Acta Biomedica Scientia

e - ISSN - 2348 - 2168
Print ISSN - 2348 - 215X

www.mcmed.us/journal/abs

Research Article

A LABORATORY PERSPECTIVE FOR THE UNDERSTANDING OF ERRORS IN POTASSIUM MEASUREMENT

P. Suseela[1*], C. Uthirakumar[2], S. Sathishkumar[1]

[1] Medserve Medical Diagnostic Services, Kidney Care and Specialty Hospital, Coimbatore, Tamil Nadu, India.
[2] VRR Institute of Biomedical Science, Chennai, Tamil Nadu, India.

ABSTRACT

It is not an easy task to recognize the errors in potassium measurement in the laboratory. Falsely elevated potassium levels if goes unrecognized by the laboratory and clinician, it is difficult to treat masked hypokalemic state, which is again a medical emergency. Such cases require proper monitoring by the clinician, so that cases with such history of pseudohyperkalemia which cannot be easily identified in the laboratory should not go unrecognized by clinician. The aim of this article is to discuss about the errors and causes of spuriously elevated potassium and how to minimize the errors causing pseudohyperkalemia.

Keywords :-Pseudohyperkalemia, Hemolysis, Fist Clenching, Leukocytosis.

Access this article online	
Home page: http://www.mcmed.us/journal/abs DOI: http://dx.doi.org/10.21276/abs.2018.5.1.3	Quick Response code

Received:09.01.18	**Revised**:18.01.18	**Accepted**:24.01.18

INTRODUCTION

There are three phases of errors to testing the sample that is preanalytical errors, analytical errors and postanalytical errors. Majority of errors can occur in preanalytical phase. Preanalytical errors accounts to (65%) and postanalytical errors (25%) and remains analytical errors due to analytical problems have been significantly reduced [1]. Potassium is the main intracellular cation in the body and is principally involved in membrane potential and electrical excitation of both nerve and muscle cells and regulates acid- base balance. It helps your heartbeat stay regular and move nutrients into cells and waste products out of cells. 60-70 % of clinical decisions are based on the laboratory results and potassium is among the ten most commonly tested analytes [2]. Hence the article is to discuss the errors and causes of spuriously elevated potassium, and best practices to minimize those factors.

Causes of Hypokalemia

Low potassium (hypokalemia) has many causes. The most common cause is excessive potassium loss in urine due to prescription medications that increase urination [3]. Hypokalemia may result from inadequate potassium intake, increased potassium excretion, or a shift of potassium from the extracellular to the intracellular space. Increased excretion is the most common mechanism. Poor intake or an intracellular shift by itself is a distinctly uncommon cause, but several causes often are present simultaneously.

Causes of Hyperkalemia

High blood potassium isn't true hyperkalemia. Instead, it may be caused by the rupture of blood cells in the blood sample during or shortly after the blood draw. The ruptured cells leak their potassium from intracellular into extracellular fluid. This falsely raises the amount of potassium in the blood sample, even though the potassium level in your body is actually normal. Mild degrees of renal failure generally do not result in resting hyperkalemia, because of compensation by adaptive mechanisms in the kidneys and GI tract [4]. However, once

Corresponding Author Dr. **P. Suseela** Email: - drsuseelackc@gmail.com

The GFR falls below 15-20 mL/min, significant hyperkalemia can occur, even in the absence of an abnormally large potassium load.

ERRORS IN POTASSIUM MEASUREMENT

Pre-analytical Errors

Several mechanisms can create pre-analytical errors during the potassium measurement. These include;

- Hemolysis
- Contribution of potassium from platelets/ WBC/ RBC
- Specimen Contamination
- K^+/ H^+ ion exchange
- Fist clenching
- Inappropriate reference intervals

Hemolysis

Hemolysis of red blood cells releases large amounts of potassium into the surrounding plasma. Erythrocytes contain 23 times as much potassium as the plasma. The most common causes for hemolysis are related to mechanical factors during the collection process:

Use of a syringe is by far the most common cause of hemolysis, with almost 80% of hemolyzed samples associated with use of a syringe rather than an evacuated tube for sample collection [5]. Nineteen percent of syringe-collected specimens were hemolyzed in one study, as compared to 3% of specimens that were collected in evacuated tubes [6].

Vigorously eject the blood from a syringe into an evacuated tube causes shear forces on the red cell membrane, resulting in rupture of the cell [7]. Evacuated tubes should be allowed to fill slowly from the vacuum in the tube, without pressing on the syringe plunger.

Drawing the blood through a small needle ruptures red cells as they pass through either. Blood collected with a 23-gauge needle has higher potassium concentrations than blood from the same individual collected with a 19-gauge needle [8]. The hemolysis rate is inversely proportional to the diameter of the needle, with the highest hemolysis rates in 24- to 23-gauge needle.

Inverting the tube too vigorously to mix the blood with anti- coagulant also causes turbulence.

Contribution of potassium from platelets/ WBC/ RBC

All cells in the body contain a high concentration of potassium. During the blood-clotting and spinning processes, platelets and WBCs can lyse or potassium can leak from cells.

There is a fine line between insufficient time for clotting of a serum specimen and excessive time. If the specimen is centrifuged before clotting is completed, a fibrin clot may occur that interferes with pipetting and analysis. If the serum sits on the clot too long, there can be changes in test results, including the potassium. The minimum time to form a good clot is usually 20 to 30 minutes. The maximum recommended time between collection and separation of clot and serum is two hours. Clinically significant increases in potassium occur after three hours at room temperature. At elevated temperatures (32℃) the change is more complex, with a decrease due to glycolysis, followed by an increase because of potassium diffusion out of cells [9-11].

Delayed processing for any reason can result in prolonged clot contact time. One cause that is occurring with increased frequency is the use of anticoagulant drugs and aspirin that delays or prevents the formation of a good clot. Severe liver disease that results in a deficiency of clotting factors can do the same thing.

Familial pseudohyperkalemia also called the "leaky red cell syndrome," this is an inherited condition in which red blood cells, stored at room temperature, passively leak potassium through the red cell membrane. A significant increase in potassium is seen in two hours at room temperature, with a maximum increase in four hours. The condition causes no symptoms. The incidence of this condition is unknown, but it is rare [12].

Specimen contamination

Contamination of specimens can come from two sources

- potassium introduced into the specimen; and
- a material that reacts with the ISE (ion-selective electrode)

to produce a signal that is measured as potassium. Both mechanisms have been reported to erroneously increase potassium assay values.

Order of draw Potassium can become falsely elevated if the individual performing the collection fills the tubes without regard for the proper order of draw. If the blood from an EDTA tube, which contains potassium, carries over into a tube to be tested for potassium, the carryover may spike the reported result and lead to inappropriate physician intervention or the lack of intervention when it is necessary.

Fist clenching

One of the most common causes for elevated potassium is fist clenching or pumping before or during the venipuncture. Fist pumping has been taught to generations of phlebotomists as a means to make the veins more visible for venipuncture; however, it adversely affects the potassium measurement.

Analytical Errors

Other than the instrument error, very few reasons can create elevated potassium level at some point in the analytical phase such as,

- Malignant Leukocytosis
- Myeloma proliferative disorders

Malignant Leukocytosis

Leukocytosis, or elevated WBC count, is a commonly encountered by laboratory finding. Distinguishing malignant from benign leukocytosis is a significant step in the care of a patient, which initiates a vastly different decision tree. When a leukocytosis is present, measurement should be made on a lithium heparin plasma sample immediately transported on ice to the laboratory; alternatively, whole blood should be measuredimmediately on a point of care analyzer with a potassium electrode [13].

Myeloma proliferative disorders

The blood-producing cells in the bone marrow (precursor cells) develop and reproduce excessively or are crowded out by an overgrowth of fibrous tissue. Hence the myeloma proliferative disorder least to spuriously elevated potassium concentration.

Post- analytical Errors

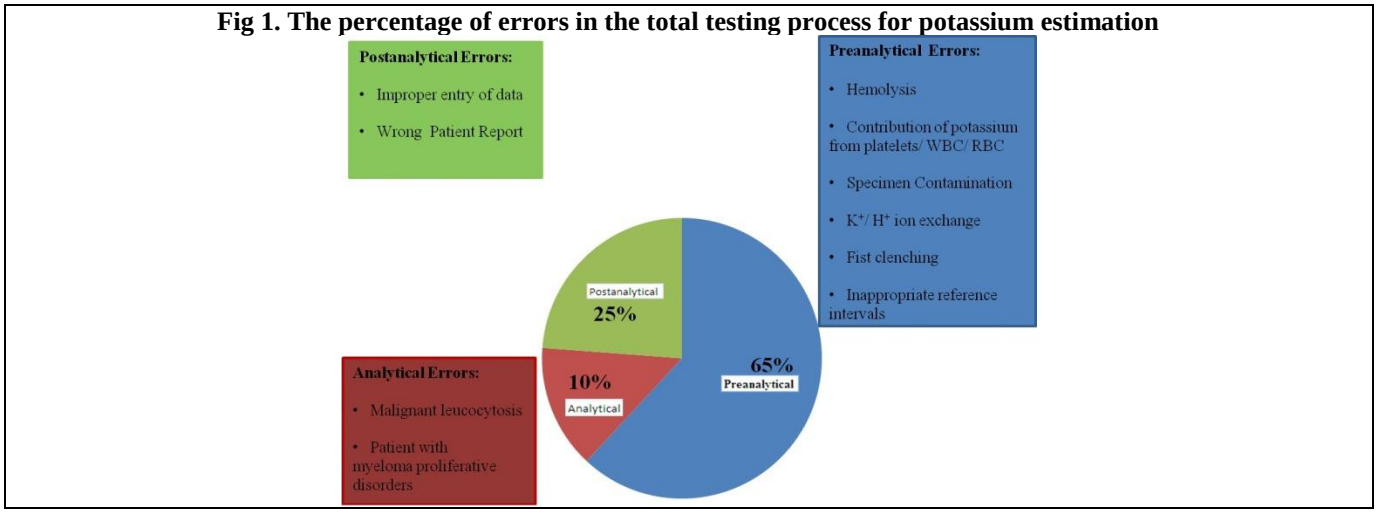
Post-analytical laboratory processes have been considered to be less prone to error than pre-analytical processes because of the widespread adoption of laboratory automation.

BEST PRACTICES TO REDUCE THE ERRORS

Although the list of factors that can elevate the plasma potassium concentration is large, relatively small number of them has a major effect and these can be reduced by following the procedures;

- No fist clenching
- Using 22- gauge needles
- Drawing directly into evacuated tubes
- Do not centrifuge before clotting is complete
- Centrifuge and aliquot specimens promptly
- Proper mixing of anticoagulants into the evacuated tubes
- Use tourniquet less than one minute
- Follow correct order of draw procedure

Fig 1. The percentage of errors in the total testing process for potassium estimation



CONCLUSION

Many factors which contribute to elevation of measured potassium or mask hypokalemia. Since 98% of potassium is intracellular, a small efflux of potassium can considerably affect the concentration of measured potassium. So utmost care should be taken from collecting the sample to transporting it to the laboratory and efforts must be taken to minimize all the factors, which affect erroneous potassium estimation. Apart from this even clinicians have more responsibility in evaluating the patient's condition when suspicious arises. When measured potassium is sharply discordant from previous readings or the patient condition is not correlating with measured laboratory value. At the bedside level if pseudohyperkalemia is suspected the laboratory should be approached immediately, so that suitable sample can be submitted and correct measurement of potassium can be redone correctly. Appropriate co-ordination among clinician and laboratory personnel can also reduce such errors and proper education should be given to phlebotomist to collect sample appropriately.

ACKNOWLEDGEMENT

None

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

1. Plebani M. (2006). Errors in clinical laboratory. *Clin chem. labmed*, 44, 750-9.

2. Forsman RW. (1996). Why is the laboratory an afterthought for managed care organizations? *ClinChem*, 42, 813–6.
3. Keith T. (2015). Medication-Induced Hypokalemia. *Pharmacovigilance Forum*, 40, 185-90.
4. Anthony JV. (2015). Potassium Disorders: Hypokalemia and Hyperkalemia. *American Family Physician*, 92, 487-95.
5. Burns ER. (2002). Hemolysis in serum samples drawn by emergency department personnel versus laboratory phlebotomists. *Laboratory Medicine*, 33, 378-80.
6. Stankovic AK. (2004). Elevated potassium values: The role of preanalytic variables. *Am J Clin Path, 121, S105-12.*
7. Carraro P. (2000). Hemolyzed specimens: A reason for rejection or clinical challenge? *ClinChem*, 46, 306-7.
8. Verresen L. (1986). Effects of needle size and storage temperature on measurements of serum potassium. *ClinChem*, 32, 698-99.
9. Ono T. (1981). Serum-constituents analyses: Effect of duration and temperature of storage of clotted blood. *ClinChem*, 27, 35-38.
10. Rehak NN. (1988). Storage of Whole Blood: Effect of Temperature on the measured concentration of analytes in serum. *ClinChem*, 34, 2111-14.
11. Zhang DJ. (1998). Effect of serum-clot contact time on clinical chemistry laboratory results. *ClinChem*, 44, 1325-33.
12. Iolascon A. (1999). Familial Pseudokalemia maps to the same locus as dehydrated heredity stromatocytosis (Heredity Xerocytosis). *Blood*, 93, 3120-23.
13. Massimo D. (2016). Spurious elevation of serum potassium concentration measured in samples with thrombocytosis. *Diagnosis*, 3, 71-74.

Cite this article:
Suseela P, Uthirakumar C, Sathishkumar S. A Laboratory Perspective For The Understanding Of Errors In Potassium Measurement *Acta Biomedica Scientia*, 2018;5(1):13-16. DOI: http://dx.doi.org/10.21276/abs.2018.5.1.3