

Falsely Elevated Serum Potassium Results

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Case History

A busy family practice physician office in which the practitioners draw blood samples from their own patients noted a higher-than-expected frequency of elevated serum potassium results for their patients and brought this to the attention of the hospital laboratory that performed the testing. Analysis of serum potassium data for samples received from physician office practices during the preceding several months revealed an unusually high percentage (14.2%) of elevated results for this practice compared to samples from other office practices (5.5%). Laboratory staff worked with the physician office staff to examine all preanalytical variables known to affect serum potassium values with special attention to those that were within the office's span of control. Specimen collection, specimen processing and patient-related factors were reviewed with staff that drew and processed blood samples with a focus on increasing awareness of factors known to cause factitious elevations in serum potassium - fist clenching, prolonged tourniquet time, insufficient clot retraction, delays in centrifugation, insufficient centrifugation, and specimen storage and transport conditions - and strategies to avoid these factors. Specific corrective actions included replacing a fixed-angle centrifuge used in the office with a horizontal (swinging-bucket) model that produced a higher quality gel barrier separating the red cell clot and serum phases. The laboratory also conducted a review of its reference range for serum potassium that resulted in a small adjustment (+0.2 mmol/L) in the upper reference limit. A follow-up analysis of serum potassium data after these interventions showed a much lower frequency of elevated results for this office practice (2.7% vs. 2.0 % for all office practices). A significant decrease of 0.2 mmol/L (from 4.57 to 4.36 mmol/L) was also observed in the average (mean) K^+ value for patients drawn in this office after these interventions.

Potassium

Potassium (K^+) is one of the most commonly performed tests in the clinical chemistry laboratory. Potassium plays key roles in maintaining water and acid-base balance, muscle and nerve cell function, and heart, kidney and adrenal function. Reference ranges for serum K^+ vary between laboratories, with reference limits as low as 3.5 and as high as 5.3 mmol/L. Low K^+ (hypokalemia) can lead to muscle weakness, irritability, paralysis and cardiac arrest at very low levels. Elevated K^+ (hyperkalemia) can be seen in patients with dehydration, diabetic ketoacidosis, severe burns and renal failure. Hyperkalemia is associated with mental confusion, muscle weakness, electrocardiographic changes and with peripheral vascular collapse and cardiac arrest if levels exceed 7.0 mmol/L. It is crucial for a laboratory to report accurate K^+ results to physicians for proper patient treatment and management. Therefore, it is necessary for those who obtain and process blood samples to be aware of the many preanalytical variables that can contribute to erroneous K^+ values. These include patient factors, venipuncture technique and specimen handling and processing variables. An erroneous result can be due to one preanalytical variable, or it can be a cumulative effect of several variables.

Causes of Pseudohyperkalemia

The term *pseudohyperkalemia* refers to the phenomenon of artificial or factitious elevation of serum K^+ results. Pseudohyperkalemia is still among the most common and recurrent quality issues faced by clinical laboratories and one of the most frequent sources of physician complaints. There are many potential causes of pseudohyperkalemia. Most of these are related to sample quality issues and occur in the **preanalytical** phase of the testing process, i.e. before the sample is actually tested. They can be divided into the following categories: specimen collection issues, specimen processing/ handling/transport issues and patient/physiological issues.

Specimen collection factors that can falsely increase serum K^+ values include: excessive **fist clenching** (releases K^+ from muscle); leaving **tourniquet** on patients arm for longer than one minute (venous stasis); holding patient's arm in upward position (reflux/backflow of anticoagulant); **betadine** contamination of venipuncture site (interferes with test); **incorrect order of draw** for vacutainer tubes (drawing lavender-top K_2 EDTA tube before gel barrier chemistry tube); **IV contamination** of blood sample with IV fluid (drawing above IV site, not turning off IV infusion), **benzalkonium** heparin coating on catheter surface (interferes with test) and **hemolysis** (difficult/traumatic draw, using small gauge needles or butterflies, drawing from IV catheters or other vascular access devices).

Specimen processing/handling/transport factors include: **pneumatic tube system effects** (RBC trauma from sample agitation, excessive tube speed, unpadded canisters); **delays in sample processing/centrifugation/transport** (leakage of K^+ from cells); **excessive centrifugation** (too high g-force, sample heating causes cell lysis); **insufficient or inadequate centrifugation** (residual RBCs above gel barrier, poor gel barrier formation causes leakage of RBCs across barrier); **recentrifugation** (mixing of serum above gel with K^+ -rich serum below gel); and **chilling** (inhibition of Na/K-ATPase pump with leakage of K^+ from RBCs into serum or plasma).

Finally, **patient or physiological factors** include **thrombocytosis** and myeloproliferative disorders with **severe leukocytosis** (release of K^+ from platelets and leukocytes); **dehydration**; **anticoagulant therapy and liver disease** (delayed clotting; if tube is recentrifuged, serum below barrier mixes with serum below barrier); **familial pseudohyperkalemia** (abnormal passive leak of K^+ across RBC membrane); and **serum vs plasma samples** (serum K^+ is greater than plasma K^+ due to release from platelets during clotting).

A poster titled "Troubleshooting Erroneous Potassiums in a Clinical Laboratory Setting" is available at http://www.bd.com/vacutainer/pdfs/VS7048_troubleshooting_erroneous_potassiums_poster.pdf. For a hard copy, please contact our laboratory client service representative Sandra Smith at 739-7800 or sandra.smith@danhosp.org.

In summary, there are many preanalytical factors that can potentially cause falsely elevated serum potassium results. Diligent care must be exercised to control all of these variables in order to obtain accurate and clinically meaningful test results.

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