

# Troubleshooting Erroneous Potassiums in a Clinical Laboratory Setting

Specimen collection, processing, handling, transport and physiological issues affect potassium values. Improper procedures may result in artificially elevated potassium values. These factors are listed in order of occurrence in the phlebotomy procedure. Any one or any combination of these factors can affect potassium results.

## SPECIMEN COLLECTION ISSUES

Factors Resulting in Elevated Potassium Values	Possible Consequences	Corrective Actions
<ul style="list-style-type: none"> <li>Leaving tourniquet on for an extended period of time</li> </ul>	<ul style="list-style-type: none"> <li>Hemoconcentration and possible hematoma due to infiltration of plasma and/or blood into tissue. Affects water balance of cells. Red cells and platelets rupture and release potassium</li> </ul>	<ul style="list-style-type: none"> <li>Release the tourniquet as soon as blood flow is established. Tourniquet should be released within 1 minute<sup>1</sup></li> </ul>
<ul style="list-style-type: none"> <li>Excessive fist clenching</li> </ul>	<ul style="list-style-type: none"> <li>Repeated fist clenching with or without tourniquet causes excessive release of potassium from skeletal muscles (pseudohyperkalemia)</li> </ul>	<ul style="list-style-type: none"> <li>Ask patient to dangle the arm for 1 to 2 minutes to allow blood to fill the veins to capacity; then reapply the tourniquet<sup>1</sup></li> <li>Massage the arm from wrist to elbow. Tap sharply at the venipuncture site with index and second finger a few times. This will cause the vein to dilate<sup>1</sup></li> <li>Apply a warm, damp washcloth (about 40°C) to the site for 5 minutes<sup>1</sup></li> <li>Avoid fist clenching during phlebotomy<sup>2</sup></li> </ul>
<ul style="list-style-type: none"> <li>Arm in an upward position</li> </ul>	<ul style="list-style-type: none"> <li>Reflux or "backflow" from anticoagulants (EDTA, Oxalate/Fluoride)</li> <li>Carryover from previous tube</li> </ul>	<ul style="list-style-type: none"> <li>Position arm downward</li> <li>Follow recommended order of draw</li> </ul>
<ul style="list-style-type: none"> <li>Betadine</li> </ul>	<ul style="list-style-type: none"> <li>When samples are drawn at the same time as starting an IV, this antiseptic can cause an increase in potassium results</li> </ul>	<ul style="list-style-type: none"> <li>Completely remove Betadine using 70% alcohol prior to venipuncture</li> <li>Use a discard tube to remove the first few mLs of blood</li> </ul>
<ul style="list-style-type: none"> <li>Order of Draw</li> <li>Lavender top potassium EDTA tubes drawn before serum chemistry tubes</li> <li>Gray top potassium oxalate/sodium fluoride tubes drawn before serum chemistry tubes</li> </ul>	<ul style="list-style-type: none"> <li>Carry over of potassium containing anticoagulants into serum tubes</li> </ul>	<ul style="list-style-type: none"> <li>Draw serum and heparin tubes prior to lavender or gray top tubes during the collection procedure</li> <li>Recommended Order of Draw<sup>1</sup></li> <ol style="list-style-type: none"> <li>Blood culture tubes</li> <li>Non additive tubes</li> <li>Additive tubes                             <ul style="list-style-type: none"> <li>Citrate tubes    • Heparin tubes    • EDTA tubes</li> <li>BD Vacutainer® SST™ Tubes    • Fluoride tubes</li> <li>BD Vacutainer® Plus Plastic Serum tubes</li> </ul> </li> </ol> <li>Draw below an IV or use alternate site</li> </ul>
<ul style="list-style-type: none"> <li>Drawing above IV site</li> </ul>	<ul style="list-style-type: none"> <li>IV fluid contamination</li> </ul>	<ul style="list-style-type: none"> <li>Draw below an IV or use alternate site</li> </ul>
<ul style="list-style-type: none"> <li>Benzalkonium heparin used for coating some catheters</li> </ul>	<ul style="list-style-type: none"> <li>Causes interferences and falsely high reading with some ion-selective electrodes</li> </ul>	<ul style="list-style-type: none"> <li>Clear the catheter line by withdrawing and discarding 5 mL of blood. This procedure is not sufficient if blood is drawn through a newly inserted catheter<sup>3,4</sup></li> <li>Collect specimen via direct venipuncture</li> </ul>
<ul style="list-style-type: none"> <li>Vigorously mixing tubes</li> </ul>	<ul style="list-style-type: none"> <li>Hemolysis due to rupture of red blood cells</li> </ul>	<ul style="list-style-type: none"> <li>Gently mix additive tube using the recommended number of inversions</li> </ul>
<ul style="list-style-type: none"> <li>Collection technique, small gauge needles, syringe/catheter draws, transfer of blood into evacuated tubes</li> </ul>	<ul style="list-style-type: none"> <li>Hemolysis</li> </ul>	<ul style="list-style-type: none"> <li>Good attention to correct technique<sup>5</sup></li> <li>Use of partial draw tubes to minimize turbulence</li> <li>Use BD Vacutainer® Blood Transfer Device to move blood from a syringe into an evacuated tube</li> </ul>
<ul style="list-style-type: none"> <li>Traumatic draw</li> </ul>	<ul style="list-style-type: none"> <li>Hemolysis</li> </ul>	<ul style="list-style-type: none"> <li>Select appropriate vein size for volume of blood</li> <li>Do not probe</li> </ul>
<ul style="list-style-type: none"> <li>Mislabeling specimen</li> </ul>	<ul style="list-style-type: none"> <li>Results reported on wrong patient</li> </ul>	<ul style="list-style-type: none"> <li>Verify patient ID</li> <li>Use electronic patient ID system (eg. BD.id™)</li> </ul>

## PROCESSING/HANDLING/TRANSPORT ISSUES

Factors Resulting in Elevated Potassium Values	Possible Consequences	Corrective Actions
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<ul style="list-style-type: none"> <li>• Pneumatic tube systems with: <ul style="list-style-type: none"> <li>— Speed too high</li> <li>— Unpadded canisters or stations</li> <li>— Excessive agitation</li> </ul> </li> <li>• Delays in processing/transport</li> </ul>	<ul style="list-style-type: none"> <li>• Red blood cell trauma and damage<sup>6</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Adequate packing of specimens to avoid excessive mixing of the sample</li> </ul>
<ul style="list-style-type: none"> <li>• Centrifugation at too high g force</li> </ul>	<ul style="list-style-type: none"> <li>• Release of potassium from cells</li> </ul>	<ul style="list-style-type: none"> <li>• Serum/plasma should be removed/separated from cells within 2 hours of collection<sup>5,7</sup></li> <li>• 1000-1300 x g for BD Vacutainer® SST™ Glass Tubes and 16 mm BD Vacutainer® SST™ Plus Plastic Tubes.<sup>7</sup></li> <li>• 1100-1300 x g for BD Vacutainer® SST™ Plus Plastic Tubes (13mm)<sup>7</sup></li> </ul>
<ul style="list-style-type: none"> <li>• Increased heat exposure in centrifuge</li> </ul>		<ul style="list-style-type: none"> <li>• &lt;1300 x g for all non gel tubes<sup>7</sup></li> <li>• Temperature regulated centrifuge</li> </ul>
<ul style="list-style-type: none"> <li>• Running fixed angle centrifuge continuously for long periods of time</li> </ul>		
<ul style="list-style-type: none"> <li>• Re-centrifugation</li> </ul>	<ul style="list-style-type: none"> <li>• Mixing of serum below the gel with serum above the gel</li> </ul>	<ul style="list-style-type: none"> <li>• Do not re-centrifuge BD Vacutainer® SST™ Tubes.<sup>7</sup> Aspirate serum from tube and place in a clean test tube to re-centrifuge</li> </ul>
<ul style="list-style-type: none"> <li>• Poor barrier formation in gel tubes</li> </ul>	<ul style="list-style-type: none"> <li>• Red blood cells above gel</li> <li>• Leakage of RBCs across barrier, RBC contamination, high potassiums, and other erroneous test results</li> </ul>	<ul style="list-style-type: none"> <li>• Follow manufacturer's recommendation for centrifugation time and g force. Invert BD Vacutainer® SST™ Tubes gently 5 times immediately after specimen collection. Allow tube to clot 30 minutes in a vertical position. Centrifuge samples for 10 minutes in a horizontal swing bucket, 15 minutes in a fixed angle<sup>7</sup></li> <li>• 1000-1300 x g for BD Vacutainer® SST™ Glass Tubes and 16 mm BD Vacutainer® SST™ Plus Plastic Tubes<sup>7</sup></li> <li>• 1100-1300 x g for BD Vacutainer® SST™ Plus Plastic Tubes (13 mm)<sup>7</sup></li> <li>• &lt;1300 x g for all non gel tubes<sup>7</sup></li> <li>• Periodically check/calibrate centrifuges</li> <li>• Use swing bucket centrifuge</li> <li>• Do not re-centrifuge gel tubes. Transfer serum to another tube if re-</li> </ul>
<ul style="list-style-type: none"> <li>• Chilling whole blood beyond 2 hours</li> </ul>	<ul style="list-style-type: none"> <li>• Cold inhibits glycolysis which provides energy for pumping potassium into the cell. Without this energy, potassium will leak from the cells falsely elevating the results</li> </ul>	<ul style="list-style-type: none"> <li>• To chill a sample, place either in crushed ice or a mixture of ice and water<sup>5</sup></li> <li>• Do not chill &lt; 15° C.</li> </ul>

## PHYSIOLOGICAL ISSUES

Factors Resulting in Elevated Potassium Values	Possible Consequences	Corrective Actions
<ul style="list-style-type: none"> <li>• Thrombocytosis</li> <li>• Myeloproliferative disorders with severe leukocytosis</li> </ul>	<ul style="list-style-type: none"> <li>• Platelets release potassium during clotting in serum. Typically seen when &gt; 1,000 x 10<sup>9</sup> L. An increase of 1 million platelets/μL corresponds to an increase of about 0.7 mEQ/L in the serum potassium<sup>8,9</sup></li> <li>• In plasma more platelets remain above the gel barrier</li> </ul>	<ul style="list-style-type: none"> <li>• Allow complete clot formation</li> <li>• Centrifuge at the high end of recommended centrifugation range</li> </ul>
<ul style="list-style-type: none"> <li>• Dehydration</li> </ul>	<ul style="list-style-type: none"> <li>• Inherent higher potassium levels possible, related to patient condition</li> </ul>	<ul style="list-style-type: none"> <li>• Hydrate patient then re-draw specimen</li> </ul>
<ul style="list-style-type: none"> <li>• Anticoagulant therapy (Coumadin, Heparin)</li> <li>• Liver Disease</li> </ul>	<ul style="list-style-type: none"> <li>• Medically induced delays in the clotting process. If tube is re-spun, serum below barrier (higher potassium) mixes with serum above barrier</li> </ul>	<ul style="list-style-type: none"> <li>• NOTE: 30 minute clotting may not be sufficient. Observe clot formation up to 1 hour</li> <li>• Transfer serum to another tube if re-spinning is necessary</li> <li>• Use heparinized plasma for potassium analysis</li> <li>• Add thrombin to accelerate clotting<sup>10</sup></li> <li>• Ease patient fears about the procedure</li> </ul>
<ul style="list-style-type: none"> <li>• Fear of imminent venipuncture</li> </ul>	<ul style="list-style-type: none"> <li>• Leads to acute hyperventilation and a net potassium efflux from cells</li> </ul>	<ul style="list-style-type: none"> <li>• Ease patient fears about the procedure</li> </ul>
<ul style="list-style-type: none"> <li>• Familial pseudohyperkalemia</li> </ul>	<ul style="list-style-type: none"> <li>• Represents an abnormal passive leak of potassium across the RBC membrane especially at lower temperatures, because of an autosomal dominant loci on chromosome 16<sup>11,12</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Check patient history</li> </ul>
<ul style="list-style-type: none"> <li>• Oral therapy of Cotrimoxazole</li> </ul>	<ul style="list-style-type: none"> <li>• Hyperkalemia with renal tubular dysfunction</li> </ul>	<ul style="list-style-type: none"> <li>• Discontinuation of cotrimoxazole normalizes serum potassium levels and symptoms</li> </ul>
<ul style="list-style-type: none"> <li>• Serum vs Plasma</li> </ul>	<ul style="list-style-type: none"> <li>• Potassium is greater in serum than in plasma due to release of K<sup>+</sup> from platelets during clotting</li> <li>• Plasma Potassium increases over time due to presence of cells in plasma</li> </ul>	<ul style="list-style-type: none"> <li>• Standardize on either specimen type</li> <li>• Establish normal reporting ranges for both serum and plasma</li> <li>• Centrifuge within 2 hours</li> <li>• Aspirate plasma from tube, put in clean tube and re-spin plasma</li> </ul>

**Note:** This troubleshooting guide is intended for use with the complete BD Vacutainer® Blood Collection System, and may not apply when interchanging blood collection components from other manufacturers.

#### REFERENCES

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