



Perioperative Serum Potassium Changes in Patients Undergoing Openheart Surgery Under Cardiopulmonary Bypass: A Comparative Study Between Two Group of Patients- One Group of Patients on Long Term Preoperative Diuretics and The Other Group Not on Diuretics

KEYWORDS

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INTRODUCTION

The patients who undergo cardiac surgery in our hospital can be mainly divided into two groups. The first group of patients are who have coronary artery disease and the second group of patients are those with valvular heart disease. The first group of patients undergo coronary artery bypass grafting and the second group undergo valve repair or replacement. These patients will undergo these surgeries under cardiopulmonary bypass. They are in different class on the New York Heart Association's physical status classification. Based on the severity of the disease and the symptoms, these patients are treated with different group of medications. As the disease advances these patients develop cardiac failure. When systolic heart failure occur, the heart can no more pump adequate amount of blood into the systemic circulation leading to symptoms of low cardiac output or of the fluid overload to the heart. When diastolic dysfunction occur, the patients develop heart failure due to atrial hypertension. Congestive cardiac failure leads to the symptoms like easy fatigability, dyspnea and congestion. The medical management of heart failure includes angiotensin converting enzyme inhibitors, diuretics, vasodilators and digitalis. Diuretics are used to relieve circulatory congestion. Symptoms improve as the pulmonary and peripheral edema are relieved. Diuretics reduce atrial and ventricular diastolic pressures thereby reducing the diastolic stress on the ventricular wall. This will help in preventing persistent cardiac distension and improve sub-endocardial perfusion. Chronic use of diuretics will lead to hypokalemia. So potassium supplementation is given in patients on chronic diuretics use. Potassium sparing diuretics helps in avoiding hypokalemia but they will not cause adequate natriuresis. Hypokalemia or hyperkalemia in the perioperative period cause cardiac conduction disturbances and they are not desirable. There are various factors in the perioperative period which can alter potassium homeostasis like the presence of diabetic mellitus, hypertension, chronic renal failure, ischemic and valvular heart diseases, respiratory and metabolic acid-base disturbances, hypothermia, blood transfusion, dose and duration of the use of cardioplegia. The potassium homeostasis is maintained by giving potassium correction in the form of intravenous potassium in hypokalemia and by giving calcium, sodium bicarbonate, glucose-insulin infusion, nebulization with beta 2 agonists when hyperkalemia occurs.

This is an observational study to study the role of preoperative use of diuretics in the incidence of altered serum potassium levels in the perioperative period. We compared two group of patients with one group on long term preop-

erative diuretic and the other group not on diuretics. This study helped us to understand whether diuretics played a role in the perioperative potassium homeostasis.

AIMS AND OBJECTIVES

1. To study the differences in the perioperative serum potassium changes between one group of patients on long term preoperative diuretics and the second group of patients who were not on preoperative diuretics who underwent openheart surgery under cardiopulmonary bypass.
2. To compare the interventions needed to keep potassium homeostasis between the two groups.

METHODOLOGY

The study was conducted in the Cardiothoracic operating suites and in the cardiothoracic intensive care units in Christian Medical College Hospital, Vellore.

100 consecutive patients between 14 – 75 years who underwent cardiac surgeries during the 6 months study period in Christian Medical College Hospital, Vellore.

Exclusion criteria

- Age < 14 years
- Chronic renal failure with serum creatinine > 1.6 mgms%

The study was conducted over a period of 6 months between July to December 2012. A pilot study was conducted prior to the commencement of the study.

SAMPLE SIZE: (46)

Sample size was calculated using the formula for single proportion – Absolute precision

$$I_1 = Z^2 P (1- P)$$

d 2

where I_1 = sample size

Z = Z statistic for a level of confidence i.e. for 95% is 1.96

P = expected prevalence or proportion

d = precision

Expected proportion is 60%. So $P = 0.6$

For 10% precision, $d = 0.1$

Desired confidence interval is 95%.

Substituting the values for Z, P and D,

$$n = 1.96^2 (0.6) (1 - 0.6)$$

$$0.12$$

$$n = 92$$

A total sample size of 92 patients would be needed for the study. This study had a total number of 100 patients with 50 patients in each arm.

Patients who were scheduled for cardiac surgery were evaluated by the anaesthetist in the preanaesthesia clinic and were explained in detail about the study design. Patients who had given consent and fulfilled the inclusion criteria were allocated into either of the group depending on their diuretic intake.

Duration of diuretic intake: Any patient who is on diuretic for more than a month are considered as being on chronic diuretic use.

Hypokalemia is defined as a serum potassium of less than 3.5 MEq/L and Hyperkalemia is defined as a serum potassium of more than 5.5 MEq/L.

Chronic renal failure: Patients whose serum creatinine value is more than 1.6 are considered to be in chronic renal failure and they were excluded from the study.

The patients who fulfilled the inclusion criteria and gave consent were enrolled in the study. All medications that the patient was taking preoperatively were continued as per the routine schedule except ACE inhibitors. Tablet lorazepam and tablet omeprazole were given as premedication the night before and on the day of surgery. The preoperative comorbid conditions like diabetic mellitus, chronic renal failure, the medication taken like diuretics, ACE inhibitors, digoxin, Potassium supplements are all noted in the proforma. A baseline arterial blood gas (ABG) is done and the values entered in the proforma. The ABG is repeated once the patient is on the cardiopulmonary bypass circuit, before coming out of bypass circuit and after coming out of the bypass circuit. Any incidence of hypokalemia or hyperkalemia is noted along with the interventions made to keep the potassium levels normal. In hypokalemia, potassium chloride (KCl) is given and in hyperkalemia the treatment includes calcium, sodium bicarbonate, glucose insulin infusion. Any need for blood transfusion is noted as it may have an influence on serum potassium levels. The potassium rich cardioplegia is used to arrest the heart during cardiac surgery. The dose and the duration of cardioplegia is also noted. These patients are not extubated in the operation suite. They are shifted to the cardiothoracic intensive care unit (ICU) with endotracheal tube and electively ventilated for a day. The patient is followed in the first two postoperative days in the ICU.

In the ICU, arterial blood gas (ABG) is repeated every four to six hourly. Any event of hypokalemia or hyperkalemia along with the interventions needed to keep the potassium level normal is noted. All patients received

nebulizations with salbutamol and ipratropium bromide after extubation. We could enroll 100 patients in this study with 50 patients in the diuretic group and fifty in the non-diuretic group. Once the adequate sample size has been achieved, all these data were entered in the Epidata software and exported into the Excel spreadsheet.

All the data collected were analyzed using Generalized Estimating Equations.

RESULTS

Total number of 100 subjects who underwent cardiac surgery under cardiopulmonary bypass, were enrolled in this study. None of them were excluded.

The outcome variables between the two groups were analyzed using Generalized Estimating Equations. There were 50 subjects in the diuretics group and 50 subjects in the non-diuretics group.

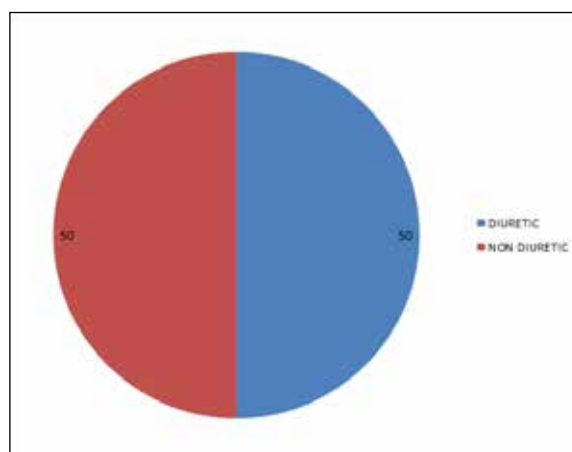


Figure 1: shows number of patients in the diuretic group and non-diuretic group.

Among the 50 patients who were on long term diuretics, 43 of the patients were taking the loop diuretic furosemide and 7 patients were taking the potassium sparing diuretic spironolactone.

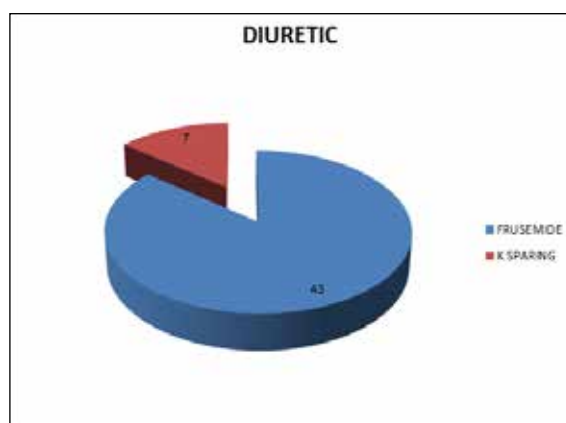


Figure 2: shows the number of patients on different types of diuretics.

CLINICAL CHARACTERISTICS OF THE PATIENTS IN EACH GROUP:

AGE DISTRIBUTION:

The median age of the patients in the diuretic group was 43 years. And the median age in the non-diuretic group was 56 years. The patients with age less than 30 years were more in the diuretic group and with the age more than 60 years were more in the non-diuretic group. Between the age 30 to 60 years the patients were equally distributed in both the groups.

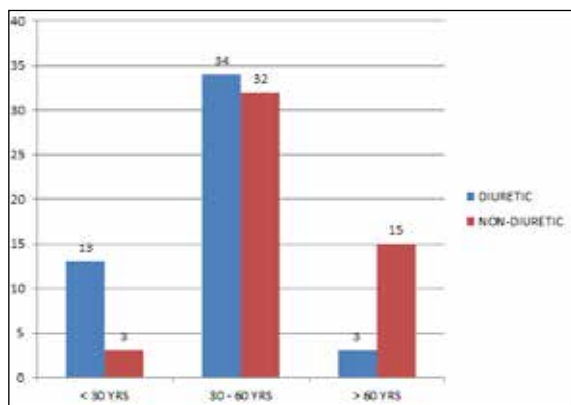


Figure 3: shows the age distribution between the two groups.

SEX DISTRIBUTION:

There sex was equally distributed in the diuretic group with 25 male patients and 25 female patients. In the non-diuretic group there were 37 male patients and 13 female patients.

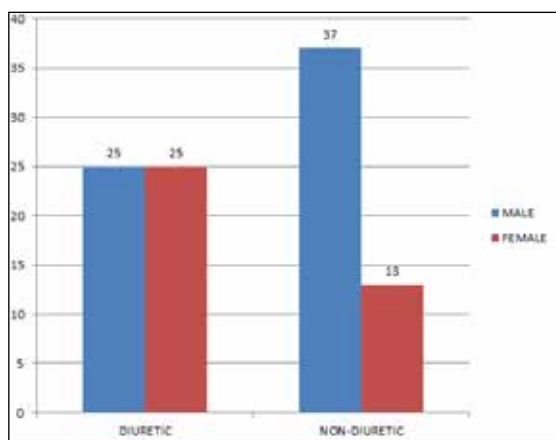


Figure 4: shows the sex distribution between both the groups.

PREOPERATIVE CHARACTERISTICS BETWEEN BOTH THE GROUPS:**ASSOCIATED SYSTEMIC DISEASES:**

Diabetes mellitus, hypertension and renal dysfunction were the major systemic diseases which affects the perioperative serum potassium levels. Their incidences varied between both the groups.

DIABETIC MELLITUS:

Patients with diabetes mellitus were more in number in the non-diuretics group than in the diuretic group. Only 6% of the patients were diabetic in the diuretic group where as 40% of the patients were diabetic in the non-diuretic group.

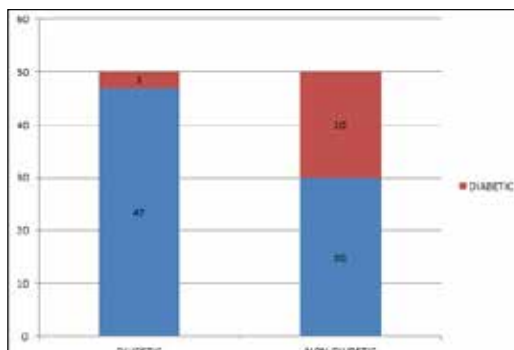


Figure 5: shows the number of patients with diabetic mellitus in each group.

RENAL DYSFUNCTION:

Preoperative renal dysfunction was uncommon in both the groups. The serum creatinine of all the patients in the diuretic group was less than 1.5 mgms whereas in only 4 patients in the non-diuretic group the serum creatinine was more than 1.5 mgms. The serum creatinine on the second postoperative day showed that 4 patients in the diuretic group newly had their serum creatinine raised above 1.5mgms whereas only one patient had his serum creatinine raised above 1.5mgms newly when compared to the preoperative value.

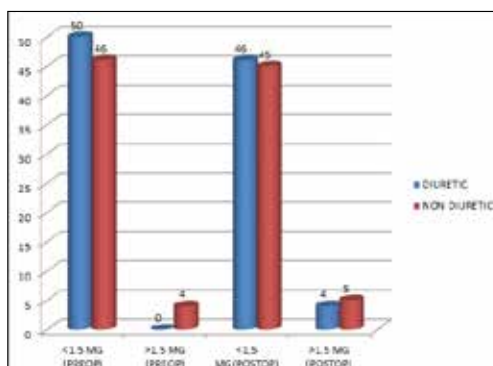


Figure 6: Preoperative and postoperative serum creatinine in both groups.

PATIENTS ON ACE INHIBITORS:

Angiotensin converting enzyme inhibitors are known to cause hyperkalemia in patients with renal insufficiency and in patients who are on potassium sparing diuretics and potassium supplements. In our study only three patients were found to be on this drug of which two were in the diuretics group and one patient in the non-diuretics group.

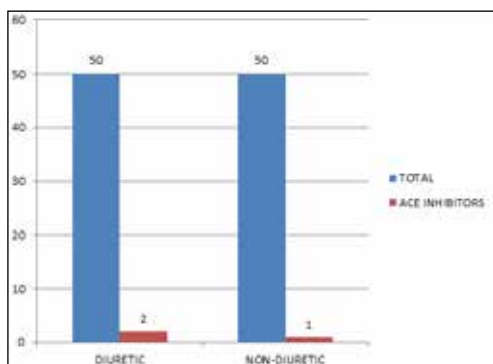


Figure 7: shows number of patients on ACE inhibitors in each group.

PATIENTS ON DIGOXIN AND POTASSIUM SUPPLEMENTS:

The number of patients who received digoxin and potassium supplements were more in the diuretic group. As diuretics are known to cause hypokalemia and hypokalemia in patients on digoxin will lead to digoxin toxicity, almost all these patients were on potassium supplements. In the diuretic group 33 patients were on digoxin and 32 patients were on potassium supplements in the preoperative period whereas only 3 patients were on digoxin in the non-diuretics group and none of these patients were on potassium supplements in the preoperative period.

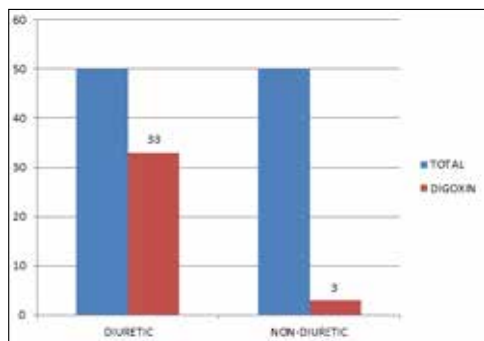


Figure 8: shows the number of patients on digoxin in each group.

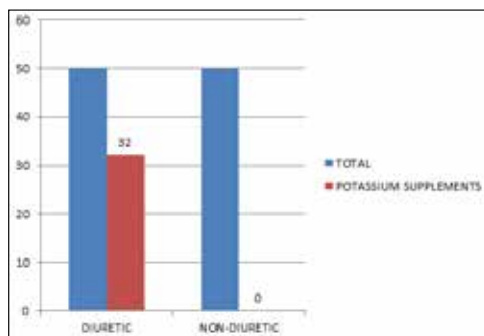


Figure 9 : shows the number of patients on potassium supplements.

PREOPERATIVE DIAGNOSIS AND SURGERY:

The nature of cardiac lesion for which the patient underwent surgery differ in both the groups. The patients with coronary artery disease underwent coronary artery bypass grafting (CABG) and the patients with valvular heart disease underwent valve replacement surgeries. The valve replacement surgery included mitral valve replacement, aortic valve replacement and double valve replacement. Few patients underwent a combination of a valve replacement and coronary artery bypass grafting.

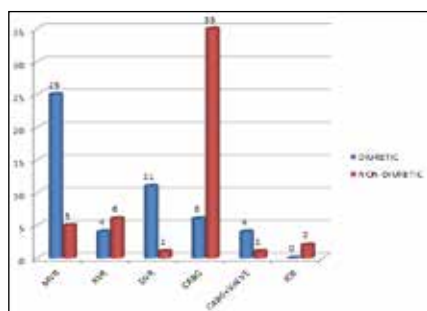


Figure 10: shows the type of surgery in each group.

In the diuretic group Mitral valve replacement was the commonest surgery and in the non diuretic group coronary artery bypass grafting was the commonest surgery. Overall in the diuretic group 25 patients had mitral valve replacement, 4 patients had aortic valve replacement, 11 patients had double valve replacement, 6 patients had CABG and a valve replacement. In the non-diuretics group 35 patients had CABG, 6 patients had aortic valve replacement, 5 patients had mitral valve replacement, one patient had double valve replacement, one patient had CABG with a valve replacement and two patients had intracardiac repair.

PERIOPERATIVE CHARACTERISTICS BETWEEN THE TWO GROUPS:

CARDIOPLEGIA REQUIREMENT:

All patients underwent cardiac surgical procedure under cardiopulmonary bypass and with cardioplegia. Cardioplegia, a potassium rich fluid given to arrest the heart which helps the surgeon to operate on a non-beating heart and a bloodless surgical field. Simple cardiac procedures require cardioplegia once which lasts for almost 20 minutes. More complicated procedures and double valve replacement may take a longer time that cardioplegia should be given more than once which may affect the serum potassium levels in the perioperative period. The figure 11, shows the details of cardioplegia requirements in both the groups.

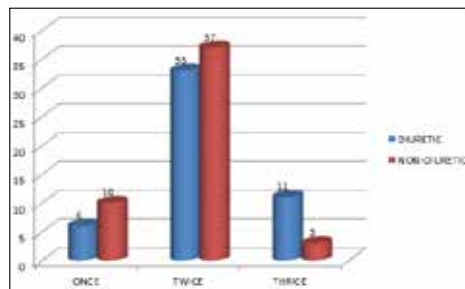


Figure 11: shows the cardioplegia requirements in each group.

The requirements of cardioplegia in the diuretic group was, once in 6 patients, twice in 33 patients and three times in 11 patients. In the non-diuretic group 10 patients required cardioplegia once, 37 patients required twice and 3 patients required cardioplegia three times.

BLOOD AND BLOOD PRODUCTS REQUIREMENT:

Cardiac surgeries require back-up of adequate numbers of blood and blood products in the perioperative period. Blood loss is common intraoperatively. The dilution of blood by the heart-lung machine will cause the haemoglobin to drop. Also post operative blood loss through the wound drain is also anticipated. The Figure 12, shows the intraoperative and the postoperative blood transfusion requirements.

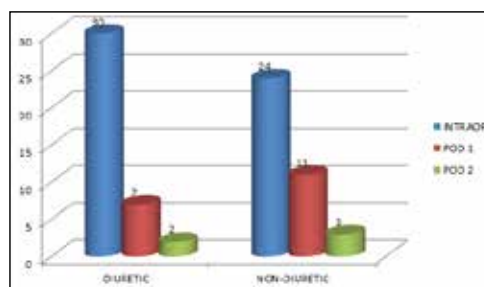


Figure 12: shows the transfusion requirements in each group till second postoperative day.

In the diuretic group 30 patients required packed cell transfusion intraoperatively, 7 patients on the first postoperative day and 2 patients on the second postoperative day. In the non-diuretics group 24 patients required packed cell transfusion in the intraoperative period, 11 patients in the first postoperative day and 3 patients in the second postoperative day.

HYPOKALEMIA AND POTASSIUM CORRECTION:

The combination of factors like diuretics, hypothermia, cardiopulmonary bypass are expected to cause hypokalemia. Injection Potassium Chloride (kcl) is given as intravenous infusion to correct hypokalemia. Figure 13 and 14 shows the number of patients who required potassium correction and the amount of potassium needed to correct hypokalemia. In cardiac surgical patients a serum potassium level of more than 4 MEq/L is desired. As a result patients whose serum potassium is between 3.5 to 4 MEq/L also received potassium correction. Hence the amount of potassium chloride required to keep the serum potassium above 4 MEq/L is also recorded.

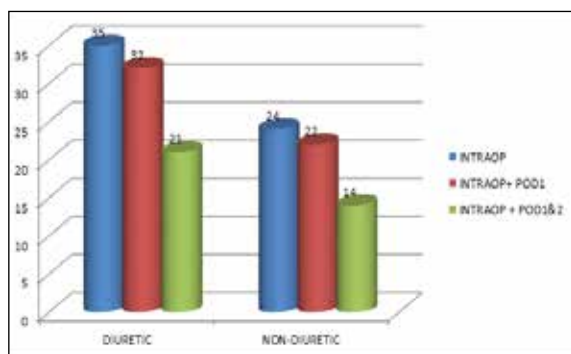


Figure 13: shows the number of patients who needed kcl correction in the perioperative period.

In the diuretic group 35 patients required potassium correction in the intraoperative period, 32 patients required correction in the intraoperative and the first postoperative day and 21 patients needed potassium correction all the three days. In the non-diuretics group 24 patients required kcl correction in the intraoperative period, 22 patients required correction in the intraoperative and the first postoperative day and 14 patients needed potassium correction all the three days.

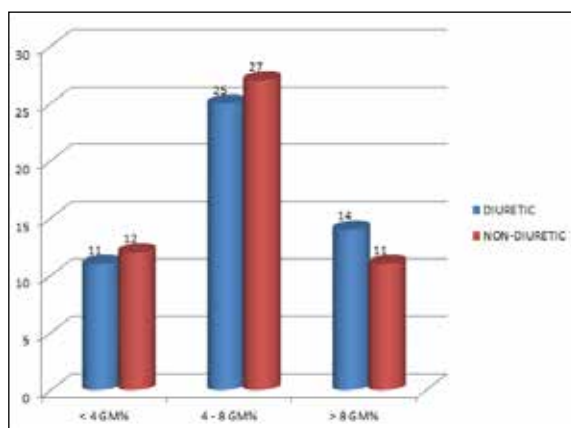


Figure 14: shows the amount of kcl needed to keep serum potassium > 4MEq/L

In the diuretic group 11 patients required less than 4 gms kcl, 25 patients required 4-8 gms kcl and 14 patients required more than 8 gms kcl in all the 3 days to keep the serum potassium level more than 4MEq/L. In the non-diuretic group 12 patients required less than 4 gms kcl, 27 patients required 4-8 gms kcl and 11 patients required more than 8 gms kcl in all the 3 days to keep the serum potassium level more than 4 MEq/L.

INSULIN REQUIREMENT:

Good glycemic control is important in cardiac surgical patients. Insulin is usually given as an infusion if blood sugars are high. Glucose-insulin infusion is started as a treatment of hyperkalemia. The requirement of insulin in the perioperative period between both groups is given in the figure 15.

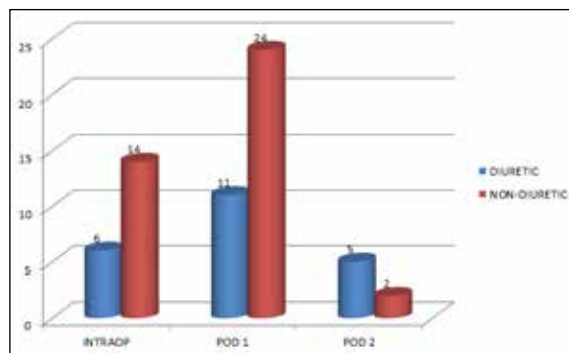


Figure 15: shows the insulin requirement in the perioperative period in both the groups.

In the diuretic group 6 patients require insulin in the intraoperative period, 11 patients needed insulin in the first postoperative day and 5 patients required insulin in the second postoperative day. In the non-diuretics group 14 patients required insulin in the intraoperative period, 24 patients required insulin in the first postoperative day and 2 patients needed insulin in the second postoperative day. Incidentally the non-diuretics group had more patients who are diabetic than in the diuretic group.

TREATMENT WITH SODIUM BICARBONATE:

7.5% sodium bicarbonate is given as intravenous bolus dose or as an infusion to correct acidosis. It is also used in the treatment of hyperkalemia. Maintaining the acid base balance is important to keep the serum potassium level within the normal range. Acidosis leads to hyperkalemia and alkalosis leads to hypokalemia due to intercompartmental shift of potassium ions. Figure 16, shows the details of sodium bicarbonate requirements in the perioperative period.

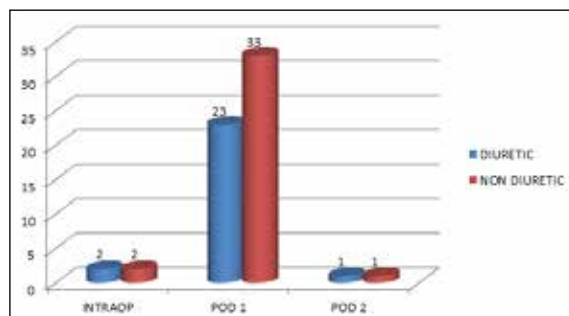


Figure 16: shows sodium bicarbonate requirement in the perioperative period in both the group.

The requirement of sodium bicarbonate peaked in the first postoperative day with 23 patients in the diuretic group and 33 patients in the non-diuretic group needing it. In both the diuretic and the non-diuretic group only 2 patients intraoperatively and 1 patient on the second postoperative day required treatment with sodium bicarbonate

CALCIUM REQUIREMENT:

Maintaining serum calcium level is important for the optimal contractility of the myocardium. Calcium is given intravenously when the ionic calcium is low. It is also given as the first line of drug in the treatment of hyperkalemia. Calcium protects the heart from the deleterious effects of hyperkalemia though it will not lower serum potassium level.

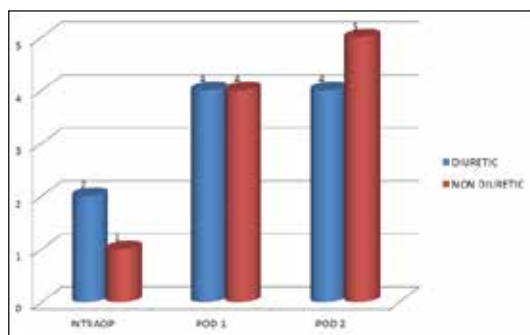


Figure 17: shows the number of patients treated with calcium in both groups.

The total number of patients who required calcium is very less indicating hyperkalemia was uncommon in both the diuretic and non-diuretic groups. In the diuretic group only 2 patients required calcium in the intraoperative period, 4 patients required calcium in the first post operative day and 4 patients needed calcium in the second postoperative day. In the non-diuretic group only 1 patient received calcium intraoperatively, 4 patients required calcium in the first postoperative day and 5 patients required calcium in the second postoperative day.

MAGNESIUM REQUIREMENT:

Hypomagnesemia is one of the cause for perioperative arrhythmias. Hypokalemia associated hypomagnesemia will not respond to treatment with potassium correction alone. Magnesium should be given as an intravenous bolus in case of arrhythmias not responding to potassium correction. Most of the time magnesium is given empirically to treat arrhythmias which is not getting corrected even after potassium correction for hypokalemia. Figure 18 shows the details of magnesium requirement in the perioperative period.

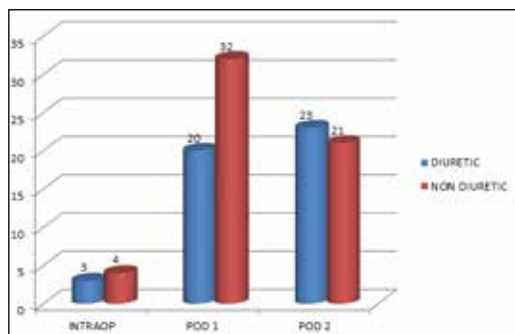


Figure 18: shows the number of patients treated with magnesium in both groups.

In the diuretic group, 3 patients required magnesium intraoperatively, 4 patients required magnesium on the first postoperative day and eight patients received magnesium in the second post operative day. In the non-diuretics groups, 3 patients required potassium in the intraoperative period, 2 patients in the first and the second postoperative day.

PERIOPERATIVE FUROSEMIDE REQUIREMENTS:

Furosemide commonly known as lasix is a loop diuretic used in the cardiac surgical patients. As fluid overload cannot be tolerated well in these patients in the postoperative period, furosemide administration is common in the post operative period.

Also furosemide is given in the treatment of hyperkalemia so that potassium is excreted out. The following picture shows the details of furosemide requirements in the perioperative period.

The following figure shows the details of furosemide requirement in both the diuretic and non diuretic group.

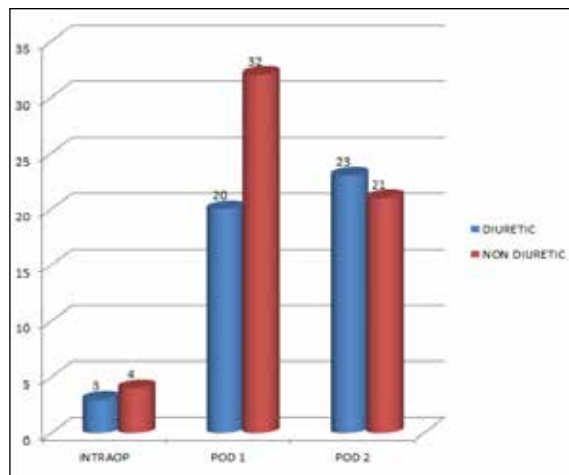


Figure: 19 shows the number of patients received lasix in the perioperative period in both the groups.

The number of patients who received furosemide intraoperatively are 3 in the diuretic group and 4 in the non-diuretics group. In the first postoperative day, 20 patients in the diuretic group and 32 patients in the non diuretic group required furosemide. The requirements of furosemide on the second postoperative day are 23 patients in the diuretic group and 21 patients in the non-diuretics group.

DISCUSSION

Chronic use of diuretics like frusemide and thiazide is known to cause hypokalemia. In the cardiac patients who undergo open heart surgery, hypokalemia significantly increases the risk for perioperative arrhythmias.

Most of these patients are on oral potassium supplements to prevent hypokalemia. Also patients who are on digoxin are known to develop toxicity if serum potassium is low.

On the other hand patients who are taking potassium sparing diuretics and angiotensin converting enzyme inhibitors are known to develop hyperkalemia because of potassium retention by kidneys due to the inhibited effect of aldosterone. Patients with chronic renal failure poorly excrete potassium and are known for elevated serum potassium levels.

Diabetic mellitus with insulin treatment cause intra cellular shift of potassium causing hypokalemia in the extracellular compartment. In contrast, patients with diabetic nephropathy may develop hyperkalemia.

This is an observational study which evaluated the role of long term preoperative diuretics on the perioperative serum potassium changes namely hypokalemia and hyperkalemia.

All the datas were analyzed using Generalized Estimating Equations.

In our study there was a clinically significant hypokalemia in the patients who were on long term diuretics preoperatively.

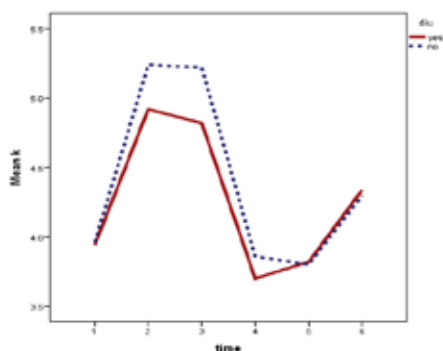
In both diuretic and non diuretic groups serum potassium was higher in the sample immediately after cardioplegia compared to baseline. This may be attributed to the high potassium in the cardioplegia solution.

The serum potassium levels tend to drop slightly after the cross clamp release and a further decrease after coming of bypass. This trend seen in both the groups may be due to the diuretic effect of mannitol.

Most of the patients had serum potassium supplementation in the 1st post operative day to keep the serum potassium levels between 4-4.5 mEq/L. even though the serum potassium trends in both the groups are similar, patients in the diuretic group had lower potassium levels compared to non diuretic group.

However these changes are not statistically significant. Also there is no statistically significant difference in the potassium requirements. This may be partly due to the fact that potassium is a predominantly intracellular cation.

These changes are similar to the results of Babka R, Pifarre R titled 'potassium replacement during cardiopulmonary bypass'. (1)



Graph 1 : shows the trend of serum potassium levels in the preoperative period(1), on pump(2), before coming out of bypass (3), after coming out of bypass(4), first post operative day (5) and the the second postoperative day(6).

In a similar study published in 1990, Bhatt SB etal (2) reported a similar results where there was no significant difference in the incidence of hypokalemia and the potassium requirement between two group.

In an older study by , Saidi M etal (3) done in children between two group of patients with one group on diuretics

and digitalis and other group not on these drug, it was found that the children taking digitalis and diuretics had increased incidence of hypokalemia when comparing to the other group. Our study also reflects the same pattern with the incidence of hypokalemia was more in the diuretic group which was clinically significant but not statistically.

The incidence of hypokalemia during the intraoperative period was more in the diuretic group than the non-diuretic group. Only three patients in the diuretic group and two patients in the non-diuretic group in whom hypokalemia settled with intraoperative correction of potassium.

All the hundred patients included in this study in either group needed potassium correction at least once in either intraoperative or in the first or second postoperative day. As many as 35 patients in the diuretic group had hypokalemia where as the number in the non-diuretic group was 24 in the intraoperative period.

In the diuretic group 21 patients required potassium correction all the three days where as only 14 patients required potassium correction all the three days in the non-diuretic group. The amount of kcl required to keep the potassium in the normal range also varied between the two groups. The number of subjects who required less than four grams of kcl correction were 11 in the diuretic group and 12 in the non-diuretic group. Similarly 25 and 27 subjects in the diuretic and the non-diuretic group required a potassium correction of between 4 to 8 gms kcl, respectively. The subjects who required more than 8 gms kcl correction are also comparable between both the groups. It was 14 in the diuretic group and 11 in the non-diuretic group.

The potassium requirement to keep the serum potassium above 4meq/l was higher in the non-diuretic group. This can be explained by the fact that the diabetic patients were more in the non-diuretic group. Most of these patients required insulin infusion in the perioperative period. As insulin causes intracellular shift of potassium, these patients required more amount of potassium to keep the serum potassium level above 4- 4.5 meq/L. This explains the reason for the increased potassium requirement in the non-diuretic group. Diabetic mellitus and glucose intolerance were associated with statistically significant hyperkalemia in a study conducted by Donald O. Weber and Michael D. Yarnoz.(4)

In a subgroup of patients in the diuretic group who are also on oral syp. potassium in the preoperative period, the amount of potassium correction needed to keep the serum potassium value above 4meq/l, is significantly lesser when compared to the patients who were not on potassium supplements preoperatively. This can be explained by the fact that even when the patients were taking diuretics, the potassium lost in the urine is constantly replenished by the potassium supplements. This was found to be a statistically significant finding with the p value of 0.000.

The effects of parameters like haemoglobin, serum creatinine, serum bicarbonate, base excess, pH, Pco2 were all found to be clinically insignificant in affecting the perioperative potassium requirements in both the groups with the p values more than 0.7.

In our study 15 patients in the diuretic group and 7 patients in the non diuretic group required magnesium treatment. However this was not statistically significant. Mag-

nesium supplementation is usually done on an empirical basis as a personal preference. We do not routinely measure serum magnesium in our patients. But assume that hypomagnesemia is associated with hypokalemia.

In the diuretic group, there were only 7 patients who were taking spironolactone, an aldosterone antagonist and a potassium sparing diuretic. The analysis shows that the patients who were taking potassium sparing diuretic had required 0.07 gms kcl lower than who were not on that drug. This is statistically insignificant with the p value of 0.8.

The subjects who were taking angiotensin converting enzyme inhibitors (ACE inhibitors) were two patients in the diuretic group and only one patient in the non diuretic group. Though ACE inhibitors are expected to cause hyperkalemia, this is statistically insignificant ($p = 0.7$) in this study as overall only 3 patients were on this drug.

Patients in both the groups received sodium bicarbonate either as a treatment for acidosis or in some instances as a treatment for hyperkalemia. 26 patients in the diuretic group and 36 patients in the non diuretic group required sodium bicarbonate treatment in the intraoperative and the post operative period. The incidence of alteration in the serum potassium levels in these patients is statistically insignificant with the p value of 0.2.

Calcium is given in the perioperative period to correct hypocalcemia and also as a first line of treatment of hyperkalemia. 10 patients in each of the groups receive calcium correction in the perioperative period. The effect of diuretic intake and calcium correction was not found to play any statistical significance ($p = 0.3$) in the incidence of hypokalemia or hyperkalemia.

The diuretic furosemide commonly known as frusemide is given to cardiac patients in the perioperative period to avoid or treat fluid overload. As frusemide is expected to excrete potassium along with urine the effect of usage of intraoperative and postoperative frusemide was also studied. Only 3 patients in the diuretic group and 4 patients in the non diuretic group required frusemide intraoperatively. In the first post operative period 20 patients in the diuretic group and 32 patients in the non diuretic group received lasix. In the second postoperative day, 23 patients in the diuretic group and 21 patients in the non diuretic group required frusemide. Among the patients who received perioperative frusemide treatment, those in the diuretic group required 0.17 gms less kcl than in the non diuretic group which is statistically insignificant.

The role of cardioplegia, the high potassium rich fluid, in altering the serum potassium levels is also studied. In the diuretic group 6 patients received cardioplegia once, 33 patients twice and 11 patients thrice. In the non diuretic group 10 patients received once, 37 patients received twice and 3 patients received thrice. Adjusting for the cardioplegia, the analysis shows that the diuretic group required 0.05 gms less potassium than the nondiuretic group. However this is found to be statistically insignificant ($p = 0.9$).

The role of blood transfusion in altering the serum potassium levels also studied between the two groups. The intraoperative need for blood transfusion was more in this study, with 30 patients in the diuretic group and 24 patients in the nondiuretic group received blood intraopera-

tively where as 11 patients in the diuretic group and 14 patients in the nondiuretic group received blood postoperatively. Adjusting for blood transfusion, the study shows that the diuretic group received 0.45 gms more kcl than the nondiuretic group which though clinically significant is not statistically significant ($p = 0.5$).

TABLE SHOWING RISK VARIABLES, THE MAGNITUDE OF CHANGE(B), THE CONFIDENCE INTERVAL AND THE P VALUE

RISK VARIABLES	B	95% CONFIDENCE INTERVAL	P VALUE
Diuretic	-0.107	-0.692 TO 0.478	0.720
K sparing	-0.073	-0.675 TO 0.530	0.813
Diabetic			
YES	-1.331	-2.343 TO -0.319	0.010
NO	0.183	-0.440 TO 0.807	0.564
ACE Inhibitor			
YES	-0.500	-3.272 TO 2.272	0.724
NO	-0.093	-0.681 TO 0.496	0.757
K supplements			
YES	-2.043	-2.574 TO -1.511	0.000
NO	-0.448	-1.180 TO 0.284	0.230
Digoxin			
YES	-0.334	-0.914 TO 0.245	0.258
NO	0.231	-0.726 TO 1.184	0.636
Creatinine	-0.240	-0.861 TO 0.382	0.450
Haemoglobin	-0.040	-0.670 TO 0.590	0.901
HCO3	-0.082	-0.663 TO 0.498	0.781
Base Excess	-0.081	-0.666 TO 0.504	0.787
PCO2	-0.108	-0.692 TO 0.477	0.718
Urea	-0.072	-0.834 TO 0.689	0.852
Cardioplegia	-0.054	-0.852 TO 0.744	0.895
Blood			
YES	0.466	-0.908 TO 1.839	0.506
NO	0.200	-0.884 TO 1.284	0.718
Insulin			
YES	-0.684	-2.654 TO 1.285	0.496
NO	0.456	-0.205 TO 1.117	0.177
Sodabicarb			
YES	0.775	-0.670 TO 2.219	0.293
NO	0.327	-0.228 TO 0.882	0.248
Calcium			
YES	1.714	-1.589 TO 5.017	0.309
NO	-0.253	-0.844 TO 0.338	0.402
MgSo4			
YES	-0.750	-5.194 TO 3.694	0.741

NO	-0.137	-0.705 TO 0.432	0.638
Lasix			
YES	-0.173	-1.248 TO 0.903	0.753
NO	0.650	-0.132 TO 1.431	0.103

CONCLUSIONS:

The observations of the study on 'perioperative serum potassium changes in patients undergoing open heart surgery under cardiopulmonary bypass: A comparative study between two group of patients – one group of patients on long term preoperative diuretics and the other group not on diuretics' are

1. There is no significant statistical difference in the incidence of hypokalemia or hyperkalemia between the two group of patients.
2. A subgroup of patients who received preoperative oral potassium supplementation were found to be requiring 2 gms lesser potassium correction than in those who never received oral potassium in the preoperative period which is statistically significant with the p value of 0.000.
3. The patients who were diabetic and also on long term diuretic therapy required 1.3 gms lesser kcl to keep their potassium above 4 mEq/L than those who were not diabetic. This was found to be statistically significant with a p value of 0.010.
4. The role of other preoperative medications like ACE inhibitors, digoxin, did not have any statistical significance in causing a difference in serum potassium levels in both the groups.
5. The effects of parameters like haemoglobin, serum creatinine, serum bicarbonate, base excess, pH, Pco₂ were all found to be clinically insignificant in affecting the perioperative potassium requirements in both the groups with the p values more than 0.7.
6. This study did not show any significant statistical difference in the perioperative requirement of sodium bicarbonate, calcium, magnesium ,glucose-insulin infusion and fructose.
7. The role of cardioplegia and blood transfusion were also found to be statistically not significant in causing a change in serum potassium levels between both the groups.

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