant
P≤0.05	Significant
P≤0.001	Highly significant

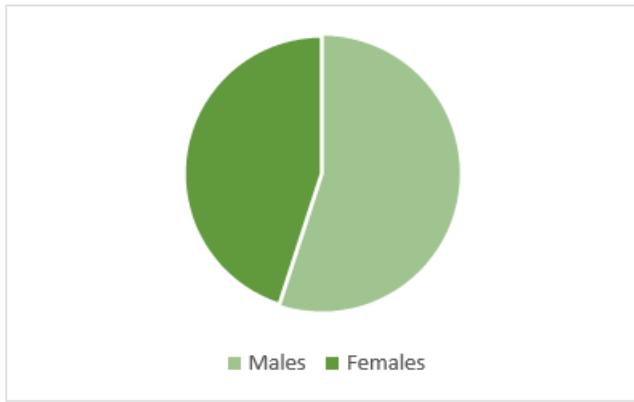
Crosstab

			Groups		Total
			Group1	Group2	
Sex	F	Count	4	6	10
		% Within Group	26.7%	40.0%	33.3%
	M	Count	11	9	20
		% Within Group	73.3%	60.0%	66.7%
Total		Count	15	15	30
		% Within Group	100.0%	100.0%	100.0%

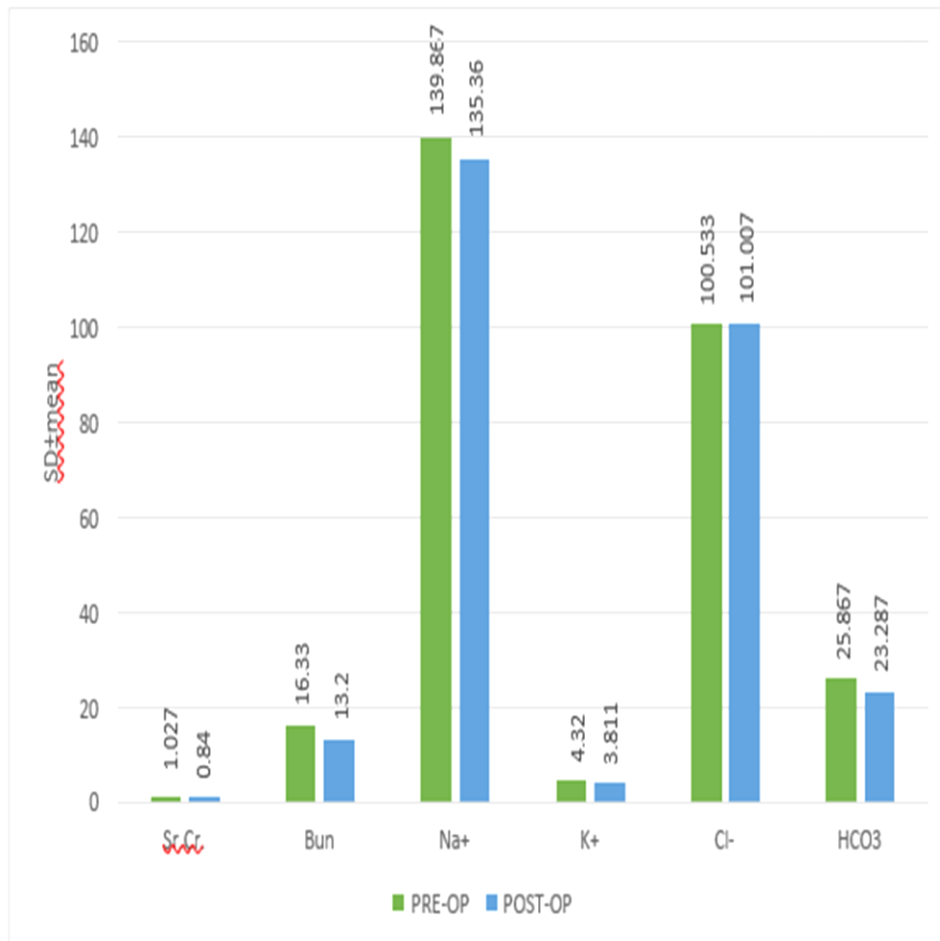
## GROUP-1

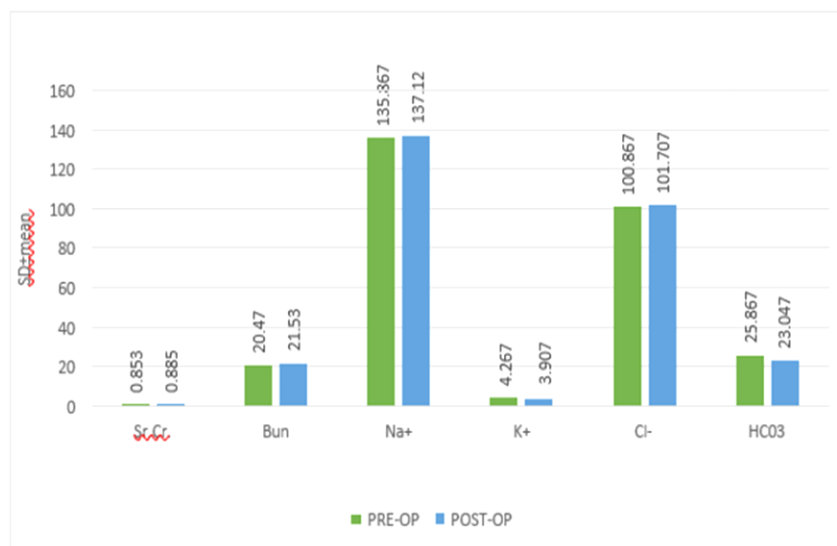


GROUP-2



GROUP-1





Group Statistics

Group	N	Mean	Std.Deviation	P value	
Sr.cr-Preop	Group1	15	1.027	.3453	.101
	Group2	15	.853	.1846	.733
Sr.cr-Postop	Group1	15	.840	.2746	.098
	Group2	15	.880	.3550	.733

Group Statistics

Group	N	Mean	Std.Deviation	P value	
Bun -Preop	Group1	15	16.33	9.826	.015
	Group2	15	20.47	4.678	.018
Bun-Postop	Group1	15	13.20	9.149	.055
	Group2	15	21.53	5.150	.068

Group Statistics

Group	N	Mean	Std.Deviation	P value	
Na+-Preop	Group1	15	139.867	3.9073	1.000
	Group2	15	135.867	2.8752	1.000
Na+-Postop	Group1	15	135.360	2.6787	.057
	Group2	15	137.120	3.7301	.063

Group Statistics

Group		N	Mean	Std.Deviation	P value
K+-Preop	Group1	15	4.320	.5401	.770
	Group2	15	4.267	.4435	.770
K+- Postop	Group1	15	3.811	.4745	.070
	Group2	15	3.907	.4978	.070

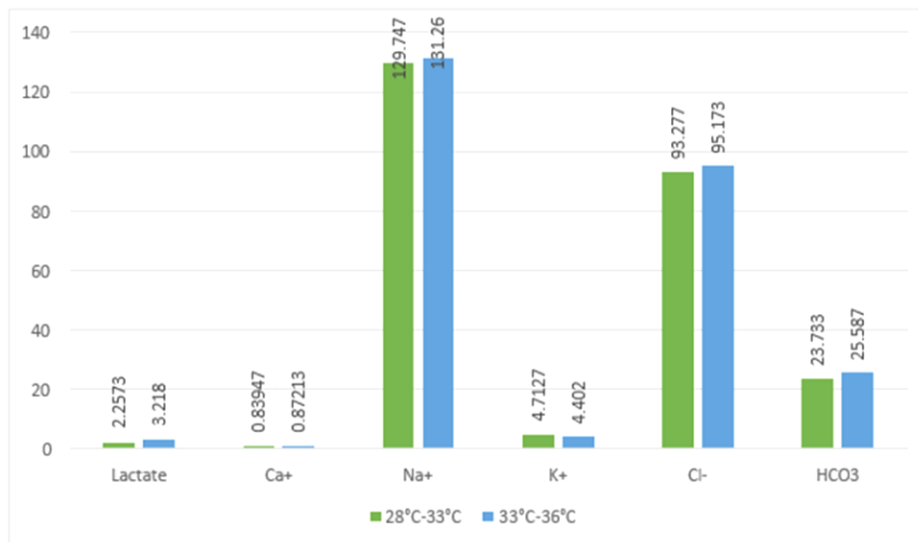
Group Statistics

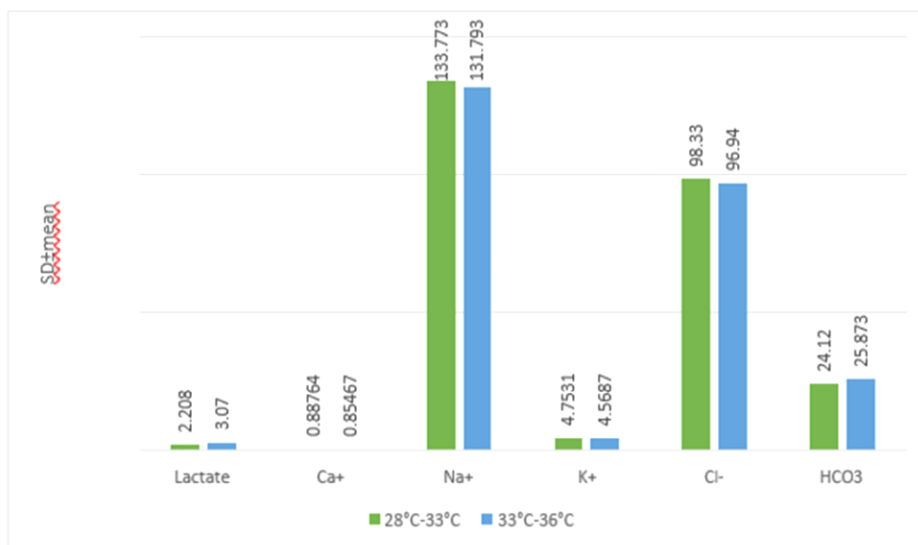
Group		N	Mean	Std.Deviation	P value
Cl_ -Preop	Group1	15	100.533	4.8087	.822
	Group2	15	100.867	3.0206	.822
Cl_ -Postop	Group1	15	101.007	5.3162	.679
	Group2	15	101.707	3.6972	.679

Group Statistics

Group		N	Mean	Std.Deviation	P value
HCO3-Preop	Group1	15	25.867	3.0907	1.000
	Group2	15	25.867	2.2949	1.000
HCO3-Postop	Group1	15	23.287	3.9609	.108
	Group2	15	23.047	3.4002	.108

PERI-OP(GROUP-1)





Group Statistics

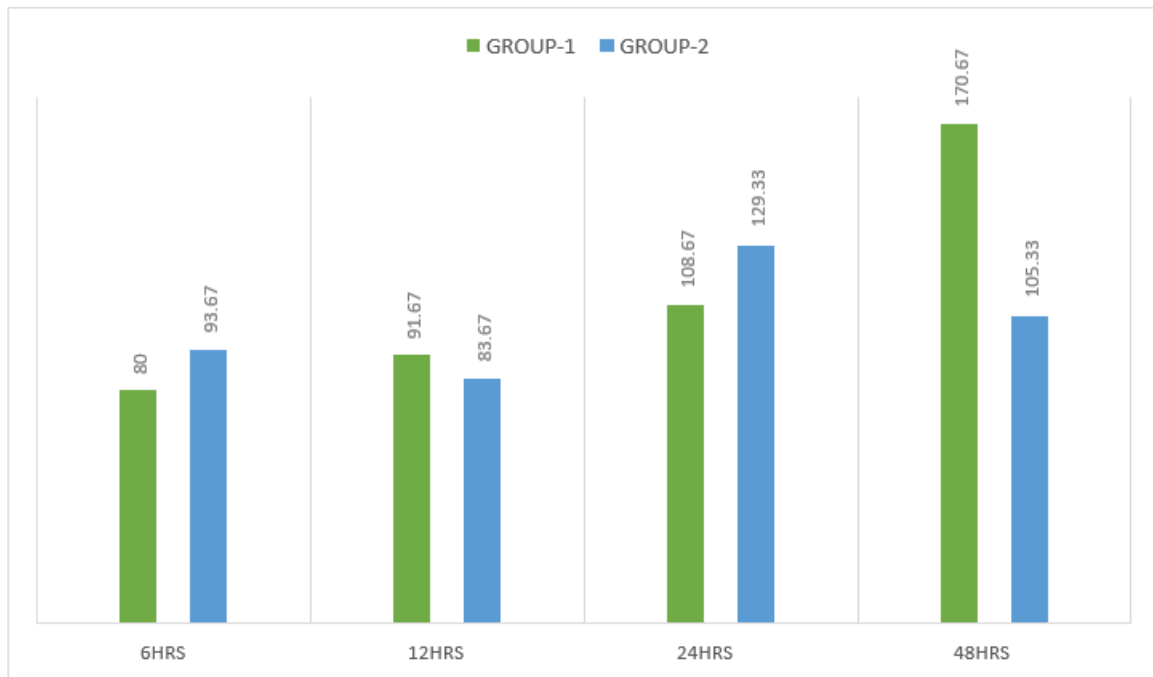
	Temperature	N	Mean	Std.Deviation	P value
Lactate-Periop	28°C-33°C	15	2.2573	.91792	.022*
	33°C-36°C	15	3.2180	1.23676	.023*
Ca+-Periop	28°C-33°C	15	.87213	.116196	.541
	33°C-36°C	15	.83947	.168152	.542
Na+-Periop	28°C-33°C	15	129.747	4.6680	.384
	33°C-36°C	15	131.260	4.7056	.384
K+-Periop	28°C-33°C	15	4.7127	.74971	.202
	33°C-36°C	15	4.4020	.53313	.203
Cl_-Periop	28°C-33°C	15	93.227	5.7495	.251
	33°C-36°C	15	95.173	2.8761	.254
HCO3-Periop	28°C-33°C	15	23.733	2.2752	.010*
	33°C-36°C	15	25.587	1.2270	.011*

Group Statistics

	Temperature	N	Mean	Std.Deviation	P value
Lactate-Periop	28°C-33°C	15	2.2080	.88697	.037*
	33°C-36°C	15	3.0700	1.23793	.038*
Ca+-Periop	28°C-33°C	14	.88764	.056678	.153
	33°C-36°C	15	.85467	.063448	.151
Na+-Periop	28°C-33°C	15	133.773	2.5001	.026*
	33°C-36°C	15	131.793	2.1073	.027*
K+-Periop	28°C-33°C	15	4.7513	.79627	.499
	33°C-36°C	15	4.5687	.65815	.499
Cl_-Periop	28°C-33°C	15	98.333	2.2366	.109
	33°C-36°C	15	96.940	2.3718	.109
HCO3-Periop	28°C-33°C	15	24.120	1.4982	.004*
	33°C-36°C	15	25.873	1.5700	.004*

• \*Indicates p value less than 0.05 and it was statistically significant

URINEOUTPUT



Group Statistics

	Group	N	Mean	Std.Deviation	P value
UO-6hr	Group1	15	80.00	13.425	.124
	Group2	15	93.67	30.531	.129
UO-12hr	Group1	15	91.67	38.622	.557
	Group2	15	83.67	34.973	.557
UO-24hr	Group1	15	108.67	62.777	.351
	Group2	15	129.33	56.501	.351
UO-48hr	Group1	15	170.67	36.345	.000
	Group2	15	105.33	40.553	.000

## DISCUSSION

Patients undergoing cardiopulmonary bypass can have their extra plasma water removed by a process called hemoconcentration. The ultra filtration equipment used with heart-lung machines is similar to that used for dialysis patients. A bundle of microporous fibre used in ultra filtration enables the removal of dissolved solutes and plasma water from blood without sacrificing protein or clotting factor. The ultra filtration that crosses the fibres is gathered in a waste bag and thrown away, just as glomerular filtrate.

Prior to CPB, during CPB, and after CPB, these filtering approaches are utilized for two primary reasons: The first one was to prepare a nearly physiological priming solution in order to avoid potentially detrimental acid-base and electrolyte changes during the commencement of CPB. And the second one was to remove the effect on the unfavorable inflammatory response by removing pro inflammatory mediators.

In order to treat volume overload and edoema brought on by the progression of congestive heart failure, liver failure, or renal failure, including the nephrotic syndrome, furosemide, a loop diuretic, has been utilized. By blocking the sodium-chloride cotransport mechanism, furosemide prevents tubular reabsorption of sodium and chloride in the proximal and distal tubules as well as the thick ascending loop of Henle. This causes excessive excretion of water in addition to sodium, chloride, magnesium, and calcium.

In our study, we assessed the efficacy of ultrafiltration and furosemide in cardiac surgery patients undergoing CPB. In our study, we gathered information on age, gender, body surface area, serum creatinine, blood urea nitrogen, sodium, potassium, chloride, bicarbonate, calcium, and lactate. This study includes 30 patients. GROUP-1 consists of 4 females and 11 male patients, GROUP-2 consists of 6 female and 9 male patients. The mean age for GROUP-1 patient's aged 51.2

Years while GROUP-2 patient saged 52.13 years

In GROUP-1 out of 15 patients 6 patients undergone Dytor administration and 2 patients undergone Lasix administration pre-operatively, whereas in GROUP-2 out of 15 patients 1 patient undergone Dytor administration and 5 patients undergone Lasix administration during pre-operatively.

In this study post-operatively serum creatinine decreases in GROUP-1 compared to GROUP-2 which is insignificant ( $p=0.098$  and  $p=0.733$ ).

Bun level reducing in GROUP-1 than in GROUP-2 during post-operative which is significant in post-operative ( $p=0.055$ )

Sodium level decreases in GROUP-1 than in the GROUP-2 during post-operative which is significant post ( $p=0.057$ ) and insignificant post ( $p=0.063$ ) because sodium is the most abundant molecule in the plasma and it's the main determinant of extracellular fluid volume and this results in excess removal of sodium and water during ultra filtration process.

During CPB, sodium is decreases in GROUP-2 than in GROUP-1 which is significant during two different temperatures ( $p=0.026$  and  $p=0.027$ ), is due to administration of Lasix which inhibits the [Na-K-Cl<sub>2</sub>] co-transporters at the intra-luminal side of the ascending limb of the loop of Henle

During post-operatively Potassium level decreases in both groups which is insignificant in ( $p=0.070$  and  $p=0.070$ ), during peri-operatively potassium level decreases in both the groups at after rewarming phase ( $33^{\circ}\text{C}$ - $36^{\circ}\text{C}$ ) which is insignificant ( $p=0.203$  and  $p=0.499$ )

During CPB potassium level was reduced GROUP-1 is due to removal of excess plasma and potassium from patients during CUF, whereas its level reduced in GROUP-2 due to the administration of Lasix

Bicarbonate level decreases in the both the groups respectively during post-operatively, which is insignificant ( $p=0.108$  and  $p=0.108$ ) where as in peri-operatively its level increases in group-1 during after rewarming phase ( $33^{\circ}\text{C}$ - $36^{\circ}\text{C}$ ) which is significant ( $p=0.031$ ) and increases in group-2 during after rewarming phase which is significant ( $p=0.004$ )

Calcium level decreases within the normal value in both the groups during after rewarming phase due to weaning from CPB which is insignificant ( $p=0.542$  and  $p=0.151$ )

Chloride level increases in the both the groups during post-operatively and peri-operatively which is insignificant post-operative ( $p=0.679$  and  $p=0.679$ ), peri-operative ( $p=0.108$  and  $p=0.108$ )

In peri-operative, Lactate level increases in both the groups during after rewarming phase ( $33^{\circ}\text{C}$ - $36^{\circ}\text{C}$ ) which is significant ( $p=0.023$  and  $p=0.038$ )

In this study, the reason for elevated lactate level is due to vasoconstriction caused during moderate hypothermia ( $25^{\circ}\text{C}$ - $32^{\circ}\text{C}$ ) and the hemofiltration during CPB leads to

Hemo concentration which increases HCT and decreased blood transfusion resulting in hypotension during CPB, which leads to impaired tissues perfusion and decrease oxygen supply.

In post-operatively, the first 6 hours of urine output was increased in GROUP-2 than in GROUP-1 which is

insignificant( $p=0.129$  and  $p=0.124$ ) which may be due to Lasix infusion during the surgery

During 12 hours of post-operative the urine output was increased in GROUP-1 than in GROUP-2, which is insignificant ( $p=0.557$  and  $p=0.557$ )

During 24 hours of post-operative the urine output was increased in GROUP-1 than in GROUP-2, which is insignificant ( $p=0.351$  and  $p=0.351$ )

During 48 hours of post-operative the urine output was increased in GROUP-1 than in GROUP-2, which is significant ( $p=0.000$ )

In this study, the hemofiltration during CPB leads to reduced bicarbonate level is due to removal of excess plasma and electrolytes which are less than 65,000 Daltons.

Sodium bicarbonate, it might reduce the oxidative stress which occurs during cardiac surgeries and so prevent or decrease the chances of renal failure,  $\text{NaHCO}_3$  is used to restore the bicarbonate level

Lasix during CPB leads to increased sodium level due to the mechanism of action on sodium-chloride-potassium [Na-K-Cl<sub>2</sub>] co-transporters at the intra-luminal side of the ascending limb of the loop of Henle

Lactate level increases in both groups during CPB due to hypothermia, which induces peripheral vasoconstriction, and this may decrease the tissue blood flow.

Limitation: Our study sample size was small and it was single-center retrospective study.

## CONCLUSION

Ultrafiltration during CPB resulted in significantly decreased levels of BUN (blood urea nitrogen), and sodium, and had no effect on serum creatinine, potassium, bicarbonate, or chloride in RFT during the postoperative day two, which are maybe due to the effect of longer CPB duration.

The use of Lasix during CPB shows no significant changes in the RFT serum creatinine, BUN, sodium, potassium, chloride, or bicarbonate during the Postoperative day two, which suggests that a single dose of furosemide during cardiac surgery does not have any beneficial effect on the renal system.

This shows that the impact of conventional ultrafiltration during cardiopulmonary bypass in patients undergoing valvular heart surgeries is unclear in the renal parameters whereas administration of intravenous diuretic Lasix during cardiopulmonary bypass, doesn't show much significant difference in the renal parameters. Therefore, this study requires further research.

## ABBREVIATIONS

CPB-Cardio pulmonary bypass

AVR-aortic valve replacement

MVR-mitral valve replacement

TMP-trans membrane pressure

HCT-hematocrit

MUF-modified ultrafiltration

CUF-convectional ultrafiltration

Z-BUF-zero balanced ultrafiltration

ABG-arterial blood gas

RFT-renal function test

EF-ejection fraction

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