



POST OPERATIVE POTASSIUM LEVELS FOLLOWING CARDIAC SURGERIES – AN OBSERVATIONAL STUDY

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ABSTRACT

OBJECTIVES :

This study was undertaken to investigate the changes in Serum potassium levels, which occurs in patients after open-heart surgery and its impact on the postoperative period.

METHODS :

During the time period 2012-2018 data from 502 patients who underwent a wide range of cardiac surgery procedures, were prospectively collected. Potassium values were determined using arterial blood gas analysis and the results were tabulated, incidences of potassium level disturbances and its effects, and counter measures undertaken, were recorded.

RESULTS :

Out of 502 patients who underwent cardiac surgeries 150 were CABG with 5% incidence of arrhythmia, 297 were valve related surgeries with 40% incidence of arrhythmia, 55 were congenital defect correction with no incidence of arrhythmia.

CONCLUSION :

By serial monitoring of potassium values following cardiac surgeries adverse outcome of potassium levels can be managed efficiently and the mortality and morbidity associated with it can be prevented.

KEYWORDS :

INTRODUCTION :

The importance of potassium in maintaining normal heart action has been known for a long time [15]. A fall in plasma potassium during cardiopulmonary bypass has been described by many workers [1, 2, 51], and the relationship between arrhythmias and low serum potassium levels has been described [6]. Such changes, unless immediately recognized and corrected, may affect the morbidity and mortality in cardiac patients. Normal plasma levels of potassium do not preclude the possibility of total body depletion [14]. This investigation was designed to determine the changes in potassium ion concentration in patients who underwent cardiac surgery.

MATERIALS AND METHODS :

During the time period 2012-2018 data from 502 patients who underwent a wide range of cardiac surgery procedures, were prospectively collected. Ages varied from 10 to 60 years. The bypass times varied between 20 and 40 minutes. The Travenol disposable bubble oxygenator was used, with normothermic perfusion, in all cases. The priming volume was 20 ml. of Ringer's lactate solution per kilogram of body weight. By the use of a mixture of 97% pure oxygen with 3% carbon dioxide and the administration of sodium bicarbonate in the system when indicated, significant changes in blood pH were avoided. Patients who received diuretics in the postoperative period or who had a tracheostomy were excluded to avoid the adverse effects of hyperventilation [71]. In most cases, the blood remaining in the pump after the end of bypass was returned to the patient. Citrated bank blood, one to three days old, was employed for replacement of blood loss. Potassium values were determined using arterial blood gas analysis and the results were tabulated, incidences of potassium level disturbances and its effects, and counter measures undertaken, were recorded.

Patients with potassium values >5.5 meq/lit were treated accordingly. Patients with serum potassium values <2.5 meq/lit were subjected to rapid correction with 20mmol of kcl in 100ml of 0.9% normal saline bolus. Patients with potassium values between 2.5 to 3.5 meq/lit were managed with 20mmol/lit of kcl in ringer lactate

solution and the flow is titrated accordingly. Patients with arrhythmia were managed with anti arrhythmic measures according to the standardised protocol.

INCLUSION CRITERIA :

All patients undergoing cardiac surgery in Govt Stanley medical college and patients who are willing for the study.

EXCLUSION CRITERIA :

- Patients with acute/chronic renal failure (estimated clearance creatinine— $eCr < 50$).
- Patient with HYPO/HYPERKALEMIC syndromes.
- Magnesium monitoring/correction
- Ongoing infection/sepsis
- Patient with hyperventilation

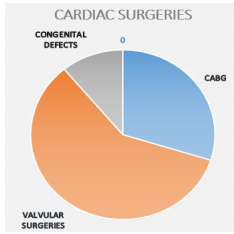
STUDY DESIGN:

Prospective study with sample size of 502.

RESULTS :

All 502 patients enrolled in this study were eligible for inclusion in the analysis. Serum potassium was normally distributed with (30%) patients having potassium levels below the traditional clinical threshold of 2.5 meq/L. Female sex, past history of arrhythmias and hypertension were commonly found in patients with lower potassium levels. Patient characteristics not associated with decreased serum potassium levels were age, weight and height, past history of congestive cardiac failure and ejection fraction of the heart. Elevated potassium levels were associated with a history of congestive cardiac failure and older age. Preoperative arrhythmia was noted among 10% people with valvular disease with more incidence among mitral valvular disease (6%). Post-operative arrhythmias occurred in 45% of the patients, 23% of patients had post-operative ventricular arrhythmias and 22% of patients had post-operative atrial arrhythmias. Serious post-operative

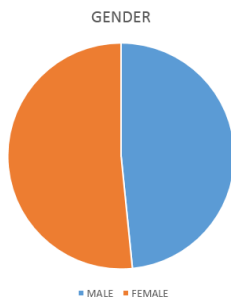
arrhythmias occurred in 1% of patients. Patients with potassium values >5.5meq/lit were noted among 6% of patients.



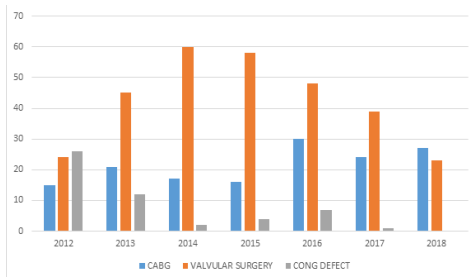
VARIOUS CARDIAC SURGERIES (FIG 1)

SURGERIES	MALE	FEMALE
CABG	112	38
VALVULAR SURGERIES	115	182
CONG DEFECT SURGERIES	16	39

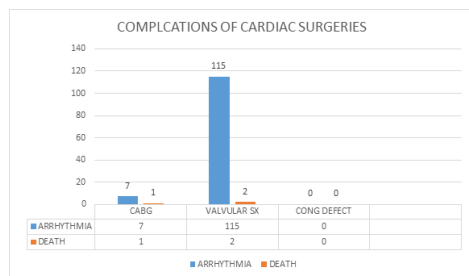
CARDIAC SURGERIES AND GENDER DISTRIBUTION (TAB 1)



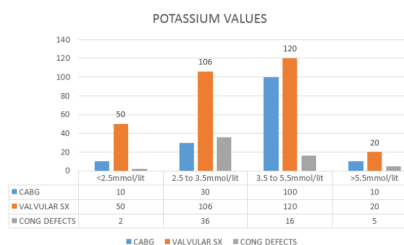
GENDER DISTRIBUTION (FIG 2)



INCIDENCE OF VARIOUS CARDIAC SURGERIES OVER YEARS (FIG 3)

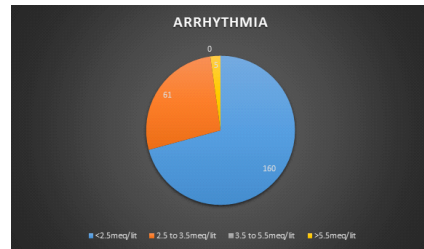


COMPLICATIONS OF POTASSIUM IMBALANCE IN CARDIAC SURGERY (FIG 4)



SR.POTASSIUM LEVELS IN VARIOUS CARDIAC SURGERIES (FIG 5)

SURGERIES	<2.5mmol	2.5 to 3.5mmol/lit	3.5 to 5.5mmol/lit	>5.5mmol/lit
CABG	10	30	100	10
VALVULAR SURGERIES	50	106	120	20
CONG DEFECT SURGERIES	2	36	16	1



INCIDENCE OF ARRHYTHMIA WITH RESPECT TO POTASSIUM VALUES (FIG 6)

All adverse outcomes occurred in patients with a post-operative serum potassium level of < 3.5 meq/L. This study had tried to validate an association between hypokalemia and the risk of adverse outcomes in cardiac surgery. Maintaining levels of serum potassium between 3.5 and 5.5 meq/L there was no association between potassium level and the incidence of any type of peri-operative arrhythmia. However below this threshold the association became progressively stronger.

DISCUSSION:

Significant elevations of extracellular potassium generally thought to be above 7.0 meq/L reduces the resting potential across the cell membrane and lead to an inability to conduct an electrical charge. Milder elevations of potassium levels have infrequently been found to be associated with development of arrhythmias. In laboratory investigations, There is also a rare association between hyperkalemic periodic paralysis, a genetically inherited condition and the development of cardiac arrhythmias (9). Decreases in extracellular potassium increase the duration of the action potential (increased phase 3 depolarization duration), increase automaticity (increased slope of diastolic depolarization) and decrease conduction velocity (10). These mechanisms may partly account for the relationship of hypokalemia to cardiac arrhythmias. Hypokalemia in laboratory models precipitates re-entrant cardiac arrhythmias by decreasing conduction, increasing refractoriness and unidirectional block (1). However, this effect can be reversed by infusion of potassium suggesting that the reversal of hypokalemia may help to avert an adverse outcome (1). The ischaemic heart appears to be particularly vulnerable to hypokalemia and is therefore at greater risk for malignant arrhythmias. One of the most convincing data was provided by Hulting (12) who studied patients admitted to a coronary care unit with a diagnosis of MI and found that the incidence of ventricular fibrillation was 3.5% increasing to 8% in patients with hypokalemia (<3.5meq/L). No episodes of ventricular fibrillation occurred when the serum potassium level was greater than 4.6meq/L, but levels less than 3.9 meq/ L were associated with a five-fold increase in the risk of ventricular tachycardia. Solomon et al (13) found an increase in the incidence of ventricular fibrillation in patients with potassium levels greater than 4.6 versus those with less than 3.0 meq/ lit. These studies demonstrating the association between hypokalemia and serious arrhythmias indicate that postoperative testing of serum potassium in patients with open heart surgery can identify patients who are at an increased risk for an adverse outcome. The findings in this study differ sharply from the findings of the before mentioned studies. Reasons for these differences are that in this study the patient population had pre-existing cardiac disease and underwent cardiac surgery but the patients studied by Vietz et al (6) were relatively healthy and underwent non-cardiac surgery. The higher incidence

of hypokalemia reported by Vietz et al (6) and Hirsh et al (7) may reflect an acute redistribution of body potassium due to adrenergic influence of preoperative anxiety rather than total body depletion. In our institute all patients undergoing cardiac surgery routinely receive sedative pre-medication and this negates the adrenergic influence of anxiety. Acute potassium redistribution increases the threshold for impulse generation as opposed to chronic potassium depletion that lowers the threshold (15,16). The findings in this study showed that mortality occurred at a serum potassium level < 3.5 meq/L. Although not reaching statistical significance, agrees with the observation by Shah et al (5) that hypokalemia is independently associated with cardiac mortality. Hypokalemia therefore is independently associated with the risk of peri-operative arrhythmias and may predict the need for CPR. It is also reversible in contrast to virtually all other known risk factors for poor outcome such as age, sex, poor ejection fraction of the heart, diabetes mellitus and emergency surgery. Potassium replacement is simple and inexpensive and may mitigate an adverse outcome in large no of patients. The focus of this study was to examine the association between monitoring serum potassium level and outcome. However this study has a few limitations. In addition magnesium levels were not determined in these patients. In summary, there was a significant association found between serum potassium levels of less than 3.5 meq/L and post-operative arrhythmias in patients undergoing elective Cardiac surgeries. Of the previously identified risk factors for adverse outcomes during cardiac surgery, such as age, sex and emergency procedures, hypokalemia may represent the only potentially reversible risk factor. Post-operative frequent potassium screening and repletion should be considered for patients scheduled for elective cardiac surgery. Both screening and therapy represent low risk and low cost prophylaxis.

CONCLUSION:

By serial monitoring of potassium values following cardiac surgeries adverse outcome of potassium levels can be managed efficiently and the mortality and morbidity associated with it can be prevented.

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