Preanalytical Variables Best Practices in Blood Collection and Handling

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Date: 08/30/2021

Learning Objectives

At the end of this session, you will be able to:

1. Verbalize the three phases of testing
2. Identify errors that occur in the preanalytical phase
3. Understand and identify contributing factors in specimen collection, processing, handling and storage that affect specimen quality and test results
4. Use this knowledge to minimize preanalytical errors in your institution, enhance sample quality, improve patient satisfaction and enhance patient care

Today's Clinical Lab Testing

Impacts up to 70% of medical decisions

1. Assists with diagnosis of disease in conjunction with other medical signs and symptoms
2. Identifies pre-disposition for developing diseases and/or conditions
3. Reduces potential for less invasive tests and treatments
4. Guides management strategies for specific diseases
5. Estimates disease progression and treatment response

Risk Assessment

Diagnosis

Prognosis

Treatment Selection

Disease Monitoring and Management

Source: The Lewin Group (2005). The Value of Diagnostics: Innovation, Adoption, and Diffusion into Health Care

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Three Phases of Laboratory Testing

Preanalytical

- Physiological/biological factors (healthcare practitioners can’t control)
- Technical factors (healthcare practitioners have the ability to control)

Analytical

- Instrument and reagent dependent

Postanalytical

- Result reporting and clinical interpretation

Green, SF. 2013 The cost of poor blood specimen quality and errors in pre-analytical processes. Clinical Biochemistry. 46: 1175-1179. http://dx.doi.org/10.1016/j.clinbiochem.2013.06.001


“The results I give the doctor depend entirely on the quality of the sample I receive.”

Preanalytical Variables and Specimen Collection Manual

Establish a specimen collection manual that includes instructions for the following:

1. Patient preparation
2. Type of collection container, amount of specimen required
3. Need for special timing for collection
4. Types, amounts of preservatives, anticoagulants
5. Need for special handling between collection and receipt times
6. Proper specimen labeling
7. Need for appropriate clinical data when indicated

College of American Pathologists (CAP) 2016. Laboratory Accreditation Program Laboratory General Checklist, Northfield, IL. GEN. 40100.

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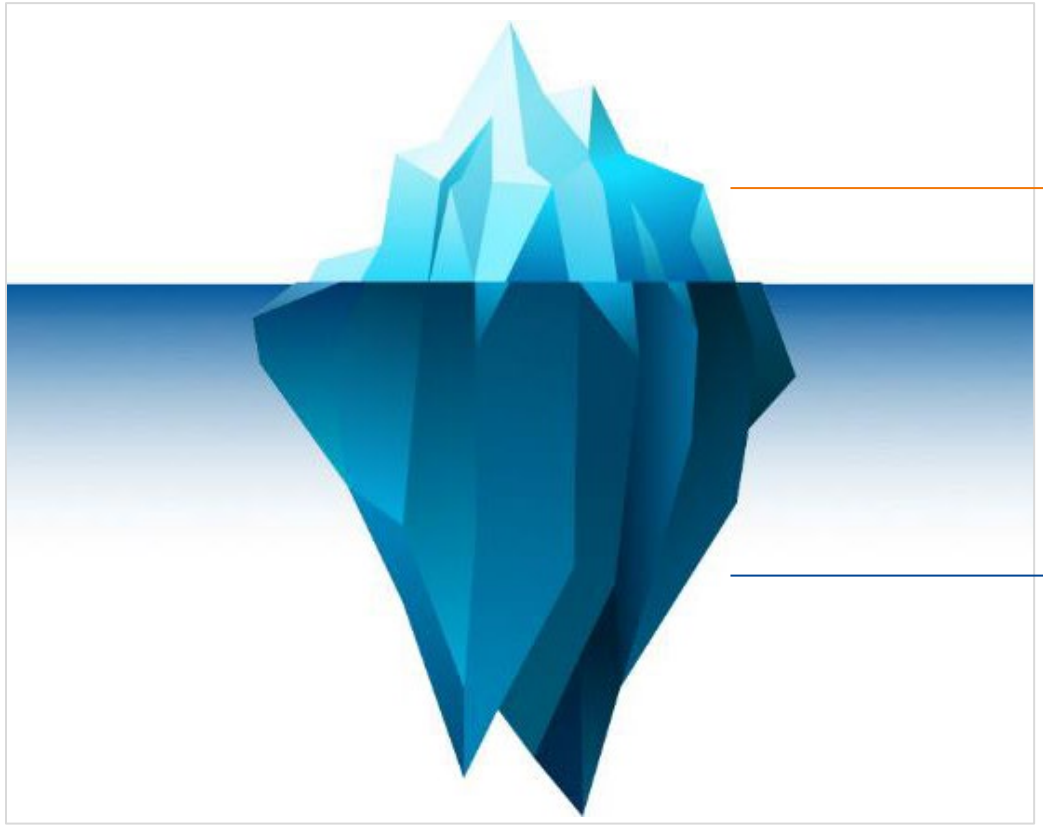
The Erroneous Results in the Laboratory Medicine Iceberg



30% **Analytical and Postanalytical Errors**

70% **Preanalytical Errors**

Plebani, M. 2009. Exploring the iceberg of errors in laboratory medicine. Clinica Chimica Acta. 404: 16-23. doi:10.1016/j.cca.2009.03.022.

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Preanalytical Variables and Factors that Impact Specimen Quality

Before sample collection:

- Patient identification errors
- Sample identification errors

Giavarina D, Lippi G. 2017. Blood venous sample collection: Recommendations overview and a checklist to improve quality. Clinical Biochemistry 50: 568-573. http://dx.doi.org/10.1016/j.clinbiochem.2017.02.021

Preanalytical Variables and Factors that Impact Specimen Quality

During sample collection:

- Wrong container or sample matrix
- Wrong additive
- Inappropriate Blood-to-Additive Ratio
- Insufficient volume
- Clotted samples/platelet clumping
- Spurious hemolysis
- Sample contamination
- Site selection/preparation
- Tube/needle selection
- Tourniquet placement/time
- Difficult venous access (DVA)
- Draws from intravenous (IV) catheters

Giavarina D, Lippi G. 2017. Blood venous sample collection: Recommendations overview and a checklist to improve quality. Clinical Biochemistry 50: 568-573. http://dx.doi.org/10.1016/j.clinbiochem.2017.02.021

Preanalytical Variables and Factors that Impact Specimen Quality

After sample collection:

1. Labeling error
2. Inappropriate sample management (e.g. mixing)
3. Insufficient centrifugation
4. Inappropriate transportation
5. Inappropriate storage (time, temperature)

Giavarina D, Lippi G. 2017. Blood venous sample collection: Recommendations overview and a checklist to improve quality. Clinical Biochemistry 50: 568-573. http://dx.doi.org/10.1016/j.clinbiochem.2017.02.021

Preanalytical Variables and Patient Identification

- Use two unique identifiers (full name, date of birth, etc. according to institutional protocol)
- Ask patient to provide information
- Have measures to accommodate hearing limitations / language barriers
- Minimize interruptions, distractions

1. Follow institution's protocol for unconscious patients
2. Verify information on labels, patient ID band, report discrepancies
3. Positive patient ID must be made and discrepancies resolved before specimen collection

Clinical and Laboratory Standards Institute (CLSI). Collection of Diagnostic Venous Blood Specimens, 7th Edition, CLSI Standard GP41. Wayne, PA: Clinical and Laboratory Standards Institute, April 2017.
Giavarina D, Lippi G. 2017. Blood venous sample collection: Recommendations overview and a checklist to improve quality. Clinical Biochemistry 50: 568-573. http://dx.doi.org/10.1016/j.clinbiochem.2017.02.021

Preanalytical Variables and Causes for Patient ID Errors

- Failure to check ID wristband every time
- Missing ID wristband
- Placing wrong wristband on patient
- Relying on verbal identification by patients("are you Mr. Smith?")
- Relying on other caregiver to provide identification

1. Identifying patient only as John / Jane Doe
2. Failure to distinguish between patients with the same/similar names
3. Malfunctioning barcode scanner

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Preanalytical Variables and Specimen Labeling / Identification

Label specimens immediately

- Critical for patient care

Tubes must be labeled in front of the patient

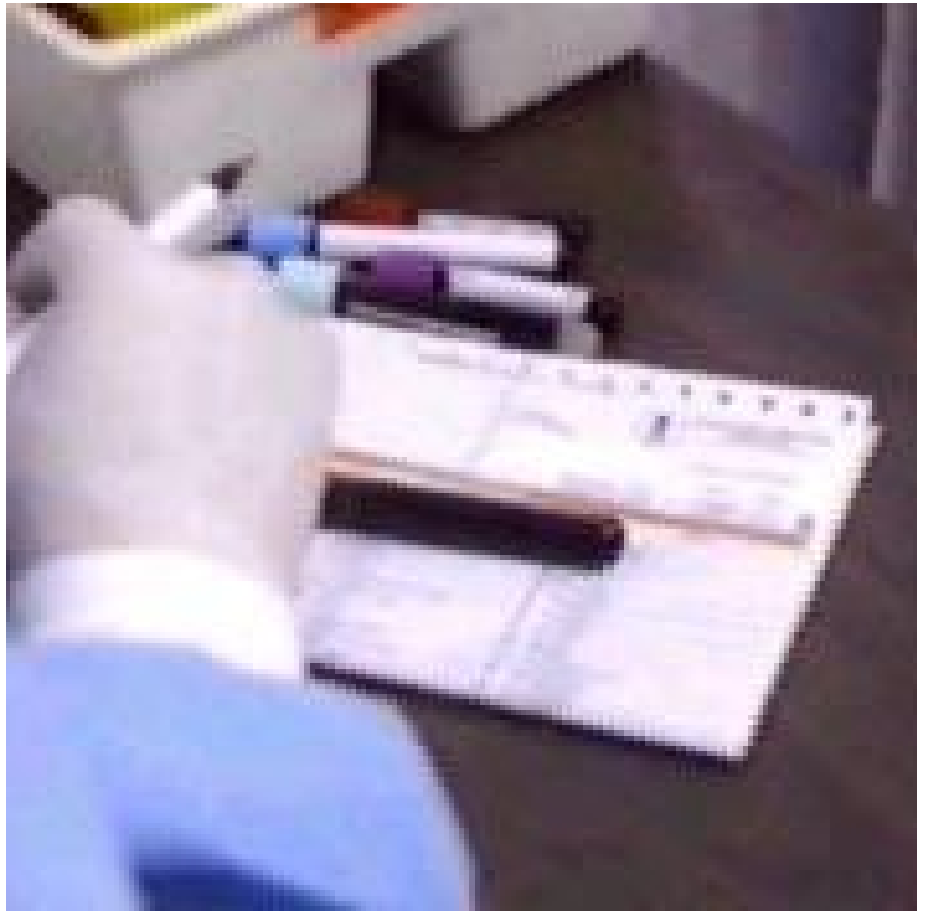
- At bedside
- At phlebotomist chair

Label must be affixed with the following information:

- Full name
- ID number
- Date, time as required, i.e., Therapeutic Drug Monitoring
- Collector's initials

Impact of improper specimen labeling:

- Recollection
- Reanalysis
- Misdiagnosis
- Malpractice cases
- Labor costs



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Preanalytical Variables and Causes of Mislabeled Specimens

- Carrying multiple specimen labels into patient room
- Labeling away from bedside
- Labeling specimens by someone other than collector
- Failing to use blood bank labeling protocol
- Failing to document collection date, time
- Re-labeling of specimens in the lab
- Using multiple label types applied to specimen
- Labeling tubes prior to collection

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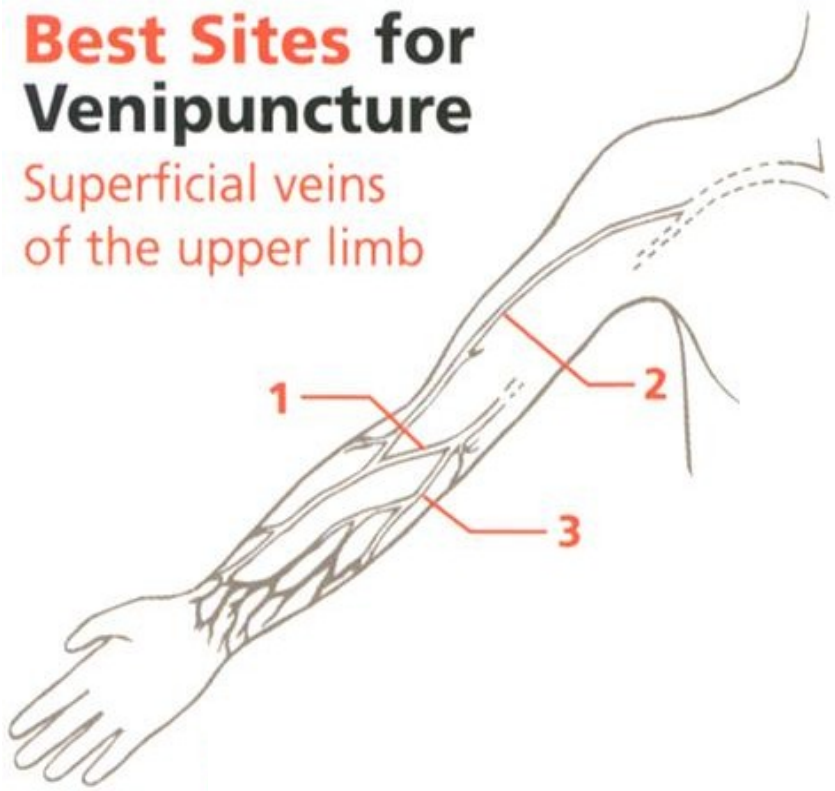
Preanalytical Variables and Site Selection



1 **Median Cubital Vein**

A superficial vein, most commonly used for venipuncture, it lies over the cubital fossa and serves as an anastomosis between the cephalic and basilic veins.

2 **Cephalic Vein**

Shown in both forearm and arm, it can be followed proximally where it empties into axillary vein.

3 **Basilic Vein**

Shown in the forearm and arm, it divides to join the brachial vein.

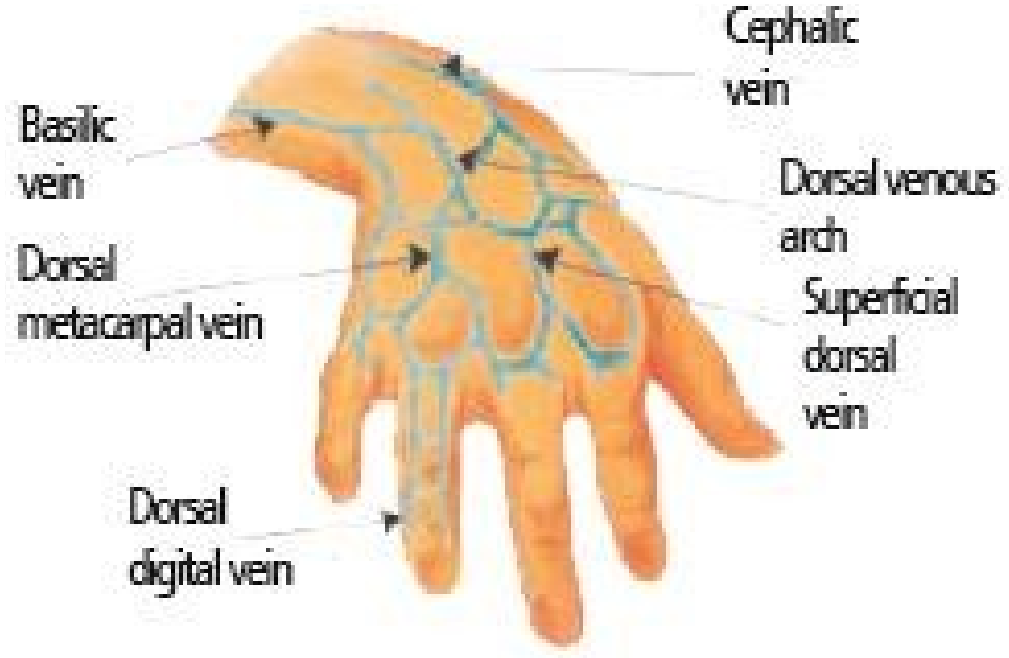
Clinical and Laboratory Standards Institute (CLSI). Collection of Diagnostic Venous Blood Specimens, 7th Edition, CLSI Standard GP41. Wayne, PA: Clinical and Laboratory Standards Institute, April 2017.

Preanalytical Variables and Site Selection - Hand

Hand or wrist veins may only be used when ante - cubital fossa veins are unsuitable or unavailable.

Extra care needed to anchor these veins.

A small gauge needle and small volume evacuated tubes may be required because these veins have a narrow circumference



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Preanalytical Variables and Inappropriate Sites for Venipuncture

Sites That Must Not Be Used	
Site	**Rationale**
Fistula, arm with a fistula, or vascular graft	• Threatens the integrity of fistulas and vascular grafts, which can lead to serious patient complications
Arteries[12,13]	• Risk of misinterpretation of results and patient mismanagement if arterial blood is used rather than venous blood; **NOTE:** Arterial and venous blood specimens are not equivalent for many analytes. • Poses a significantly higher risk of injury and complications than venous access
Veins on lateral and palmar surface (underside) of the wrist[14-21,25]	• Increased risk of nerve, tendon, and arterial involvement
Infected sites	• Potential for altered test results, exacerbation of infection, and patient discomfort

Clinical and Laboratory Standards Institute (CLSI). *Collection of Diagnostic Venous Blood Specimens,* 7th Edition, CLSI Standard GP41. Wayne, PA: Clinical and Laboratory Standards Institute, April 2017.
Ernst DJ and Ernst C. Phlebotomy for Nurses. 1st Edition, 2001. HealthStar Press. Page 25

Preanalytical Variables and Inappropriate Sites for Venipuncture

Sites That Require Physician's Permission	
Site	**Rationale**
Limbs on the side of a mastectomy	• Risk of lymphedema and the potential for altered test results[22-24]
Any part of the lower extremities	• Risks tissue necrosis in diabetic patients and thrombophlebitis in patients with coagulopathies
Sites That Should Be Avoided	
Site	**Rationale**
Extensive scarring, healed burns	• Palpation and needle insertion complications • Inability to detect adverse reactions
Hematoma	• May cause discomfort to the patient and potential altered test results
Above and below infusing fluids or from a VAD	• Possible contamination of specimen with IV fluids[26] (see Subchapter 5.3.2)
Inflamed sites (including inflamed tattoos)	• Patient discomfort and possible complications
Edematous sites	• Potential for altered test results
Extremity affected by stroke and injury	• Inability to detect adverse reaction, eg, nerve injury, pain, infection

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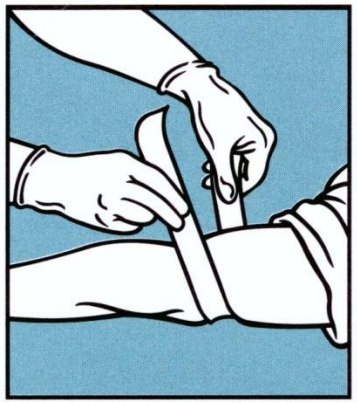
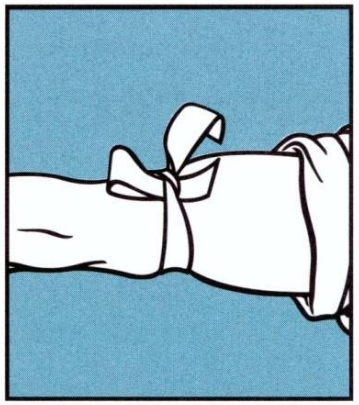
Preanalytical Variables and Tourniquet Application

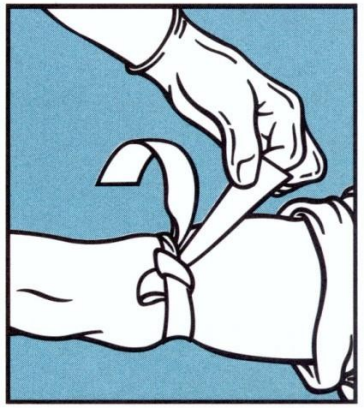


Position the tourniquet 3-4 inches above the venipuncture site

Tuck a portion of one end under the opposite end to form a loop



Cross the Tourniquet over the patient's arm



A properly applied tourniquet for easy release

Clinical and Laboratory Standards Institute (CLSI). *Collection of Diagnostic Venous Blood Specimens, 7th Edition*, CLSI Standard GP41. Wayne, PA: Clinical and Laboratory Standards Institute, April 2017.

Preanalytical Variables and Tourniquet Use

- Use no more than one tourniquet
- Use non-latex tourniquets to prevent latex sensitivity and allergic reactions
- Use single-use tourniquets to prevent spreading of MRSA
- Apply pressure for no more than 1 minute to prevent hemo- concentration
- Release tourniquet as soon as blood flows into first tube
- If pressure exceeds one minute before accessing the vein, release and reapply after two minutes
- Constriction must not be excessive or provide discomfort to the patient; may be used over clothing to prevent pinching
- Blood pressure cuff inflated below patient's diastolic pressure may be used by those trained to use such devices

Clinical and Laboratory Standards Institute (CLSI). *Collection of Diagnostic Venous Blood Specimens, 7th Edition,* CLSI Standard GP41. Wayne, PA: Clinical and Laboratory Standards Institute, April 2017.

Preanalytical Variables and Improper Tourniquet Use

Poses a risk to patients

May affect test results

Hemo-concentration causes erroneously high values for:

- Protein-based analytes
- Packed Cell Volume
- Cellular elements

Affected analytes include:

- Albumin
- Alkaline phosphatase
- Calcium
- CBC parameters – RBC, WBC, Differential, Hemoglobin, Hematocrit
- Potassium
- Glucose
- Triglyceride
- Total protein

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Preanalytical Variables and Fist Clenching

Clenching the fist is not mandatory

Veins do become more prominent,
easier to enter

Fist should be clenched and held until blood flows into collection device, then released

Fist pumping or vigorous motion to open and close the hand is to be avoided

Pumping can cause significant elevations

- Potassium
- Ionized Calcium

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Preanalytical Variables and Site Preparation, Disinfection

1. Disinfect site to minimize microbiological contamination of specimen, patient
2. 70 percent isopropyl alcohol solution with clean gauze pad or prepared pad; chlorhexidine also acceptable
3. Scrub with back-and-forth motion with friction
4. Use non-alcohol cleanser if blood alcohol analysis ordered
5. Use facility-specific cleanser if blood cultures are ordered
6. Allow to air dry completely before venipuncture; at least 30 seconds for blood cultures
7. Avoid blowing or waving at site to encourage drying
8. Avoid using non-sterile gauze to dry the area
9. Re-palpating vein requires that the site be cleansed again

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Preanalytical Variables and Site Preparation, Disinfection

Residual disinfectant can be introduced into the sample if drying is not complete

Alcohol can cause hemolysis, increased ethanol level

Benzalkonium compounds may affect electrolyte results

Betadine contamination:

- False elevation of phosphorus, uric acid, potassium
- Oxidative effect causes false-positive stool hemoglobin, urine glucose

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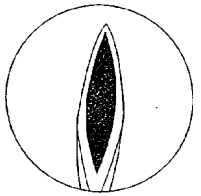
Preanalytical Variables and Needle Selection



Determine appropriate gauge based on amount of blood to be drawn, age of patient, and vein size

- 19-23 gauge most commonly used
- 22-23 gauge in children
- 25 gauge can result in more hemolysis, slower fill – however, the new BD RightGauge™ Ultra-Thin Wall Cannula Technology modifies these issues

Goal:

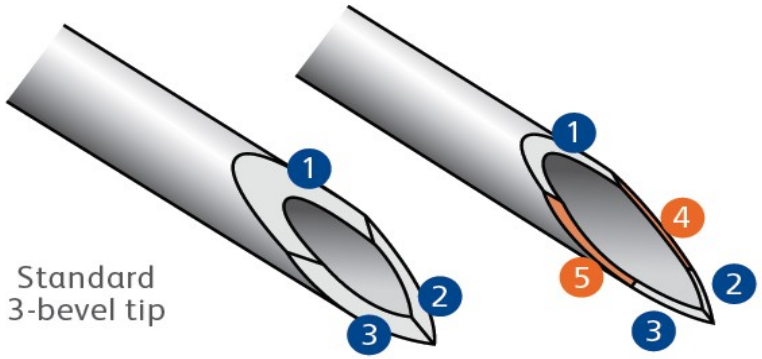
To minimize hemolysis and thrombogenicity due to pre-analytical variables

Clinical and Laboratory Standards Institute, document GP41

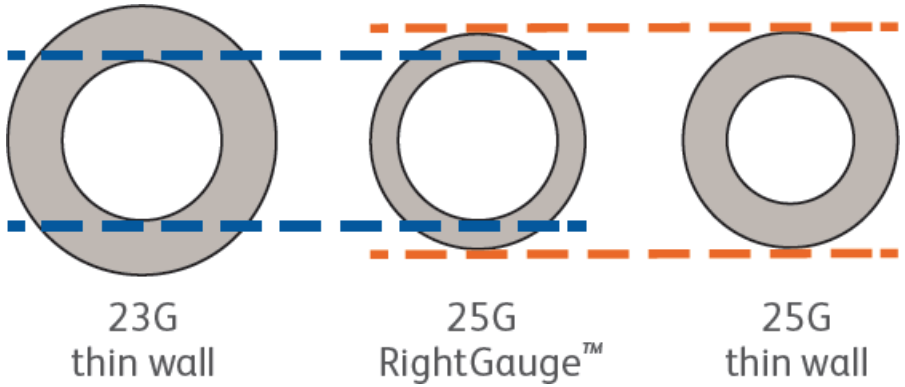
Clinical and Laboratory Standards Institute, document GP41

25g Needle Technology
Uses 5 Bevels and BD RightGauge™ Ultra-Thin Wall Cannula Technology with an Inner Diameter Similar to 23g

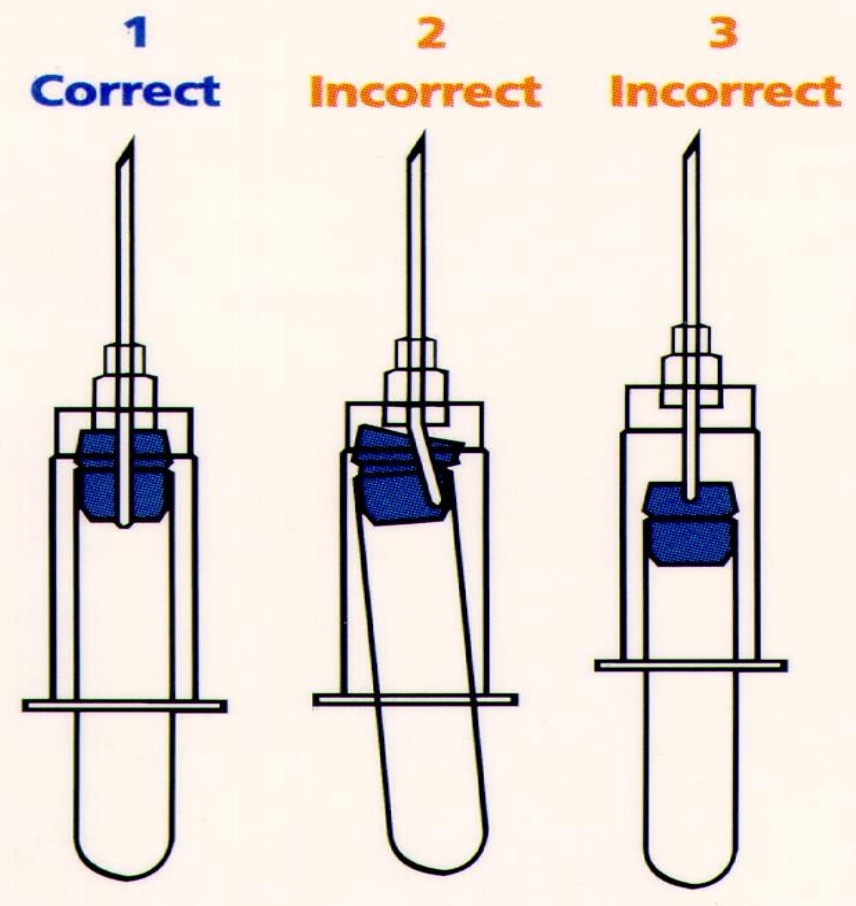
1. 5 bevels instead of 3 **minimizes patient discomfort.** The new technology requires 32% less penetration force when compared with equivalent gauges of the current BD PBBCS with a thin wall 3-bevel cannula.



2. Ultra-Thin Wall Cannula enables **easier access to small, difficult veins** without comprising sample quality or tube fill time.



Preanalytical Variables and Proper Tube Alignment - Insertion

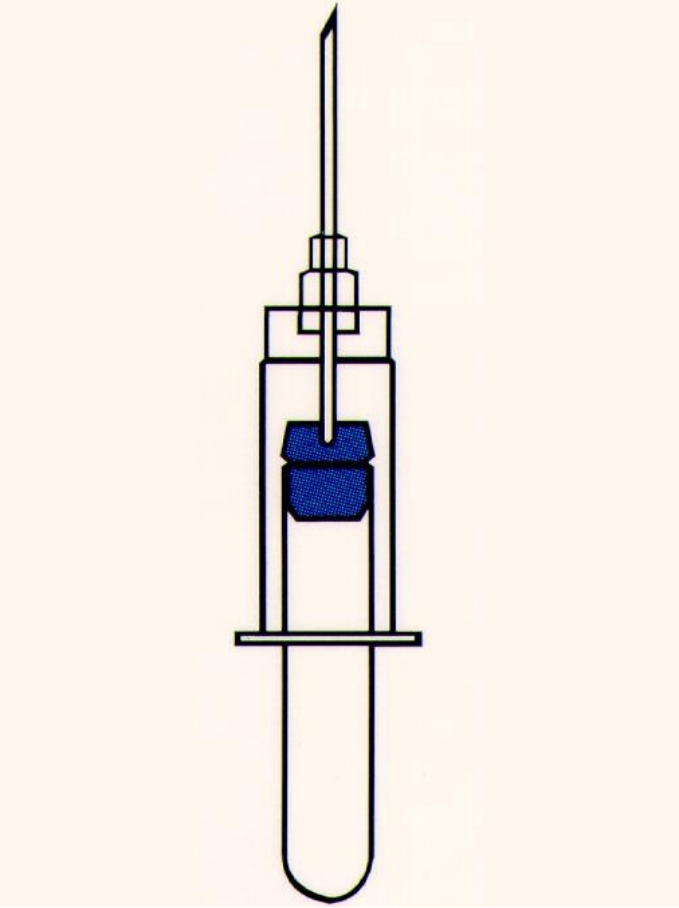


1 **Correct**
Proper insertion of tube into holder.

2 **Incorrect**
Improper insertion resulting in an incompletely punctured stopper.

3 **Incorrect**
Partially punctured stopper.

Preanalytical Variables and Proper Tube Removal



Remove tube from contact with the back end of the blood collection needle before removing from patient's arm

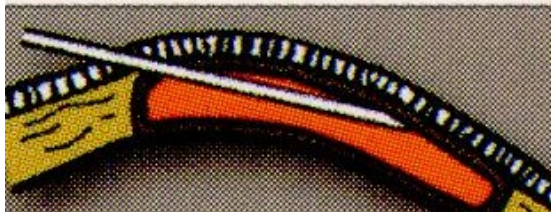
No blood leakage from needle tip when removing the needle

Minimizes blood exposure to patient or self

Safety

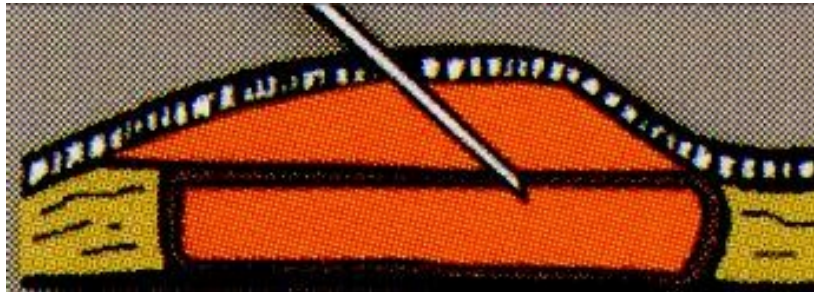
Preanalytical Variables and Needle Positioning in Vein

Bevel on lower or upper vein wall



1. Pull back slightly
2. Avoid rotating or changing needle angle

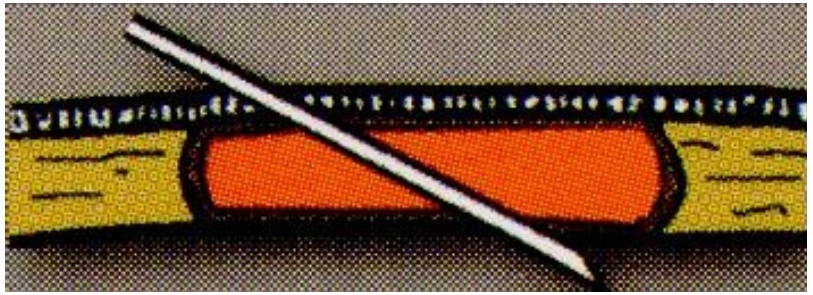
Partial needle insertion



1. Should a hematoma form, immediately remove tourniquet and needle
2. Elevate arm above the patient’s heart and apply pressure. Do not bend patient’s arm

Preanalytical Variables and Needle Positioning in Vein

Puncture through vein



1. **Withdraw the needle slightly to establish blood flow**

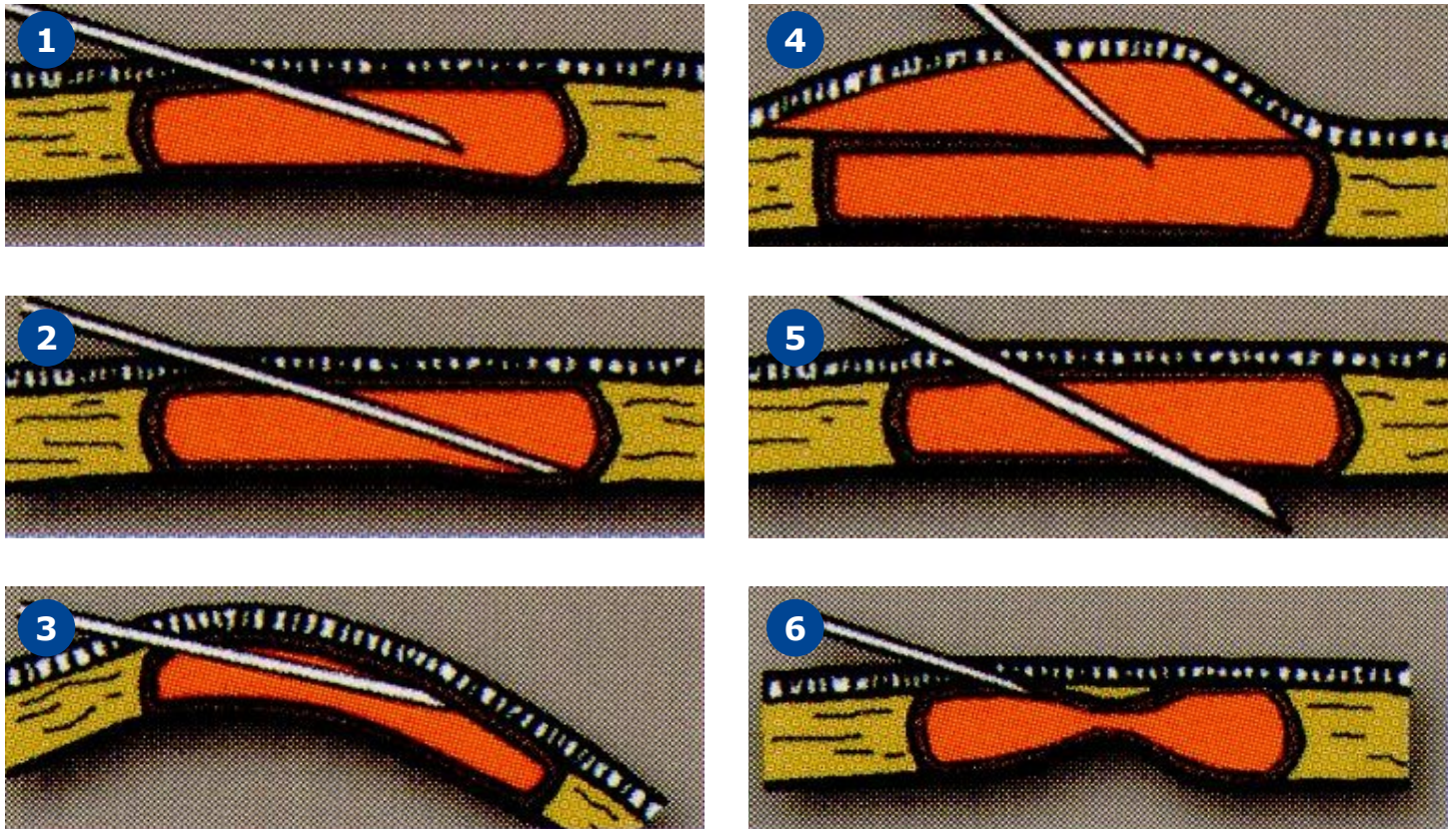
Collapsed vein

1. **Tighten tourniquet by grasping the ends with one hand and twisting together.**
   Should blood flow fail to resume, remove tube, wait a few seconds for blood flow to reestablish, and insert a smaller volume tube.
2. **Remove Needle**

Preanalytical Variables and Difficult Venous Access

Needles should run in the same direction as the vein

Insert needle quickly and smoothly at a 15 degree angle to the skin



Preanalytical Variables and Tube Selection

- Tubes must be within acceptable use date; not past expiration date
- Tubes may or may not contain additives
- Tube tops color-coded by additive or use

Improper choice of additive/ anticoagulant for intended testing may affect test results

- K_2EDTA (spray-coated) vs. K_3EDTA (liquid)
- Plasma vs. serum
- Sodium vs. Lithium heparin
- Presence of gel for therapeutic drugs
- Grey top tube (Glucose, C&S)
- Royal blue tube (K_2EDTA, clot activator)

Rafflick, RAR, et. Al. 2010. Impact of blood collection devices on clinical chemistry assays. Clinical Biochemistry 43: 4-25. doi:10.1016.j.clinbiochem.2009.10.001.

Preanalytical Variables and Order of Draw

Blood culture tube or bottle

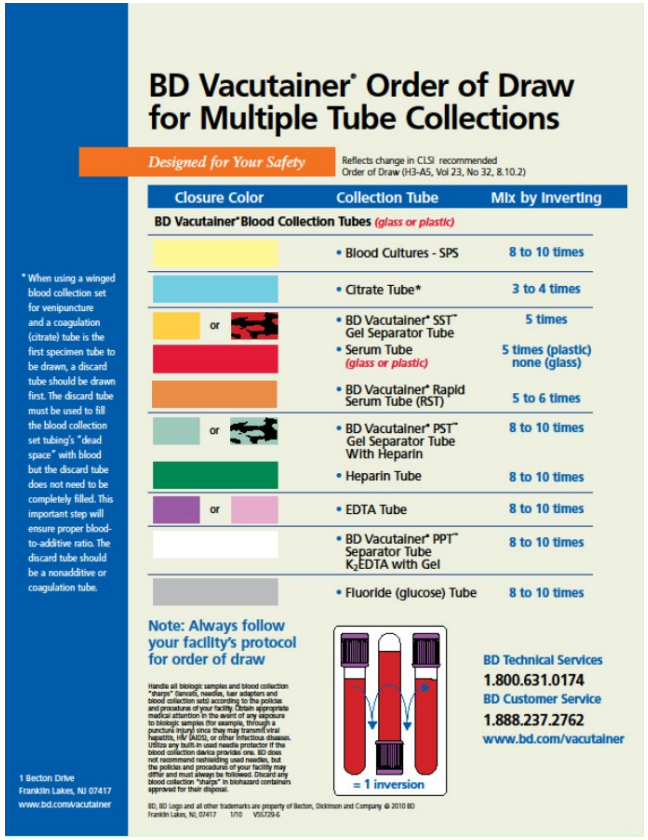
Coagulation tube
(e.g., citrate, blue closure)

Serum tube with or without clot activator, with or without gel
(e.g., red closure)

Heparin tube with or without gel plasma separator
(e.g., green closure)

EDTA
(e.g., lavender closure)

Glycolytic inhibitor
(e.g., gray closure)



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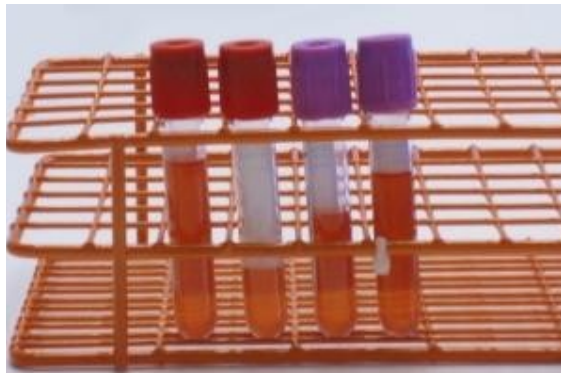
Preanalytical Variables and Blood-to-Additive Ratio



Tubes contain additives, clot activator or anti-coagulant

Additive is engineered with designated Blood-to-Additive Ratio

Ratio not achieved when tubes either under or over filled

Winged blood collection sets contain dead-air space in tubing depending upon the tubing length

- 0.3 mL for 7-inch tubing
- 0.5 mL for 12-inch tubing

When drawing coagulation (Sodium Citrate light-blue top) tubes, use a discard tube first

- Filling of discard tubes unnecessary, just enough to clear dead space
- Can be Coag tube or non-additive tube

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Preanalytical Variables and Syringe Draws

- Avoid venipuncture with traditional needle and syringe for safety reasons
- Syringe stopper materials can contaminate specimen, interferes with drug assays
- Needle should enter at 30 degree angle or less
- Needle should remain as stable as possible while maintaining a slow, steady withdrawal of blood
- Excessive pulling pressure must be avoided
- Transfer into tubes should be done with a designated blood transfer device, not an injection needle

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Preanalytical Variables and Coag Tube Minimum Fill Level

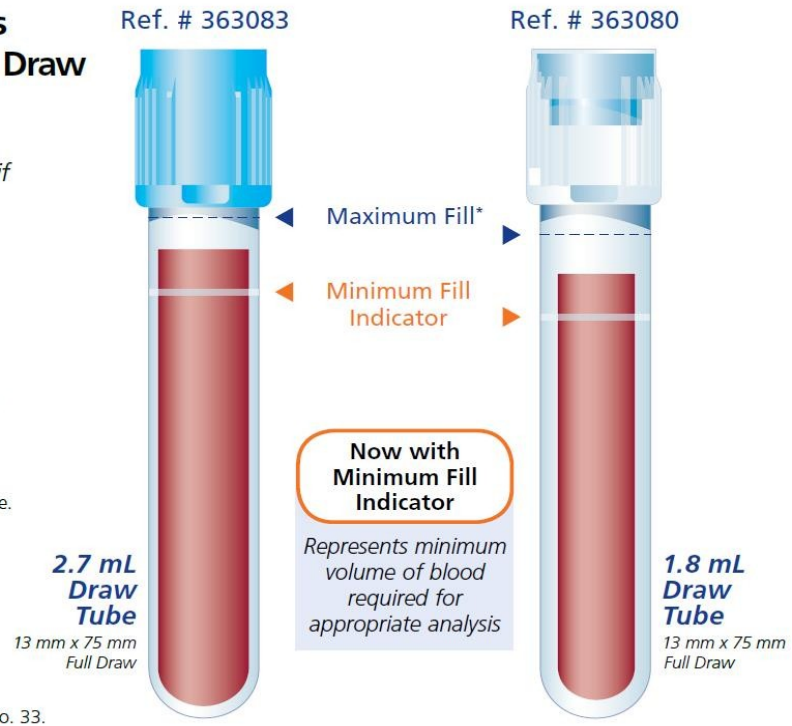
BD Vacutainer® Plus Plastic Citrate Tube

BD Vacutainer® Plus Plastic Citrate Tube Draw Volume Guide

Sufficient volume achieved if blood drawn falls above minimum fill indicator. For blood transfer, ***do not*** *fill above illustrated dashed maximum line.*

Note: The quantity of blood drawn into evacuated tubes varies with altitude, ambient temperature, barometric pressure, tube age, venous pressure and filling technique.

*According to CLSI guideline, Dec. 2003, Doc. H1-A5, Vol. 23, No. 33.



Preanalytical Variables and Impact of Under-Filled Tubes

EDTA

- Cell shrinkage or swelling – time dependent
- Abnormal cell morphology, cell counts

Sodium Citrate

- Prolonged PT, aPTT

Heparin

- Troponin
- CK
- Creatinine
- Aminoglycosides (Gentamicin, Tobramycin)

Oxalate Fluoride

- Hemolysis

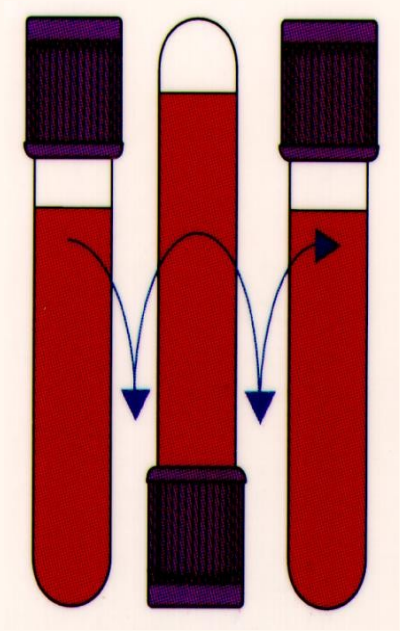
Preanalytical Variables and Causes of Short Filled Tubes

- Using winged blood collection sets
- Using expired evacuated tubes (vacuum)
- Transferring blood from a syringe to evacuated tube
- Collapsing vein
- Removing tube prematurely during venipuncture

Preanalytical Variables and Ways to Avoid Short Fills

- Using a discard tube with a winged blood collection set
- Using blood collection tubes within acceptable use date, prior to expiration
- Allowing vacuum to aspirate blood from syringe
- Allowing vein to recover if collapsed
- Allowing tube to remain in place until blood flow ceases

Preanalytical Variables and Proper Tube Mixing



One Inversion

Specimen mixing – gently invert, not shake – tubes ASAP after collection

- SST (gold top) tubes: Invert 5 times
- Sodium (Na) citrate (blue top) tubes: Invert 3 to 4 times
- Other additive tubes: Invert 8-10 times

Insufficient or delayed mixing can cause:

- Fibrin strands, micro-clots, platelet clumping, clotted specimens
- Hemolysis

Excessive mixing of coag tubes (>4 inversions) can cause activated platelets

Preanalytical Variables and Serum Separator Tubes (SST)

Invert
5
Times

- Gently invert 5 times to mix clot activator with blood.

Clot
30
Minutes

- Allow blood to clot for a minimum of 30 minutes in a vertical position.
- Observe a dense clot.

Spin
10
Minutes

- Centrifuge at FULL SPEED (between 1100 and 1300g) for 10 minutes for swing-head units or 15 minutes for fixed angle units (balance tube in centrifuge).
- Barrier will form, separating serum specimen from clot.
- Transport spun tube to laboratory.

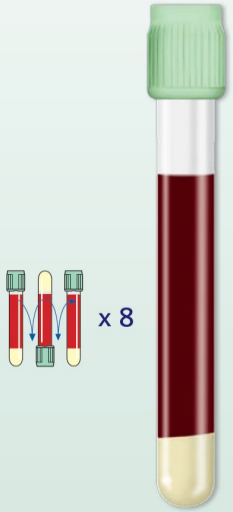
BD Vacutainer Technical Services
1.800.631.0174

Preanalytical Variables and Plasma Separator Tubes (PST)

Invert

8-10

Times

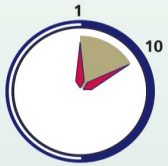


- Gently invert 8-10 times immediately after collection to mix lithium heparin anticoagulant with blood.
- Insufficient mixing may lead to microclot and fibrin strand formation.

Spin

10

Minutes



Centrifuge at

1100 - 1300*g*

- Centrifuge at full speed

  1100 – 1300*g* for 13 mm Plus Plastic tubes

  1000 – 1300*g* for 16 mm Plus Plastic tubes

  for 10 minutes in a swing-bucket unit or 15 minutes for a fixed-angle unit (balance tubes in centrifuge).
- Gel barrier will form to separate plasma from red blood cells.

Ready for Analysis

- Use in laboratory for plasma determinations in chemistry.

Preanalytical Variables and Fibrin

Can cause significant disruption to instrument operation and process workflow

Preanalytical Variables and Clotted Samples

Account for 65% of CBC rejections*

Causes

- Overfilling additive tubes
- Mixing inadequate or delayed
- Drawing from DVA patient
- Filling evacuated tubes slowly
- Drawing blood into syringe, then transferring
- Improper choice of needle or other equipment

Impact

- Specimen rejection leads to specimen recollection
- Instrument downtime due to probe or cell clogging
- Micro-clots and clotted blood influence key parameters

*CAP Q Probe 92-05 Hematology Specimen Acceptability

Preanalytical Variables and Ways to Avoid Clotted Samples

Mix anti-coagulated specimens adequately to distribute additive

Avoid drawing in syringes

Conduct period in-servicing of all personnel involved in blood collection

Enforce collection policies and specimen rejection criteria

Preanalytical Variables and Platelet Clumps

Impact

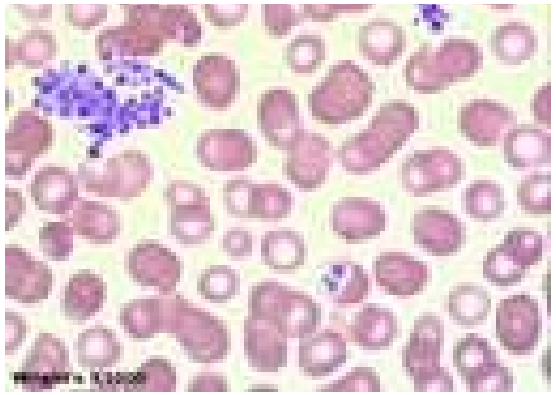
- ↓Platelet Count
- ↑WBC Count

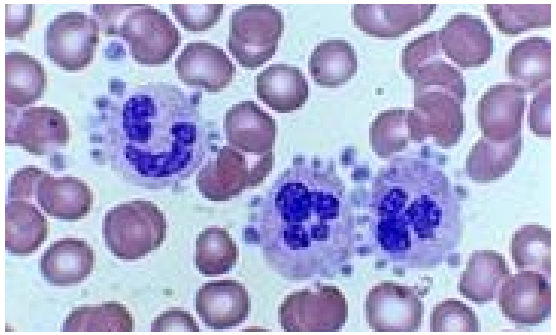
Causes

- Poor mixing after collection
- Overfilling additive tubes
- EDTA induced

Remedies

- Verify Platelet Count with blood drawn in NaCitrate
- Collect & analyze at 37°C
- Vortex sample





Preanalytical Variables and Special Situations

Preanalytical Variables and Timing of Specimen Collection

Medications & Timed Testing

1. Therapeutic Drug Monitoring (TDM)
2. Glucose
3. Blood Cultures
   - Antibiotic therapy
4. Anticoagulation Monitoring
5. Cardiac Markers

Diurnal variations

1. Cortisol
2. Adrenocorticotropin
3. Other hormones

Preanalytical Variables and Collection near IV site

If a site distal to the IV site needs to be used:

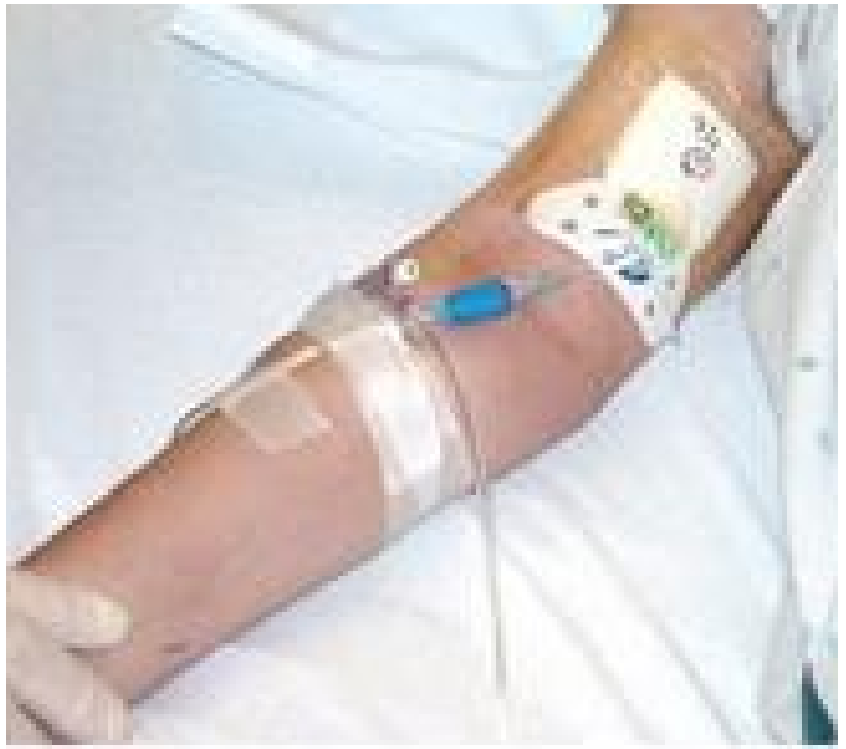
Have the responsible caregiver turn off IV for at least two minutes

Apply tourniquet below IV site

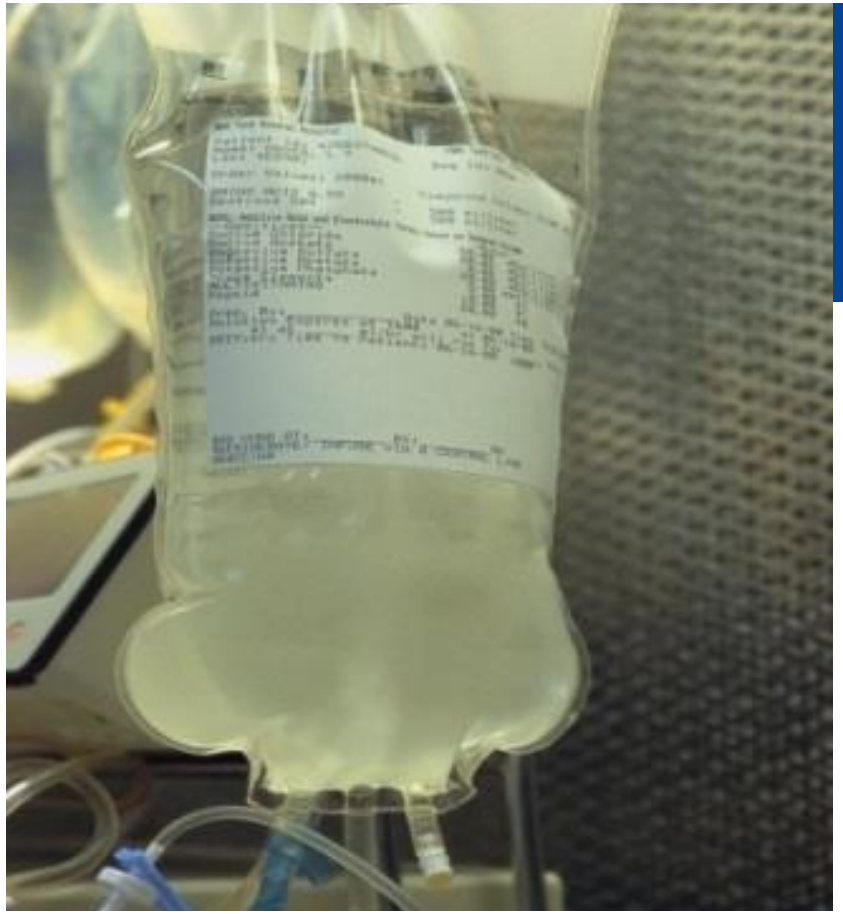
Select vein other than the one with the IV

Perform venipuncture, discarding the first 5mL of blood

Indicate the IV solution, arm used, and drawn below IV



Preanalytical Variables and Collection from patients receiving IV fluids



Blood should be obtained from the arm opposite the one receiving IV solution

When IVs are in both arms:

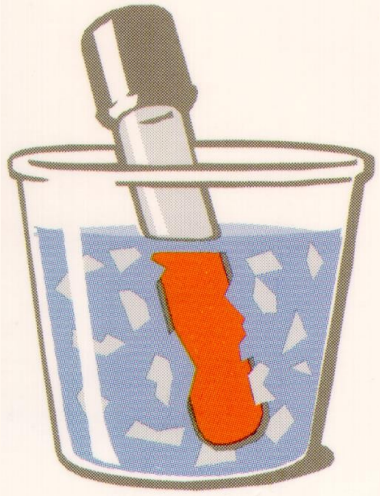
- Draw blood specimen from a vein distal (peripheral) to the IV site
- Place tourniquet between the IV and venipuncture sites

Preanalytical Variables and Transport Temperature

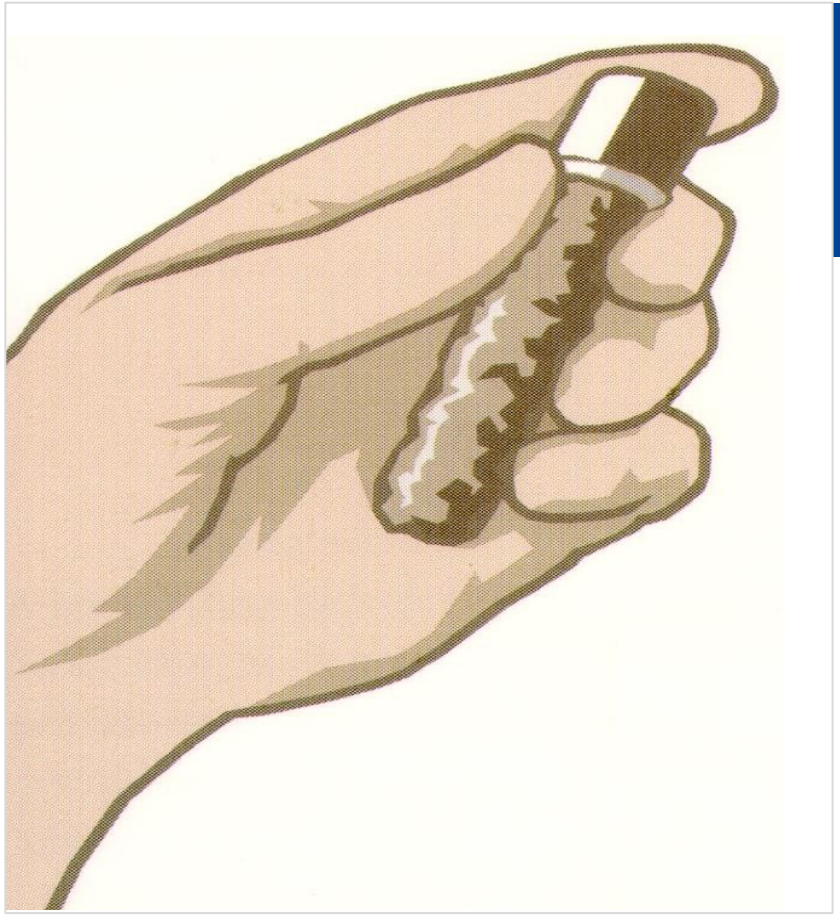
Analytes that require the metabolic processes to be slowed down must be transported in an ice slurry to avoid erroneous lab results.

Examples:

- ACTH
- Acetone
- Angiotensin Converting Enzyme (ACE)
- Blood Ammonia
- Gastrin
- Parathyroid Hormone
- Catecholamines
- Free Fatty Acids
- Lactic Acid
- Pyruvate
- Renin Activity
- Vitamin D



Preanalytical Variables and Light-sensitive samples



Wrap light-sensitive specimens in aluminum foil for transport

Light-sensitive analytes include:

- Bilirubin
- Erythrocyte Protoporphyrin
- Carotene
- Vitamin A
- Vitamin B6

Preanalytical Variables and Clot Formation

Clot Formation

Normal blood clots in 45 min.
+/- 15 min

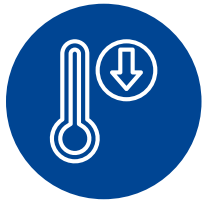
Specimens from patients on anticoagulant therapy or with coagulopathies take longer to clot

Preanalytical Variables and Centrifugation

Centrifugation: Time and Speed

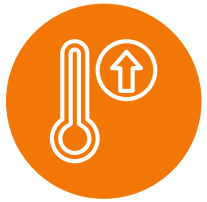
- **Complete** clotting of sample or maintenance of anticoagulation
- Centrifuge to separate cells from serum/plasma
- Centrifuge at speeds, time recommended by tube manufacturer
  - Horizontal swing bucket recommended
- Do not centrifuge original tube a second time
- Remove serum or plasma and place in a secondary tube if a second round of centrifugation is indicated
  - ↑ K
  - ↓ Glucose

Preanalytical Variables and Storage Temperature



Risks related to low storage temperatures

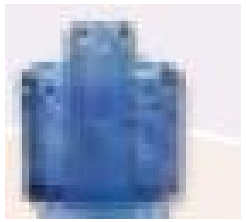
- Increased potassium from RBC rupture
- Increased RBC swelling, increased HCT, MCV
- Decreased Platelets, MCHC, Sed Rate
- Increased WBC from platelet clumping
- Cold-induced activation of intrinsic coagulation system



Risks related to high storage temperatures

- Accelerate degradation of labile coagulation factors
- Serum/plasma proteins

Preanalytical Variables and Causes of Hemolysis



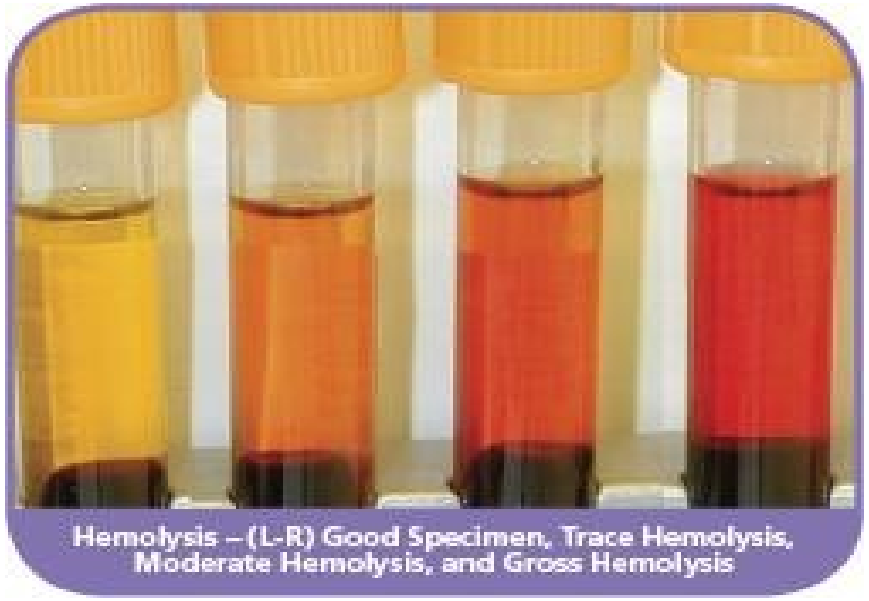
- Needle gauge size either too small or large for vein
- Use of syringes:
  - Withdraw too quickly
  - Syringe volume too large
  - Expel blood into tube with force
- Drawing from intravenous or central lines
- Improper blood to additive ratios
- Filling tubes by hand
- Mixing too vigorously or rough transport
- Failing to allow alcohol to dry completely
- Using tube with volume too large, too much vacuum
- Incompatible collection devices
- Blood frothing due to poor connections
- Drawing blood from hematoma

World Health Organization (WHO) Guidelines on Drawing Blood: Best Practices in Phlebotomy. WHO, Geneva, Switzerland, 2010. ISBN 978 92 4 159922 1

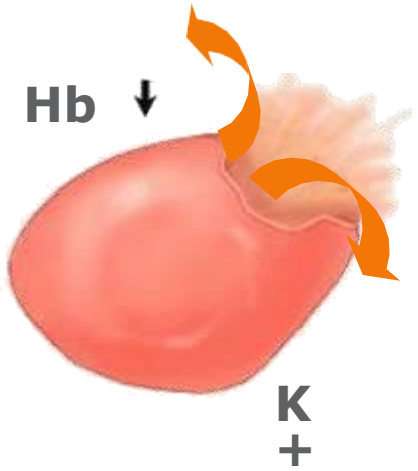
Preanalytical Variables and Impact of Hemolysis

Can affect results in all laboratory disciplines:
Chemistry, hematology, coagulation, microbiology

Rupture of red blood cells leads to contamination of the serum or plasma with intracellular components



Hemolysis – (L-R) Good Specimen, Trace Hemolysis, Moderate Hemolysis, and Gross Hemolysis



Preanalytical Variables and Impact of Hemolysis

- Often results in recollection
- Delays test results and patient treatment
- Decreases patient satisfaction

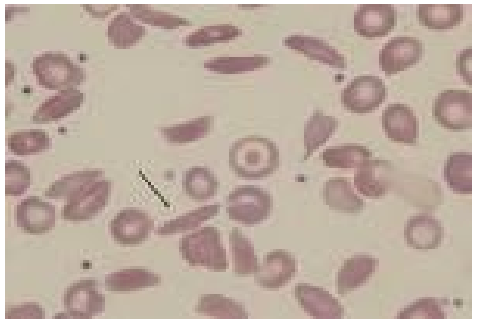
- Causes increased values:
  - Potassium, LD, AST, ALT, iron, total protein, phosphorus, magnesium
- Causes falsely decreased values:
  - RBC, HCT, WBC
  - Albumin, Alkaline phosphatase, sodium (from specimen dilution)

Hemolysis may not be apparent in whole blood assays, such as point-of-care tests

Rafflick, RAR, et. Al. 2010. Impact of blood collection devices on clinical chemistry assays. Clinical Biochemistry 43: 4-25. doi:10.1016.j.clinbiochem.2009.10.001.

Preanalytical Variables and *In-vivo* Hemolysis

Metabolic Disorders



Physical Agents

Chemical Agents

Infectious Agents

BD


“The results I give the doctor depend entirely on the quality of the sample I receive.”

Conclusions

1. The 3 phases of laboratory testing are: _____.

2. Preanalytical factors are responsible for ___% of laboratory errors.

3. Preanalytical errors can lead to erroneous test results and misinterpretation.

4. Preanalytical errors often result in the need to re-collect samples, longer turnaround time, increased costs, delayed patient treatment, and reduced patient satisfaction.

5. Good phlebotomy technique and awareness of the factors that can affect specimen quality are essential for patient care.

6. Preanalytical factors can affect specimen quality.

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