

REVIEW ARTICLE

POTASSIUM MEASUREMENT: CAUSES OF ERRORS IN MEASUREMENT

Kavitha P¹, Omprakash B²

HOW TO CITE THIS ARTICLE:

Kavitha P, Omprakash B. "Potassium Measurement: Causes of Errors in Measurement". Journal of Evolution of Medical and Dental Sciences 2014; Vol. 3, Issue 27, July 07; Page: 7515-7519, DOI: 10.14260/jemds/2014/2927

ABSTRACT: It is not a easy task to recognize the errors in potassium measurement in the lab. Falsely elevated potassium levels if goes unrecognized by the lab 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 the causes and mechanisms of spuriously elevated potassium and minimize the factors causing pseudohyperkalemia. Literature search performed on pubmed using terms "pseudohyperkalemia", "spurious hyperkalemia", "and masked hyperkalemia", "reverse pseudohyperkalemia", "factitious hyperkalemia".

KEYWORDS: Pseudohyperkalemia, potassium, spurious hyperkalemia.

INTRODUCTION: The three phases of testing the sample are: preanalytical phase, analytical phase and postanalytical phase. Majority of errors occur during preanalytical phase. Preanalytical error accounts to (46-68%) and postanalytical error (18.5-47%) and analytical error due to analytical problems have been significantly reduced.⁽¹⁾ Potassium is most commonly tested analyte and nearly 60-70% of clinical decisions are based on laboratory results.⁽²⁾ Majority of errors occurs during preanalytical phase-during labeling, collection of samples, during transportation and centrifugation all these leads to faulty testing.⁽³⁾

Causes of pseudohyperkalemia:

Mechanical factors: During blood draw if tourniquet is applied for prolonged period of more than 1min it can cause hemoconcentration, hemolysis, altered water balance. During blood draw fist clenching should avoided as it causes muscle contraction and release of potassium from forearm muscle and increased blood flow.⁽⁴⁻⁶⁾ In a study conducted, it was found that the measured potassium in the pumping hand was 1.04mmol/L higher when compared to non pumping hand. Inappropriate needle diameter, traumatic venipuncture or probing, increased turbulence due to diameter mismatch of catheter, excessive force with syringe draws either during aspiration or transfer, tube adapter device and mismatch needle can all result in hemolysis and leads to pseudohyperkalemia. Mechanical force during specimen processing such as vigorous mixing, excessive centrifugal force or prolonged recentrifugation can also result in pseudohyperkalemia.^(3, 4) Cases of pseudohyperkalemia due to pneumatic tube transport especially in disease states with fragile cell membranes such as leukemia and disorders of RBC cell membranes leads to hemolysis and potassium leakage.^(7, 8)

Temperature: Initially there will be decrease in potassium levels and later increase in potassium levels. If temperature is high, this is due to utilization of glucose that generates ATP for sodium-potassium pump. Cold temperature inhibits sodium-potassium pump resulting in leakage of

REVIEW ARTICLE

potassium. Temperature for specimen storage prior to testing is 15-25°C.⁽³⁾ Elevated potassium levels are more commonly seen in sample collected from far places from the testing point due to changes in temperature while transporting. This type of elevation in potassium levels is referred to “seasonal pseudohyperkalemia.”^(9, 10)

Chemical factors: antiseptics containing ethanol is used to clean the area before venipuncture, if this is not allowed to dry completely before drawing blood, the antiseptic solution can enter the blood stream and disrupt cell membranes and in turn increase potassium levels.⁽³⁾

Time: From the time of collection to time of processing if too long, this delay in processing can result in utilization of available glucose to generate ATP. ATP fuels sodium-potassium pump and maintains the gradient across the membrane, when ATP production comes to a halt, failure of pump results in leakage of potassium out of cell resulting in pseudohyperkalemia. So processing time should be minimized.

Patient factors: crying out of fear of getting a prick (venipuncture) even for shorter time is associated with respiratory alkalosis, which leads to significant hyperkalemic response mediated by increased α -adrenergic activity.⁽¹¹⁾ Increase in platelet count results in increased release of potassium during the clotting process, this increase in potassium was found initially but declined presumably caused by re-entry of potassium into RBC to maintain homeostasis.⁽¹²⁾ Factitious hyperkalemia may be seen in leukemia due to increased fragility of the cell membranes.⁽⁸⁾ Post splenectomy period there will be pseudohyperkalemia in the patients.^(13, 14) In patients with chronic renal disease, pseudohyperkalemia due to co-existing myeloproliferative neoplasm was identified only when therapy failed to reduce potassium concentration in serum.^(15, 16) Familial pseudohyperkalemia is an autosomal disorder characterized by abnormal passive outward leakage of potassium across the erythrocyte membrane.^(17, 18) This occurs when blood is stored in room temperature.

Contaminants: order of draw should be followed while drawing blood or else carryover and backflow of potassium salts of tube additives such as ethylenediamine tetra-acetic acid or oxalate can elevate measured potassium and even potassium containing IV fluids are common contaminants.⁽²⁸⁾ So it is advisable to follow order of draw to minimize errors in testing. In one of the study povidone iodine is found to be associated with increase in measurement of potassium by upto 1mmol/l, underlying mechanism is unknown.⁽¹⁹⁾ Contaminants like benzalkonium heparin, a chemical used to coat catheters in IV-access catheter devices to decrease thrombus formation and infections, interfere with electrodes in older generation of instruments that measured potassium indirectly.^(20, 21)

Reverse pseudohyperkalemia: Reverse pseudohyperkalemias when serum potassium is normal and plasma potassium is falsely high.⁽²²⁻²⁴⁾ This phenomenon has been reported in samples of patients with leukemia, lymphoma. In another study, the plasma potassium concentration of a sample collected in a lithium heparin tube was 6.0mmol/L higher than simultaneously measured serum potassium concentration.⁽²⁴⁾ The degree of increase in potassium was directly associated with the amount of heparin in the tube. Heparin coated syringe containing $\frac{1}{3}$ the amount of heparin did not cause an increase in plasma potassium.

REVIEW ARTICLE

Masked hypokalemia: The same factors that can cause pseudohyperkalemia can mask hypokalemic state in a patient by pushing the patient's potassium level into reference interval.^(25, 26) In one study, more than a third of hypokalemic cases were missed due to hemolysis when using whole blood to estimate potassium.⁽²⁷⁾

CONCLUSION: There are many factors which contribute to elevation of measured potassium or mask hypokalemia. Since 98% of potassium is intracellular, a small efflux of potassium can significantly affect concentration of measured potassium. So utmost care should be taken from collecting the sample to transporting it to the lab 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 lab value. At the bedside level if pseudohyperkalemia is suspected the lab should be approached immediately, so that suitable sample can be submitted and correct measurement of potassium can be redone correctly. Proper coordination between clinician and lab personnel can also minimize such errors and proper education should be given to phlebotomist to collect sample correctly.

REFERENCES:

1. Plebani M. Errors in clinical laboratory. *Clin chem. labmed.* 2006, 44(6): 750-9.
2. Forsman RW. Why is the laboratory an afterthought for managed care organizations? *Clin Chem.* 1996; 42: 813-6.
3. Stankovic AK, Smith S. Elevated serum potassium values: The role of preanalytic variables. *Am J Clin Pathol.* 2004; 121: S105-12.
4. Baer DM, Ernst DJ, Willeford SI, Gambino R. Investigating elevated potassium values. *MLO Med Lab Obs.* 2006; 38: 24, 26, 30-1.
5. Bailey IR, Thurlow VR. Is suboptimal phlebotomy technique impacting on potassium results for primary care? *Ann Clin Biochem.* 2008; 45: 266-9.
6. Saleem S, Mani V, Chadwick MA, Creanor S, Ayling RM. A prospective study of causes of haemolysis during venepuncture: Tourniquet time should be kept to a minimum. *Ann Clin Biochem.* 2009; 46: 244-6.
7. Guiheneuf R, Vuillaume I, Mangalaboyi J, Launay D, Berthon C, Maury JC, et al. Pneumatic transport is critical for leukaemic patients with major leukocytosis: What precautions to measure lactate dehydrogenase, potassium and aspartate aminotransferase? *Ann Clin Biochem.* 2010; 47: 94-6.
8. Kellerman PS, Thornbery JM. Pseudohyperkalemia due to pneumatic tube transport in a leukemic patient. *Am J Kidney Dis.* 2005; 46: 746-8.
9. Sinclair D, Briston P, Young R, Pepin N. Seasonal pseudohyperkalaemia. *J Clin Pathol.* 2003; 56: 385-8.
10. Turner HE, Peake RW, Allison JJ. Seasonal pseudohyperkalaemia: No longer an issue? *Ann Clin Biochem.* 2012; 49: 94-6.
11. Krapf R, Caduff P, Wagdi P, Stäubli M, Hulter HN. Plasma potassium response to acute respiratory alkalosis. *Kidney Int.* 1995; 47: 217-24.

REVIEW ARTICLE

12. Sevastos N, Theodossiades G, Efstathiou S, Papatheodoridis GV, Manesis E, Archimandritis AJ. Pseudohyperkalemia in serum: The phenomenon and its clinical magnitude. *J Lab Clin Med.* 2006; 147: 139–44.
13. Ahmed R, Isaac AM. Postsplenectomy thrombocytosis and pseudohyperkalemia in trauma: A case report and review of literature. *J Trauma.* 2009; 67: E17–9.
14. Lambertucci JR, Otoni A, Rodrigues VL. Pseudohyperkalemia and pseudohyperphosphatemia after splenectomy in hepatosplenic schistosomiasis mansoni. *Rev Soc Bras Med Trop.* 2008; 41: 692.
15. Fukasawa H, Furuya R, Kato A, Yonemura K, Fujigaki Y, Yamamoto T, et al. Pseudohyperkalemia occurring in a patient with chronic renal failure and polycythemia vera without severe leukocytosis or thrombocytosis. *Clin Nephrol.* 2002; 58: 451–4.
16. Ifudu O, Markell MS, Friedman EA. Unrecognized pseudohyperkalemia as a cause of elevated potassium in patients with renal disease. *Am J Nephrol.* 1992; 12: 102–4.
17. Sugimoto T, Kume S, Osawa N, Nakazawa J, Koya D, Kashiwagi A. Familial pseudohyperkalemia: A rare cause of hyperkalemia. *Intern Med.* 2005; 44: 875–8.
18. Kitamura K, Tomita K. Familial pseudohyperkalemia: A rare syndrome, but diverse genetic heterogeneity. *Intern Med.* 2005; 44: 781–2.
19. Van Steirteghem AC, Young DS. Povidone-iodine (“Betadine”) disinfectant as a source of error. *Clin Chem.* 1977; 23: 1512.
20. Koch TR, Cook JD. Benzalkonium interference with test methods for potassium and sodium. *Clin Chem.* 1990; 36: 807–8.
21. Gaylord MS, Pittman PA, Bartness J, Tuinman AA, Lorch V. Release of benzalkonium chloride from a heparin-bonded umbilical catheter with resultant factitious hypernatremia and hyperkalemia. *Pediatrics.* 1991; 87: 631–5.
22. Garwicz D, Karlman M. Early recognition of reverse pseudohyperkalemia in heparin plasma samples during leukemic hyperleukocytosis can prevent iatrogenic hypokalemia. *Clin Biochem.* 2012; 45: 1700–2.
23. Garwicz D, Karlman M, Øra I. Reverse pseudohyperkalemia in heparin plasma samples from a child with T cell acute lymphoblastic leukemia with hyperleukocytosis. *Clin Chim Acta.* 2011; 412: 396–7.
24. Meng QH, Krahn J. Reverse pseudohyperkalemia in heparin plasma samples from a patient with chronic lymphocytic leukemia. *Clin Biochem.* 2011; 44: 728–30.
25. Gambino R, Sanfilippo M, Lazcano L. Pseudohyperkalemia from finger flexion during venepuncture masks true hypokalemia. *Ann Clin Biochem.* 2009; 46: 177. Hawkins R. Measurement of whole-blood potassium: Is it clinically safe? *Clin Chem* 2003; 49: 2105-6.
26. Sevastos N, Theodossiades G, Archimandritis AJ. Pseudohyperkalemia in serum: A new insight into an old phenomenon. *Clin Med Res.* 2008; 6: 30–2.
27. Hawkins R. Measurement of whole-blood potassium: Is it clinically safe? *Clin Chem.* 2003; 49: 2105–6.
28. Ijaz A, Maqsood-ul-hassan et al. EDTA contamination in laboratory specimens-effect of awareness campaign. *J call physicians surg pak* 2010; 20: 405-407.

REVIEW ARTICLE

AUTHORS:

1. Kavitha P.
2. Omprakash B.

PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Biochemistry, Karpagam Medical College, Coimbatore, Tamilnadu.
2. Associate Professor, Department of Dermatology, Rama Medical College, Kanpur.

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Kavitha,
Plot No. 15, Road No. 5, Jubilee Hills,
Hyderabad, Andhra Pradesh.
Email: kavyaanjalika@gmail.com

Date of Submission: 12/06/2014.

Date of Peer Review: 13/06/2014.

Date of Acceptance: 28/06/2014.

Date of Publishing: 05/07/2014.