



A LABORATORY PERSPECTIVE FOR ERRORS IN POTASSIUM MEASUREMENT


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ABSTRACT

Errors in potassium measurement can lead to falsely elevated potassium level that is pseudo hyperkalemia. Usually these errors are recognized either by the clinicians or laboratory personals. The factors which causes pseudo hyperkalemia can mask hypokalemia by pushing low value to normal value, which is very difficult identify by laboratory personals. In this article we are discussing the causes and mechanisms of spuriously elevated potassium.

Keywords:- Pseudo hyperkalemia, Spurious hyperkalemia, Haemolysis.

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INTRODUCTION

60 – 70% of clinical decisions are based on laboratory results and electrolytes are among the test most commonly tested analyte [1]. The majorities of errors (30-75%) occurs before the sample is analyzed (Pre analytical error) [2], 4-30% during analytical phase, remaining errors occur during report generation or interpretation. The source of potassium is usually cells. 98% of body potassium is intracellular. A small release of potassium can significantly affect the concentration of measured (Extracellular) potassium. The ratio between intracellular and extra cellular potassium is approximately 40:1. A change in the ratio as small as 2.5% will increase the potassium concentration by 0.1 mEq/L.

Measurement of Potassium

Potassium is usually measured using Ion-selective electrode (ISE), which converts the activity (or effective concentration) of ion dissolved in solution into an electric potential measured by a voltmeter. Both plasma and serum can be used to measure potassium.

Platelets release potassium during the clotting process, resulting in higher (0.36 ± 18 mmol/L) Potassium concentration in serum as compared to plasma [3]. Some authors have tried to define pseudo hyperkalemia as a difference between serum & plasma concentration of more than 0.4 mmol/L when sample is kept at room temperature & tested within an hour of collection [4] Constituents of blood -RBC (red blood cells), WBC (White Blood Cells), platelets and skeletal muscle release intracellular potassium either due to faulty collection techniques or disease states. The most common cause of cellular release is cell lysis, which can involve RBC (haemolysis), WBC (leukocytolysis), platelets (Thrombocytolysis) or all the three (pancytopenia).

Pseudo hyperkalemia is suggested when the lab value of Potassium is high but the patient does not show any signs of hyperkalemia or abnormal ECG.

Causes of pseudo hyperkalemia

Mechanical factors

A tourniquet applied for prolonged period of

more than 1 minute causes hemo concentration, altered water balance & haemolysis. Fist clenching causes local release of potassium from the forearm muscle and increased blood flow [5-7]. In our study, the measured potassium in the pumping hand was 1.0 mmol/L higher compared to a simultaneously measured non pumping hand. Traumatic venipuncture or probing, inappropriate needle diameter, excessive force with syringe draws either during aspiration or transfer, increased turbulence can all result in haemolysis & pseudo hyperkalemia [2,5].

Mechanical force during specimen processing such as vigorous mixing, excessive centrifugal force or re centrifugation of gel separator tubes may also result in pseudo hyperkalemia [2,5].

Cases of hyperkalemia have been reported, especially in disease states with fragile cell membrane such as leukemia [8,9].

Temperature

Recommended temperature for specimen storage prior to testing is 15-25°C [2]. Specimens should not be stored between 2-8°C or above room temperature for more than 24 hours [2].

Cold temperature inhibits the sodium potassium pump resulting in leakage of potassium. Higher temperature initially decrease & then increase potassium concentration, probably due to increased usage & exhaustion of glucose that generate ATP for sodium potassium pump.

Time

Delayed processing, results in decreased availability of glucose for ATP production. ATP fuel the sodium potassium pump & maintains the gradient across the cell membrane, failure of the pump results in leakage of potassium out of the cell, resulting in pseudo hyperkalemia.

Chemical Factor

Ethanol containing antiseptics, if not dried completely before venipuncture, antiseptic solution may enter the blood stream & disrupt cell membrane [2].

Patient Factor

Factitious hyperkalemia may be seen in WBC neoplasms due to increased membrane fragility and little reserve capacity for withstanding mechanical agitation or by leakage into serum [9].

Crying or fear of imminent venipuncture associated with hyper ventilation even for short duration may cause acute respiratory alkalosis, which results in a significant hyperkalemic response, mediated by enhanced alpha-adrenergic activity. Exact cellular mechanism is not known, but it is

suggested that it is due to activation of hepatic calcium dependent potassium channels through alpha receptor [10]. Thrombocytosis results in increased release of potassium during the clotting process (average increase of 0.82 mmol/L) but it is found that increase was not proportional, initial linear increase at higher levels of plasma followed by a drop, presumably caused by re entry of potassium into RBC to maintain homeostasis [11]. Increase is more profound in thrombocytosis associated with mixed RBC disorders.

Post splenectomy states has also been reported to be associated with pseudo hyperkalemia [12,13].

It is also suspected that neoplastic WBC membranes are more likely to be leaky or to be disrupted easily. It may be also due to high level of leukocytosis, where there are increased consumptions and there by exhaustion of metabolites that fuel ATP pump.

Familial pseudo hyperkalemia is an autosomal dominant disorder characterized by abnormal passive outward leakage of potassium across the RBC membrane. It is an invitro phenomenon, occurring when blood is stored at room temperature [14,15].

Contaminants

If the recommended order of draw during phlebotomy is not maintained, back flow of potassium salts of tube containing additives such as EDTA (ethylene di amine tetra acetic acid) or oxalate can elevate measured potassium.

Potassium containing IV fluids are common contaminants. Contaminants can also interfere with the ion selective electrodes that measure potassium [16,17].

Miscellaneous causes

Using plasma reference ranges to interpret serum values could result in pseudo hyperkalemia.

Mislabeled of patients samples may also show pseudo hyperkalemia.

Masked Hypokalemia

Factors which cause pseudo hyperkalemia can mask Hypokalemia by pushing the measured potassium of hypokalemic patients into normal reference interval. In one study, more than a third of hypokalemic cases were missed due to haemolysis (Which elevates potassium level) when using whole blood to estimate potassium [18]. Re evaluation of cases of suspected Hypokalemia with serum or plasma concentration of potassium within the reference range might be indicated when there is high free hemoglobin i.e high hemolysis index (HI).

CONCLUSION

There are many factors which can contribute to elevation of measured potassium or mask Hypokalemic state. Potassium predominantly being intracellular cation, a small shift cause large changes in the measured value. Efforts must be made to minimize these factors. When laboratory values are not concordant with the clinical picture, clinicians

must consult laboratory so that appropriate sample can be submitted and retesting can be done.

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CONFLICT OF INTEREST:

The authors declare that they have no conflict of interest.

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