

**Original Article**

**A STUDY ON EVALUATION OF POTASSIUM ABNORMALITIES IN A TERTIARY CARE HOSPITAL**

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**ABSTRACT**

**Objective:** To study the occurrence, causes, predisposing factors and management of potassium abnormalities in a tertiary care hospital.

**Methods:** In our study which was for a duration of six months, we recorded patient demographics, electrolyte levels, complete blood picture, liver function tests, renal parameters, comorbid conditions, medication reconciliation and electrocardiogram (ECG) changes. The data was analyzed to find out the cause for potassium abnormality and was categorized based on their severity.

**Results:** A total of 200 cases of potassium abnormalities was normalized during the study period. We observed 158 (80%) cases with hypokalemia, 37 (17%) cases with hyperkalemia and 5 (3%) cases with subsequent Potassium abnormalities. We observed the majority of hypokalemia are with disease induced 87 (55.06%) cases and 118 (74.0%) cases were with mild hypokalemia. Syrup potassium chloride was used to normalize the serum potassium levels. Majority of the hyperkalemia cases were disease induced and was found in 19 (51.35%) cases and 22 (59.45%) cases come under mild category which was managed with injection calcium gluconate.

**Conclusion:** Hypokalemia was the most common potassium abnormality seen in hospitalized patients. Disease induced potassium abnormalities was found to be more common in both hypo and hyperkalemia. The potassium levels were normalized with no major negative outcomes. Continuous monitoring of electrolyte levels is required for the patient to prevent further complications.

**Keywords:** Hypokalemia, Hyperkalemia, Disease induced, Drug-induced, Potassium supplements

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**INTRODUCTION**

In physiology, the primary ions of the electrolytes are sodium (Na<sup>+</sup>), potassium (K<sup>+</sup>), calcium (Ca<sup>2+</sup>), chloride (Cl<sup>-</sup>), hydrogen phosphate (HPO<sub>4</sub><sup>2-</sup>), and hydrogen carbonate (HCO<sub>3</sub><sup>-</sup>) [1]. Potassium is one amongst those which is the most abundant cation in the body, with estimated total-body stores of 3,000 to 4,000mmol. About 98% of potassium is seen within the intracellular compartment, and the remaining 2% is distributed within the extracellular compartment. The Sodium-Potassium adenosine triphosphate (Na<sup>+</sup>-K<sup>+</sup>-ATPase) pump located in the cell membrane is responsible for the compartmentalization of Potassium. This pump is an active transport system that maintains increased intracellular stores of Potassium by transporting Sodium out of the cell and Potassium into the cell at a ratio of 3:2. Consequently, the pump maintains a higher concentration of potassium inside the cell. Potassium plays a main role in the transmission of nerve impulse, contraction of muscles and maintenance of fluid balance in the body [2].

The normal value of serum potassium is 3.5-5.0 mmol/l. Hypokalemia is an electrolyte imbalance and is indicated by a low level of Potassium in the blood. Hypokalemia is divided into 3 categories based on serum potassium levels; mild 3.0-3.5 mmol/l, moderate 2.5-3.0 mmol/l and severe <2.5 mmol/l. Up to 21% of hospitalized patients have serum potassium levels lower than 3.5mmol/l, with 5% of patients exhibiting potassium levels lower than 3 mmol/l [3]. Hyperkalemia is defined as serum potassium concentration greater than 5.0mmol/l. It is less common than hypokalemia. Hyperkalemia is divided into 3 categories based on serum electrolytes; mild 5.1-5.5 mmol/l, moderate 5.6-6.0 mmol/l and severe >6 mmol/l. The incidence of hyperkalemia in hospitalized patients has been estimated to be 1.4-10% [4].

One of the most common electrolyte complications are Potassium abnormalities in hospitalized patients. Potassium is one of the critical electrolytes involved in various cellular activities. Potassium loss in the body affects the quality of life of the patient and increases

morbidity and mortality. So, it is very important to monitor the potassium levels, initiate the standard treatment immediately and normalize them [5]. Hence in this study, we aimed to capture the data regarding the potassium abnormalities in the hospital setting and understand the causes and their management strategies.

**MATERIALS AND METHODS**

The present study was a prospective and observational study conducted at Apollo Hospitals, Jubilee Hills, Hyderabad, India. This study was approved by the institutional ethical committee (No: SVCP/2015/28). Case records of the inpatients who are above or equal to 18 y with abnormal potassium values were included and outpatients are excluded from the study. The data was collected regarding patient's demographics such as age, family history, co-morbid conditions, abnormal potassium values, dose, frequency, lab parameters such as serum electrolytes values (Sodium, Calcium, Magnesium and Chlorides), Serum Creatinine (S. Cr), complete blood picture, electrocardiogram (ECG), liver function tests like albumin, globulin, and alkaline phosphatase were recorded. Statistical analysis is done by using descriptive statistics and CI of mean. Descriptive analysis was used to report the findings of continuous data and Categorical data, potassium abnormalities was analyzed by confidence intervals of their respective means.

**RESULTS AND DISCUSSION**

A total of 200 in-patients who have abnormal potassium values were considered for the study, of which the majority were males (53%). Higher percentage of our study population belonged to the age group of 51-60 y (27%), as it is known that risk of cardiovascular disease (Hypertension, Coronary artery diseases) and renal disease (Chronic kidney disease and Acute kidney injury) are significantly higher in this age (table 1). Blood pressure increases with age and lifetime risk of developing cardiovascular diseases among those of 55 y age and older was observed to be 90% [6,7].

Majority of our study population were found to be overweight and obese with an average body mass index (BMI) of 27.4 kg/m<sup>2</sup>. Obesity is

characterized by a marked insulin resistance which involves an abnormal regulation of Potassium uptake and metabolism (table 1).

The disease induced hypokalemia 87 (55.06%) cases and hyperkalemia 19 (51.35%) cases, and the drug-induced hypokalemia 71 (44.93%) cases and hyperkalemia 18 (48.65%) cases, were observed among 158 cases of hypokalemia (The 95% confidence interval extends from 0.7281 to 0.8410) and 37 cases of hyperkalemia (The 95% confidence interval extends from 0.1370 to 0.2449) respectively (table 2).

Chronic kidney disease (CKD), diabetes mellitus (DM), hypertension (HTN), coronary artery disease (CAD) and urinary tract infections (UTI) are the conditions where potassium abnormalities were seen

to a larger extent. In our study we noted that Lactulose, furosemide, methylprednisone, noradrenaline, actrapid, perindopril, enalapril, irbesartan, telmisartan, aspirin, and combinational drugs like furosemide +lactulose, non-steroidal anti-inflammatory drugs and angiotensin-converting enzyme inhibitors (NSAIDS+ACEI), $\beta$ -blockers, angiotensin receptor blockers and beta blockers(ARB+ $\beta$  blockers)are the drugs causing potassium abnormalities (table 3). Among disease induced hypokalemia, nephrotic disorders are the prime reasons, it can be because of increased water intake and increased reabsorption of sodium chloride and water offer to sustain the edemas, while aldosterone promotes renal excretion of K+ and H+ leads to develop hypokalemia and alkalosis [8, 9].

**Table 1: Patient demographics (N=200)**

Gender	No of cases (%)
Females	94 (47%)
Males	106 (53%)
<b>Age</b>	
Years	No of cases (%)
18-30	19 (9.5%)
31-40	27 (13.5%)
41-50	27 (13.5%)
51-60	54 (27%)
61-70	45 (22.5%)
>71	28 (14%)
<b>BMI</b>	
BMI (kg/m <sup>2</sup> ) Range	No of cases (%)
Underweight<18	40 (20%)
Normal 18.5-24.9	46 (23%)
Overweight 25-29.9	70 (35%)
Obese 30-39.9	34 (17%)
Morbid obese>40	10 (5%)

**Table 2: Details of Potassium abnormalities in the study population (N=200)**

Potassium abnormality	Hypokalemia	Hyperkalemia	Subsequent K+ abnormality
Serum K <sup>+</sup> value<3.5 mmol/l	158* (80%)	-	05(3%)
>5.0 mmol/l	-	37 **(17%)	-
<b>Severity</b>			
Mild	118 (74.6%)	22 (59.45%)	03 (60%)
Moderate	35 (22.15%)	10 (27.02%)	0
Severe	05 (3.16%)	05 (13.51%)	02 (40%)
<b>Etiology</b>			
<b>Categories</b>	<b>Hypokalemia</b>	<b>Hyperkalemia</b>	<b>Subsequent potassium abnormality</b>
Disease induced	87 (55.06%)	19 (51.35%)	05 (100%)
Drug induced	71 (44.93%)	18 (48.65%)	-
<b>ECG Changes (n= 17)</b>			
<b>Sinus Tachycardia</b>	<b>Drug-induced</b>		<b>Disease induced</b>
Hypokalemia	10 (71%)		4 (29%)
Hyperkalemia	1 (33.3%)		2 (66.7%)

\*95%CI 0.7281 to 0.8410\*\*95% CI 0.1370 to 0.2449

**Table 3: Common drugs in dosing potassium abnormalities (N = 200)**

Drugs causing potassium abnormalities		
Class	Drug	No of cases (%)
<b>Hypokalemia (n = 158)</b>		
Laxatives	Lactulose	19 (26.76%)
Loop diuretics	Furosemide	13 (18.30%)
Corticosteroids	Methyl prednisone	06 (8.45%)
Catecholamine	Nor adrenaline	01 (1.40%)
Insulin	Actrapid	01 (1.40%)
Combination	Furosemide +Lactulose	09 (12.67%)
<b>Hyperkalemia (n=37)</b>		
ACEI's*	Perindopril	02 (11.11%)
	Enalapril	02 (11.11%)
ARB'S*	Irbesartan	01 (5.55%)
	Telmisartan	01 (5.55%)
NSAIDS*	Aspirin	02 (11.11%)
Combinations	NSAIDS+ACEI'S,	02 (11.11%)
	$\beta$ -blockers +NSAIDS+ACEI's	02 (11.11%)
	ARB's+ $\beta$ blockers	02 (11.11%)

ACEI's: Angiotensin Converting Enzyme Inhibitors, ARB's: Angiotensin Receptor Blockers, NSAIDS: Non-Steroidal Anti-Inflammatory Drugs

**Management of Hypokalemia and Hyperkalemia:**

The Serum Potassium levels in hypokalemia patients were normalized with 10ml (13.3mEq) of Potassium chloride syrup, which was administered three times a day in 27 (17 %) cases, which showed 0.5mmol/l increase in Serum Potassium. Injection potassium chloride (KCl) was given in 28 (17.7%) cases and were managed with 40mEq given twice a day, which showed an increase of 0.3mmol/l serum potassium(table 4).

Potassium citrate and magnesium citrate (Potrate M) was also given for the management of hypokalemia when there was an abnormality of magnesium in metabolic alkalosis patients. Potrate M was given in 4(2.5%) cases with 15 ml twice a day, showed an increase of 0.5mmol/l serum potassium. In our study, combination therapy was given for the management of hypokalemia. Syrup potassium chloride (Potrate) 20ml and injection Potassium chloride 10 mEq, stat was given in 8 (5%) cases, which showed an increase of 0.4 mmol/l (table 4).

For the management of hyperkalemia, parenteral, nebulizers and oral dosage forms were prescribed. Calcium gluconate, insulin, potassium bind was given as injections and as nebulizers

salbutamol +ipratropium Bromide, Salbutamol were given and as oral dosage form furosemide, Potassium bind sachet, Sodium bicarbonate were given. Out of all these drugs in our studyinj. Calcium gluconate, 10ml stat was found to decrease serum potassium by 0.2mmol/l in 3 (8.1%) cases and Potassium bind sachet 15ml per oral once a day, salbutamol+ ipratropium Bromide2cc nebulizer four times a day and Salbutamol 1 cc nebulizer three times a day were given in2 (5.4%), 2(5.4%), 1(2.7%) cases respectively which showed decrease of 0.1 mmol/l serum potassium in all the three. Sodium bicarbonate 500mg per oral twice daily was given in 2 (5.4%) cases which showed a decrease of 1.1 mmol/l of serum Potassium.Furosemide20mg per oral twice daily and subcutaneous Insulin 16 units once a day was given in 1(2.7%) case which showed decrease of 0.2mmol/l serum potassium respectively(table 4).

Hyperkalemia was also managed using more than one drug. In our study the combination drugs were inj. Calcium gluconate 10 ml stat and Salbutamol 2cc nebulizer three times a day was given in 2 (5.4%) cases Which Showed a decrease of 0.3mmol/l of serum potassium(table 4).

**Table 4: Management of potassium abnormalities in the study population (N=200)**

<b>Hypokalemia (n=158)</b>						
<b>Drug</b>	<b>Dose</b>	<b>No of cases</b>	<b>Route</b>	<b>Frequency</b>		<b>Average increase in K+ value (mmol)</b>
Syrup Potassium chloride	10 ml	41	PO	OD	01	0.1
				BD	12	0.3
				TID	27	0.5
				QID	01	0.7
Inj. Potassium chloride	40meq	28	IV	BD	28	0.3
				Potassium citrate and Magnesium citrate,	15 ml	07
			TID	03		
Potassium citrate and Magnesium citrate + Inj. Potassium chloride	20 ml + 10meq	08	PO IV	Stat		0.4
<b>Hyperkalemia (n=37)</b>						
<b>Drug</b>	<b>Dose</b>	<b>No of cases</b>	<b>Route</b>	<b>Frequency</b>		<b>Average decrease in K+value (mmol)</b>
Calcium gluconate	10 ml	03	IV	Stat		0.2
Furosemide	20 mg	01	PO	BD		0.2
Potassium Bind Sachet	15 ml	02	PO	OD		0.1
Salbutamol +Ipratropium Bromide	2cc	02	Neb	QID		0.1
Salbutamol	1cc	01	Neb	QID		0.1
Sodium bicarbonate	500 mg	02	PO	BD		1.1
Insulin	16U	01	SC	HS		0.2
Calcium gluconate+ Salbutamol	10 ml + 2cc	02	IV Neb	Stat TID		0.3

In a few cases extra supplementation of potassium led to hyperkalemia and upon treatment, it subsequently resulted in hypokalemia. Such kind of Potassium abnormalities was found to be 5(3%) cases in our study. In subsequent hypokalemia and hyperkalemia, mild and severe cases were seen in 3 and 2 cases respectively, which are found in both disease and drug induced Potassium abnormalities (table 2).

Patients with longer duration of hospital stay were observed to be with subsequent hypokalemia and hyperkalemia as these patients require continuous monitoring. The initiation of potassium supplements was influenced by the duration of stay in these patients. Naranjo's causality scale was used to assess the causality of potassium abnormalities. In our study, we found that about half of the cases of druginduced hypokalemia and the drug-induced hyperkalemia were possible (table 5).

**Table 5: Causality assessment**

<b>Naranjo's scale (n=89)</b>	<b>Hypokalemia (71)</b>	<b>Hyperkalemia (18)</b>
Probable (5-8)	25	06
Possible(1-4)	30	09
Definite(≥9)	14	03
Doubtful	02	00

**LIMITATIONS**

Difficulty in accessing data in ICU and Hemodialysis department. Since, data collected was from inpatient only, the status of improvement in potassium levels after discharge was unavailable.

**CONCLUSION**

From our study, we observed that hypokalemia was the most common potassium abnormality. The common causes of the abnormalities were because of diseases. However, they were mild in

nature and were treated with no negative outcome. Regular monitoring is required to prevent further complications and to improve the quality of life.

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#### AUTHORS CONTRIBUTIONS

Vidya Maheshwaram, Sahitya K, Srujana K and Naveen Kumar V, Pharm D students collected the data. Dr Rawheena Mayee research guide, Dr Aparna Yerramilli, Dr Sanjeev sharmaco-guides of this study contributed in the design of the study, protocol process, data analysis and manuscript writing.

#### CONFLICT OF INTERESTS

The author(s) declare(s) that they have no conflicts of interest to disclose.

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