Learning Objectives
Upon completion of this exercise, participants will be able to:

• identify various preanalytic errors that can occur in different stages of blood collection.
• discuss physiologic factors that impact test results.
• describe technical and mechanical factors that lead to falsely increased potassium levels.

Even though an analytical procedure is performed accurately and precisely, preanalytic variables can contribute to errors that affect specimen quality and ultimately the test result. These variables can jeopardize the health of the patient, lead to unnecessary testing, and increase the cost of health care. An understanding of these variables and standardization of procedures are essential to providing meaningful laboratory information. The Table identifies various preanalytic errors that can occur in different stages of blood collection and processing. In addition to properly identifying a patient and correctly performing the venipuncture procedure, when collecting patient specimens it is important to be aware of physiologic and technical variables that can affect test results.

Patient results are compared with a reference range for each analyte. Reference ranges are established based on the resting metabolic state of the body early in the morning after fasting a minimum of 12 hours. The basal state is influenced by many physiologic variables, the most common of which are gender and age. For example, a hemoglobin value for a male is generally higher than that for a female. Creatinine clearance is directly related to the age of the patient: generally, creatinine clearance decreases with age. Other physiological factors that influence results include time of day, activity, bed rest, posture, obesity, ingestion of food or herbal supplements, alcohol ingestion, smoking, menstrual cycle, oral contraceptives, pregnancy, and race.

Physiologic conditions also alter test results. Dehydration due to persistent vomiting or diarrhea causes hemoconcentration. In this condition, cellular components in the bloodstream are falsely increased due to a loss of fluid. On the other hand, an edematous patient may demonstrate falsely low cellular components due to the retention of fluids in the bloodstream. Hemoconcentration can also occur if a tourniquet is left on too long, causing various analytes to become falsely elevated. Tourniquets should not be left on for longer than 1 minute.

In addition, medications can change analyte levels. These changes may be a desired effect, such as the lowering of blood glucose in a patient with diabetes. The purpose of laboratory testing in this instance is to monitor glucose control. However, other medications produce an undesirable side effect or sensitivity. Some statin drugs used to lower cholesterol may be toxic to the liver and result in increased levels of liver
enzymes. In most cases where there is a physiological impact, the physician understands these effects and considers this in the interpretation of the test results. Other drugs can interfere in the test procedure and thus falsely alter the test results. For example, a drug may compete with the test reagents for the substance being tested. This may result in a falsely low or false-negative result. If a drug enhances the reaction, a falsely high or false-positive result may be reported. It is the laboratory staff’s responsibility in these cases to communicate test interference to physicians when they question the validity of test results.

Specimen hemolysis is a major cause of test interference. Hemolysis results when RBCs are damaged and the hemoglobin they contain escapes into the fluid portion of the specimen. When hemolysis occurs during the blood collection process, the specimen should be rejected if it is known that hemolysis will interfere with a particular test. For example, when a hemolyzed specimen is inadvertently analyzed, falsely elevated potassium values are produced. This error can elevate an abnormally low potassium level, thus masking a patient’s illness (e.g., adrenocortical hyperfunction) or altering a treatment regimen (e.g., medication for congestive heart failure). On the other hand, elevated potassium in an otherwise normal individual may postpone a scheduled surgery with subsequent investigations, leading to unnecessary testing, delays, and costs.

According to CLSI standards, to prevent hemolysis during a venipuncture procedure, phlebotomists should:

- allow the venipuncture site to dry after cleansing.
- avoid drawing blood through a hematoma.
- ensure the needle is fitted securely on a syringe to avoid frothing.
- avoid drawing the plunger back too forcibly when using a syringe.
- invert the tubes gently to mix the blood with the additives.

Additional technical or mechanical factors can rupture RBCs and contribute to hemolysis. The following practices should be followed to avoid hemolysis:

- When transferring a specimen from a syringe into a vacuum tube, allow the blood to fill slowly; do not forcibly push the plunger.
- Use a large-diameter needle or catheter such as 19-gauge. Studies show hemolysis rates are higher when 20- to 24-gauge needles/catheters are used.
- When blood is drawn from an intravenous tube or catheter, the diameters of the catheter, tube adapter device, and cap-piercing needle must match to avoid the negative effects of turbulence on the blood.
Because falsely elevated potassium levels can be a source of medical errors, other protocols must also be followed during blood collection. These include:

- Avoid fist clenching or pumping.
- Follow order-of-draw procedures.
- Follow specimen handling directions (e.g., clot-contact time, proper centrifugation, or respinning of gel-separator tubes).

Fist clenching or pumping affects potassium results by causing the release of muscle-cell potassium into the bloodstream. Order-of-draw procedures are important because the potassium additive in EDTA tubes could potentially carry over into a subsequent tube to be tested for potassium. Once a specimen is drawn, serum should be separated from a clot within 2 hours of collection to avoid RBC contamination. In addition, manufacturer directions should be followed regarding centrifugal force requirements and respinning of specimens to avoid gel-barrier failures.

Because the majority of test errors are attributed to preanalytic variables, proper training and constant communication with personnel performing phlebotomy are vital to reducing these errors. Personnel other than laboratory staff are increasingly involved in specimen collection and handling. The laboratory staff is responsible for training them in the protocols necessary for quality specimens. The laboratory staff is then responsible for minimizing preanalytic errors based on acceptance or rejection of specimens received. Poor phlebotomy technique often requires the patient samples be recollected; this delays physician receipt of information critical to making clinical decisions. In addition, it is a costly and inefficient use of time and resources. Accurate and timely testing leads to effective patient care.

TABLE. Preanalytic Errors.

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EDUCATIONAL COMMENTARY - IDENTIFICATION AND REDUCTION IN PREANALYTIC ERRORS ASSOCIATED WITH BLOOD COLLECTIONS (cont.)

Suggested Reading


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