

TOOL KIT:

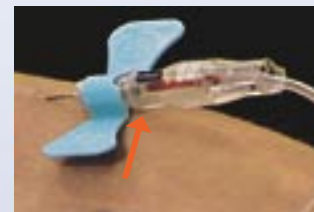
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LabNotes

Volume 13 No.3, Summer 2003

A Newsletter from BD Vacutainer Systems, Preanalytical Solutions

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Helping all people live healthy lives

LabNotes[†]

Volume 13, No.3, Summer 2003

A Newsletter from BD Vacutainer Systems, Preanalytical Solutions



Troubleshooting Erroneous Potassiums in a Clinical Laboratory Setting

Potassium (K⁺) is one of the most commonly analyzed elements in the chemistry laboratory. It can be ordered by a physician as a single test, or it can be run as part of an electrolyte panel, and analyzed in conjunction with sodium, chloride and CO₂. In the human body, potassium plays important roles in maintaining water balance and distribution, acid-base balance, muscle and nerve cell function, and heart, kidney and adrenal function.

The normal range for serum potassium is 3.5-5.0 mEq/L. When a patient exhibits a low potassium (hypokalemia), it can lead to muscle weakness, irritability, paralysis, and at very low levels, cardiac arrest. Conversely, elevated potassium (hyperkalemia), can be seen in patients with dehydration, diabetic ketoacidosis, severe burns and renal failure. Hyperkalemia is associated with mental confusion, muscle weakness, electrocardiographic

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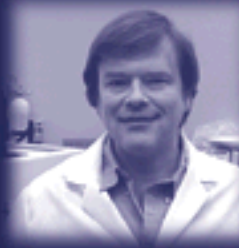
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Tool Kit
BD Vacutainer® Push Button Blood Collection Set



Look Inside for Your **FREE** Potassium Chart!

[†]This publication is a service to the customers and friends of BD, and is designed only to provide general information. It is not intended to be comprehensive or provide any legal or medical advice.



From The Editor

In this issue of LabNotes, we are pleased to present you with a new and useful tool, our "Troubleshooting Erroneous Potassiums in a Clinical Laboratory Setting" wall chart. We recognize that falsely elevated potassium values are a concern. Often, these erroneous results may be due to several preanalytical variables, including venipuncture technique, specimen handling and processing, or even mixing venous blood collection products from different manufacturers. At BD, we understand how important it is for our customers to be able to report accurate laboratory results, so we hope that you will hang this chart in your lab and use it as a reference guide if you happen to be concerned about potassium values.

Another exciting new item that we want to introduce to you in this issue is the BD Vacutainer® Push-Button Blood Collection Set. As in the past, BD is continuing to provide products that will help to ensure healthcare worker safety. This new blood collection set automatically retracts when the healthcare worker pushes the activation button with his or her index finger.

You will also learn about a relatively new CAP question that asks whether you are currently using 3.2% sodium citrate tubes for your coagulation testing.

We hope you enjoy this issue of LabNotes. As always, we look forward to your comments and suggestions.

Jeffrey B. Lawrence, MD
Editor, LabNotes

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LabNotes is published by BD Vacutainer Systems, *Preanalytical Solutions*, Franklin Lakes, NJ, providing the laboratory community with laboratory products, including the BD Vacutainer® Brand System, the BD Unopette™ Brand System, BD Microtainer® Brand Tubes, BD Microtainer® Safety Flow™ Lancets, BD Vacutainer® Safety-Lok™ Needle Holder, BD Vacutainer® Safety-Lok™ Blood Collection Set, BD Vacutainer® Needle Disposal Container, BD Eclipse™ Blood Collection Needle and BD Quikheel™ Lancet.

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changes, with peripheral vascular collapse and cardiac arrest if levels exceed 7.0 mEq/L.

It is important for the laboratory to report an accurate potassium result to the physician for proper patient treatment and management. It is, therefore, necessary to be aware of the many preanalytical variables that can contribute to erroneous potassium 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.

The tear-out poster in this issue of LabNotes will assist you in troubleshooting elevated potassium results. The wall chart is broken down into three sections (specimen collection, processing/handling/transport, and physiological issues) and gives possible causes and corrective actions to use when trying to remedy an erroneous K⁺ value. ■

See additional information continued on your FREE Potassium chart inside this edition of LabNotes

Come See Us At:
NANN Conference
October 8-11, 2003
Palm Springs, CA
BD Booth #314

Correction:
In the Spring 2003 issue of LabNotes, the CAP question that was referred to in **Tool Kit: The BD Vacutainer® Plus Plastic Tubes** had an incorrect number. The correct number is from the CAP General Laboratory checklist and is Gen. 40942, Phase I. We are sorry for any confusion that this may have caused.

RELATED INDUSTRY WEBSITE

What is OSHA?

The Occupational Safety and Health Administration or OSHA, is a government agency established to save lives, prevent injuries, and protect the health of America's workers.

To accomplish this, the federal and state governments work in partnership with more than 100 million working men and women and their 6.5 million employers covered by the Occupational Safety and Health Act of 1970.

OSHA establishes protective standards, enforces those standards, and assists employers and employees with technical assistance and consultation programs. Nearly every working

person in the nation comes under OSHA's jurisdiction.

Visit the OSHA website at www.osha.gov to find a wealth of information, including the following:

- Commission Decisions
- Compliance Directives
- FAQs
- Field Inspection Reference Manual
- Interpretive Memos and Letters
- OSHA Directives
- OSHA Standards
- OSHA Regulations and Compliance

The website allows you to search on any topic of interest, for example the Bloodborne Pathogens Standard and

www.osha.gov



the Needlestick Safety and Prevention Act, and includes technical links to other related sites.

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DID YOU KNOW...

Question: HEM.22748 Phase I

Are all coagulation specimens collected into 3.2% buffered sodium citrate?

Note: The milder chelation of 3.2% citrate over 3.8% citrate is preferred for accuracy of results.

Sodium citrate is effective as an anticoagulant due to its mild calcium-chelating properties. Of the two commercially available forms of citrate, 3.2% buffered sodium citrate (109 mmol/L of the dihydrate form of trisodium citrate Na₃C₆H₅O₇ · 2H₂O) is the recommended anticoagulant for coagulation testing. The citrate concentration in 3.8% sodium citrate is higher and its use may result in falsely lengthened clotting times with calcium-dependent coagulation tests (i.e., PT and aPTT) with slightly underfilled samples and with samples with high hematocrits. Coagulation testing cannot

If the laboratory does not adhere to recommendations for use of 3.2% buffered sodium citrate, it must have data on file to demonstrate that the alternative citrate concentration produces accurate and precise coagulation results.

be performed in samples collected in EDTA due to the more potent calcium chelation. Heparinized tubes are not appropriate due to the inhibitory effect of heparin on multiple coagulation proteins.

References:

- 1) Adcock DM, et al. Effect of 3.2% vs 3.8% sodium citrate concentration on routine coagulation testing. *Am J Clin Pathol.* 1997;107:105-110.
- 2) Reneke, J et al. Prolonged prothrombin time and activated partial thromboplastin time due to underfilled specimen tubes with 109 mmol/L (3.2%) citrate anticoagulant. *Am J Clin Pathol.* 1998;109:754-757.
- 3) NCCLS. Collection, transport and processing of blood specimens for coagulation testing and general performance of coagulation assays – third edition; approved guideline H21-A3. Wayne, PA: NCCLS, 1998.

CAP (College of American Pathologists) revised the Checklist* section for Hematology and Coagulation in November 2002. There are several revisions to this section including a new question recommending the use of 3.2% buffered sodium citrate instead of the 3.8% citrate concentration. The commentary discusses the reasoning behind the recommendation. If a laboratory currently uses 3.8% sodium citrate tubes they must provide data indicating that this concentration produces accurate and precise coagulation results. To meet your laboratory compliance needs, BD offers an array of BD Vacutainer® Plus Plastic Citrate Tubes including the 3.2% sodium citrate concentration.



CAP Checklist
Hematology and Coagulation – Nov 2002

*CAP laboratory accreditation guideline

For more information, visit www.cap.org or our website at www.bd.com/vacutainer

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"> Leaving tourniquet on for an extended period of time 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> Release the tourniquet as soon as blood flow is established. Tourniquet should be released within 1 minute¹
<ul style="list-style-type: none"> Excessive fist clenching 	<ul style="list-style-type: none"> Repeated fist clenching with or without tourniquet causes excessive release of potassium from skeletal muscles (pseudohyperkalemia) 	<ul style="list-style-type: none"> Ask patient to dangle the arm for 1 to 2 minutes to allow blood to fill the veins to capacity; then reapply the tourniquet¹ 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 dilate¹ Apply a warm, damp washcloth (about 40°C) to the site for 5 minutes¹ Avoid fist clenching during phlebotomy²
<ul style="list-style-type: none"> Arm in an upward position 	<ul style="list-style-type: none"> Reflux or "backflow" from anticoagulants (EDTA, Oxalate/Fluoride) Carryover from previous tube 	<ul style="list-style-type: none"> Position arm downward Follow recommended order of draw
<ul style="list-style-type: none"> Betadine 	<ul style="list-style-type: none"> When samples are drawn at the same time as starting an IV, this antiseptic can cause an increase in potassium results 	<ul style="list-style-type: none"> Completely remove Betadine using 70% alcohol prior to venipuncture Use a discard tube to remove the first few mLs of blood
<ul style="list-style-type: none"> Order of Draw Lavender top potassium EDTA tubes drawn before serum chemistry tubes Gray top potassium oxalate/sodium fluoride tubes drawn before serum chemistry tubes 	<ul style="list-style-type: none"> Carry over of potassium containing anticoagulants into serum tubes 	<ul style="list-style-type: none"> Draw serum and heparin tubes prior to lavender or gray top tubes during the collection procedure Recommended Order of Draw¹ <ol style="list-style-type: none"> Blood culture tubes Non additive tubes Additive tubes <ul style="list-style-type: none"> Citrate tubes BD Vacutainer® SST™ Tubes BD Vacutainer® Plus Plastic Serum tubes Heparin tubes EDTA tubes Fluoride tubes
<ul style="list-style-type: none"> Drawing above IV site 	<ul style="list-style-type: none"> IV fluid contamination 	<ul style="list-style-type: none"> Draw below an IV or use alternate site
<ul style="list-style-type: none"> Benzalkonium heparin used for coating some catheters 	<ul style="list-style-type: none"> Causes interferences and falsely high reading with some ion-selective electrodes 	<ul style="list-style-type: none"> 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^{3,4} Collect specimen via direct venipuncture
<ul style="list-style-type: none"> Vigorously mixing tubes 	<ul style="list-style-type: none"> Hemolysis due to rupture of red blood cells 	<ul style="list-style-type: none"> Gently mix additive tube using the recommended number of inversions
<ul style="list-style-type: none"> Collection technique, small gauge needles, syringe/catheter draws, transfer of blood into evacuated tubes 	<ul style="list-style-type: none"> Hemolysis 	<ul style="list-style-type: none"> Good attention to correct technique⁵ Use of partial draw tubes to minimize turbulence Use BD Vacutainer® Blood Transfer Device to move blood from a syringe into an evacuated tube
<ul style="list-style-type: none"> Traumatic draw 	<ul style="list-style-type: none"> Hemolysis 	<ul style="list-style-type: none"> Select appropriate vein size for volume of blood Do not probe
<ul style="list-style-type: none"> Mislabeling specimen 	<ul style="list-style-type: none"> Results reported on wrong patient 	<ul style="list-style-type: none"> Verify patient ID Use electronic patient ID system (eg. BD.id™)

PROCESSING/HANDLING/TRANSPORT ISSUES

Factors Resulting in Elevated Potassium Values	Possible Consequences	Corrective Actions
<ul style="list-style-type: none"> Pneumatic tube systems with: <ul style="list-style-type: none"> Speed too high Unpadded canisters or stations Excessive agitation 	<ul style="list-style-type: none"> Red blood cell trauma and damage⁶ 	<ul style="list-style-type: none"> Adequate packing of specimens to avoid excessive mixing of the sample
<ul style="list-style-type: none"> Delays in processing/transport 	<ul style="list-style-type: none"> Release of potassium from cells 	<ul style="list-style-type: none"> Serum/plasma should be removed/separated from cells within 2 hours of collection^{5,7}
<ul style="list-style-type: none"> Centrifugation at too high g force Increased heat exposure in centrifuge Running fixed angle centrifuge continuously for long periods of time 	<ul style="list-style-type: none"> Causes lysis of cells 	<ul style="list-style-type: none"> 1000-1300 x g for BD Vacutainer® SST™ Glass Tubes and 16 mm BD Vacutainer® SST™ Plus Plastic Tubes.⁷ 1100-1300 x g for BD Vacutainer® SST™ Plus Plastic Tubes (13mm)⁷ <1300 x g for all non gel tubes⁷ Temperature regulated centrifuge
<ul style="list-style-type: none"> Re-centrifugation 	<ul style="list-style-type: none"> Mixing of serum below the gel with serum above the gel 	<ul style="list-style-type: none"> Do not re-centrifuge BD Vacutainer® SST™ Tubes.⁷ Aspirate serum from tube and place in a clean test tube to re-centrifuge
<ul style="list-style-type: none"> Poor barrier formation in gel tubes 	<ul style="list-style-type: none"> Red blood cells above gel Leakage of RBCs across barrier, RBC contamination, high potassiums, and other erroneous test results 	<ul style="list-style-type: none"> 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 angle⁷ 1000-1300 x g for BD Vacutainer® SST™ Glass Tubes and 16 mm BD Vacutainer® SST™ Plus Plastic Tubes⁷ 1100-1300 x g for BD Vacutainer® SST™ Plus Plastic Tubes (13 mm)⁷ <1300 x g for all non gel tubes⁷ Periodically check/calibrate centrifuges Use swing bucket centrifuge Do not re-centrifuge gel tubes. Transfer serum to another tube if re-spinning is necessary
<ul style="list-style-type: none"> Chilling whole blood beyond 2 hours 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> To chill a sample, place either in crushed ice or a mixture of ice and water⁵ Do not chill < 15° C.

PHYSIOLOGICAL ISSUES

Factors Resulting in Elevated Potassium Values	Possible Consequences	Corrective Actions
<ul style="list-style-type: none"> Thrombocytosis Myeloproliferative disorders with severe leukocytosis 	<ul style="list-style-type: none"> Platelets release potassium during clotting in serum. Typically seen when > 1,000 x 10⁹ L. An increase of 1 million platelets/μL corresponds to an increase of about 0.7 mEq/L in the serum potassium^{8,9} In plasma more platelets remain above the gel barrier 	<ul style="list-style-type: none"> Allow complete clot formation Centrifuge at the high end of recommended centrifugation range
<ul style="list-style-type: none"> Dehydration 	<ul style="list-style-type: none"> Inherent higher potassium levels possible, related to patient condition 	<ul style="list-style-type: none"> Hydrate patient then re-draw specimen
<ul style="list-style-type: none"> Anticoagulant therapy (Coumadin, Heparin) Liver Disease 	<ul style="list-style-type: none"> Medically induced delays in the clotting process. If tube is re-spun, serum below barrier (higher potassium) mixes with serum above barrier 	<ul style="list-style-type: none"> NOTE: 30 minute clotting may not be sufficient. Observe clot formation up to 1 hour Transfer serum to another tube if re-spinning is necessary Use heparinized plasma for potassium analysis Add thrombin to accelerate clotting¹⁰
<ul style="list-style-type: none"> Fear of imminent venipuncture 	<ul style="list-style-type: none"> Leads to acute hyperventilation and a net potassium efflux from cells 	<ul style="list-style-type: none"> Ease patient fears about the procedure
<ul style="list-style-type: none"> Familial pseudohyperkalemia 	<ul style="list-style-type: none"> Represents an abnormal passive leak of potassium across the RBC membrane especially at lower temperatures, because of an autosomal dominant loci on chromosome 16^{11,12} 	<ul style="list-style-type: none"> Check patient history
<ul style="list-style-type: none"> Oral therapy of Cotrimoxazole 	<ul style="list-style-type: none"> Hyperkalemia with renal tubular dysfunction 	<ul style="list-style-type: none"> Discontinuation of cotrimoxazole normalizes serum potassium levels and symptoms
<ul style="list-style-type: none"> Serum vs Plasma 	<ul style="list-style-type: none"> Potassium is greater in serum than in plasma due to release of K⁺ from platelets during clotting Plasma Potassium increases over time due to presence of cells in plasma 	<ul style="list-style-type: none"> Standardize on either specimen type Establish normal reporting ranges for both serum and plasma Centrifuge within 2 hours Aspirate plasma from tube, put in clean tube and re-spin plasma

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.

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