PRE-ANALYTICAL VARIABLES

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Medical laboratory Technology (MLT)

- Medical Laboratory Technology is the science that deals with the screening, diagnosis, and treatment of various diseases with clinical laboratory tests.

- It plays significant role in the healthcare system and the decision-making of clinical doctors about their patients.

- It works hand in hand with modern medicine to provide right treatment to the patient.

Role of Medical Laboratory

TESTS	EXAMPLES
Screening – asymptomatic	HIV, HBV, HCV, Thalassaemia
Diagnostic – symptomatic	Diabetes, Cancers
Monitoring – on treatment	Cancer, Anaemia
Functioning of vital organs	Liver function test Renal function test Thyroid function test
Diagnosis-bleeding disorders	Coagulation assays
Blood cell count	Complete Blood Count (CBC)
Specialized assays- Cancer, Genetic abnormalities	Flowcytometry, Molecular, Cytogenetic testing

Therefore, laboratory services need to be **accurate, precise and quick**.

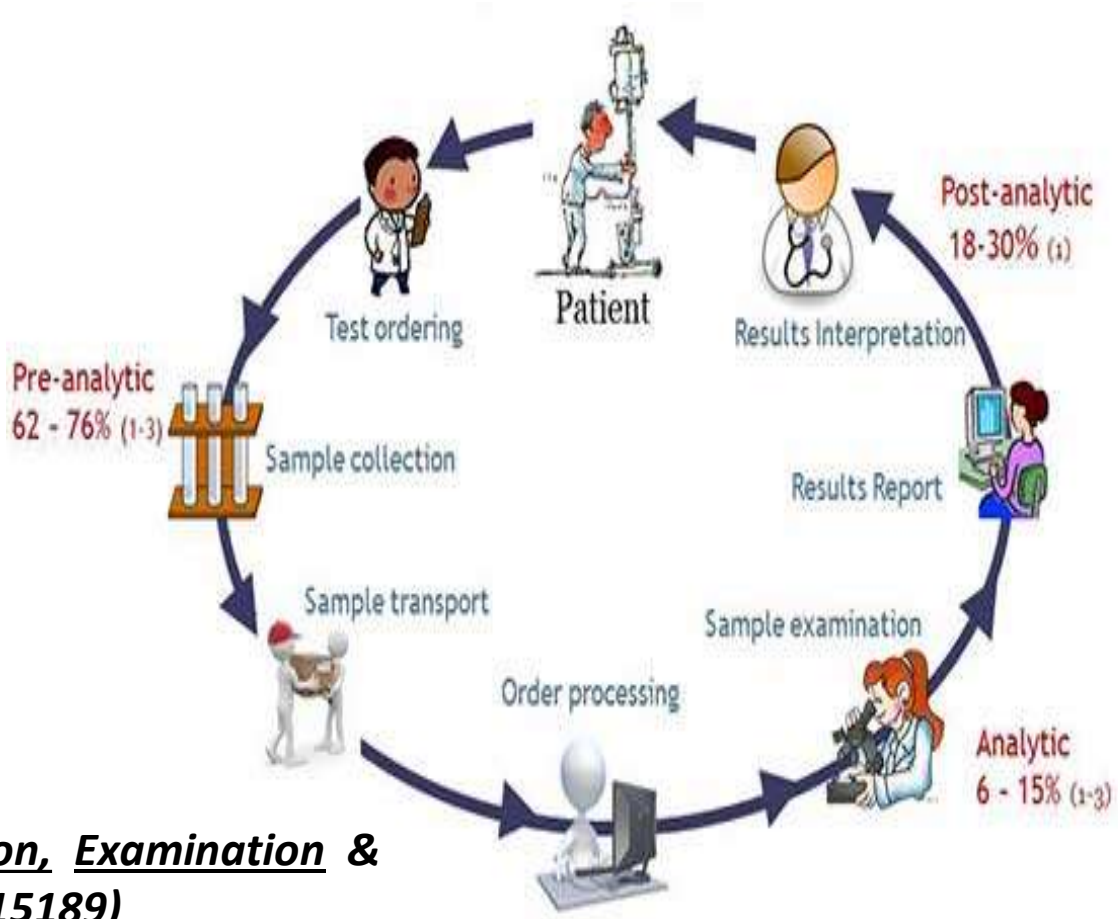
Laboratory testing process

Total testing process in the laboratory is a cyclical process divided into three phases:

Pre-analytical

Analytical

Post-analytical



Now termed as <u>Pre Examination,</u> <u>Examination</u> & <u>Post Examination</u> (As per ISO 15189)

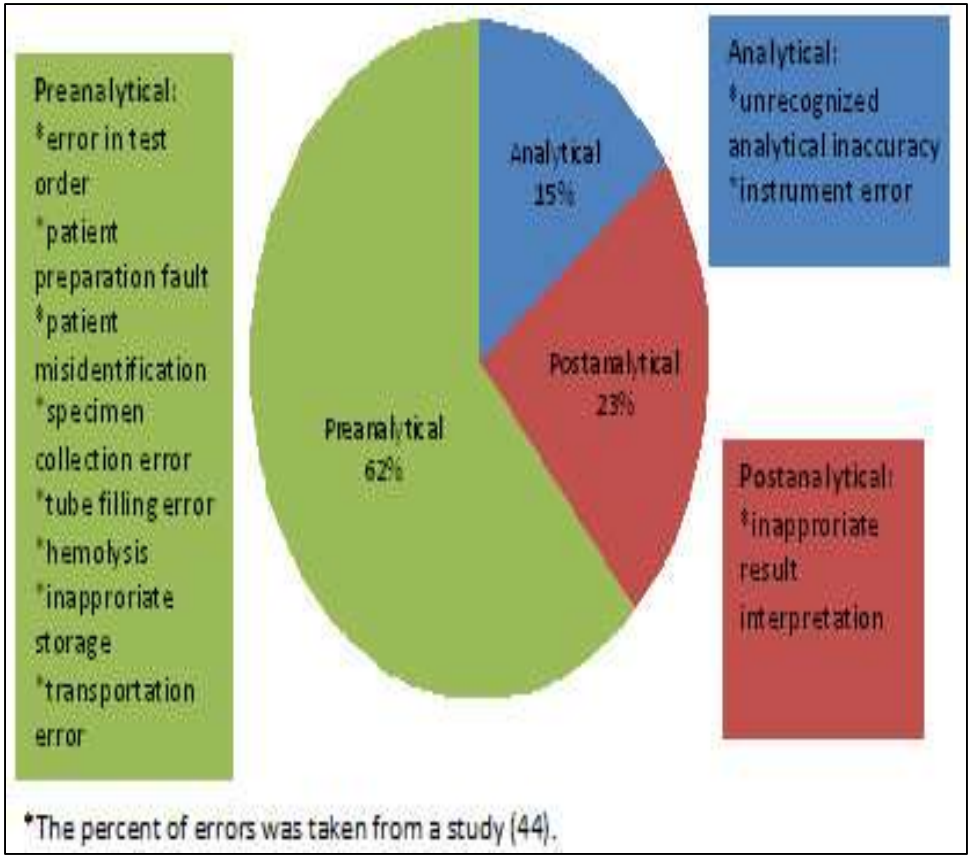
Pre-analytical variables

- Refers to-

Any and all procedures that occur during blood collection, prior to blood analysis.

Pre-analytical errors

- Mistakes during sample collection, transport and processing before analysis.
- Errors in pre-analytical stage: 60-70%
- Analytical & post analytical variables depend on pre-analytical variables



Çuhadar S. Preanalytical variables and factors that interfere with the biochemical parameters: a review. OA Biotechnology 2013 Jun 01;2(2):19

Blood collection - Phlebotomy

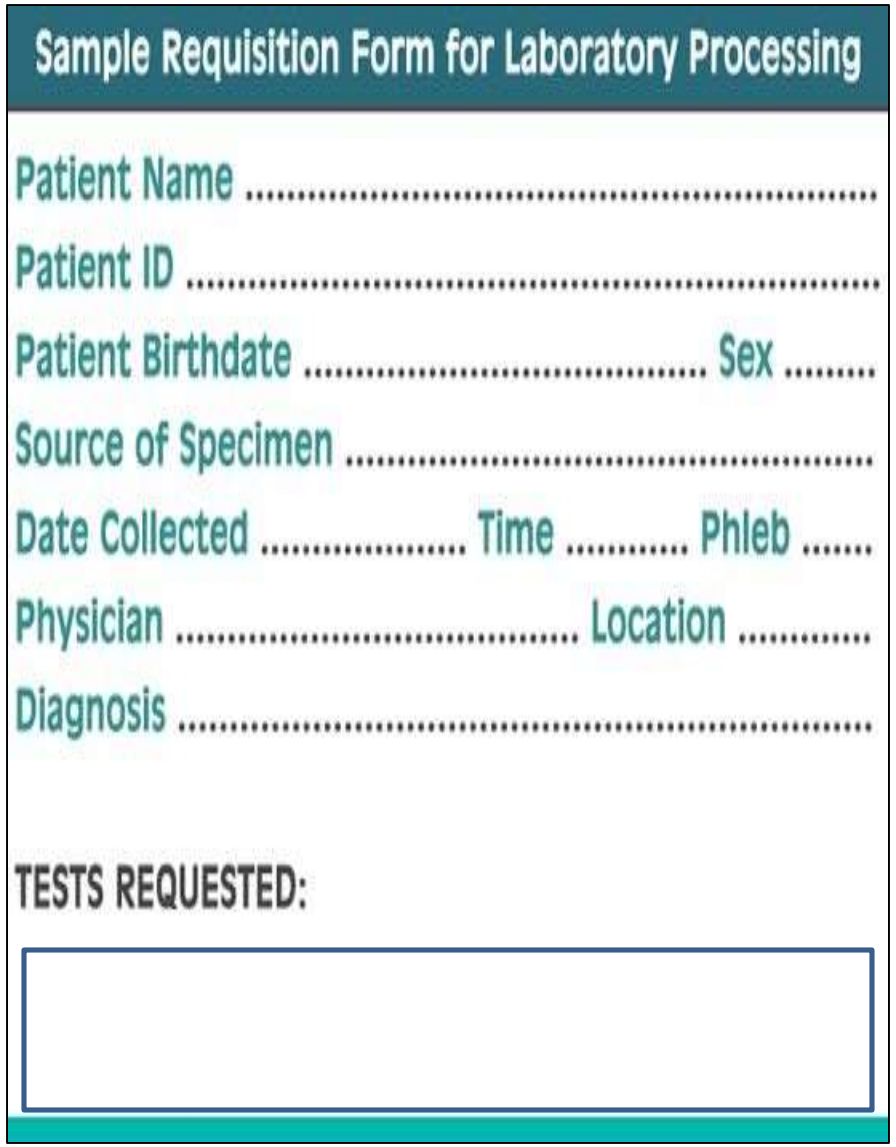
Phlebotomy
Venipuncture
Blood draw
Blood collection

- Phlebos is Greek for “Vein” Tome means to “cut” Phlebotomy means to cut a vein.
- The process of making an incision in the vein is known as **phlebotomy** and the person who carries out the procedure is known as phlebotomist.
- Phlebotomists are responsible for collecting blood samples in appropriate quantity, using right technique and container and transport them to the laboratory for testing.

Primary sample collection variables

- Patients Identification
- Patient preparation
- Labeling of tubes
- Site selecting and preparation
- Proper venipuncture technique
- Tourniquet application and time
- Order of draw
- Proper mixing
- Correct specimen volume
- Proper tube handling and specimen transporting
- Sample processing

Test requisition form


Sample Requisition Form for Laboratory Processing

Patient Name .....

Patient ID .....

Patient Birthdate ..... Sex .....

Source of Specimen .....

Date Collected ..... Time ..... Phleb .....

Physician ..... Location .....

Diagnosis .....

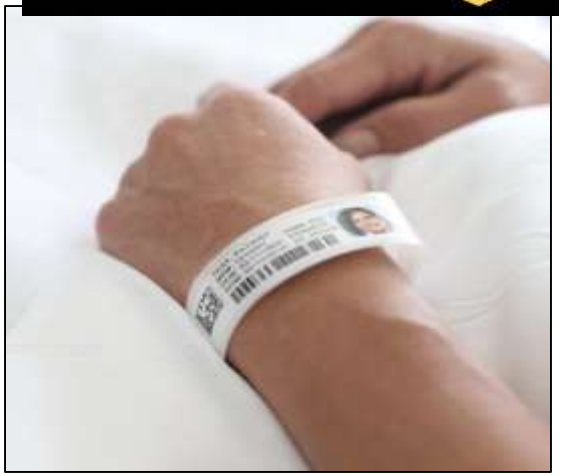
TESTS REQUESTED:

- Patient's name
- Age/Gender
- Patient's ID number
- Name of requesting doctor
- Nature and Source of specimen

  (This information must be given when requesting microbiology, cytology, fluid analysis, or other testing where analysis and reporting is site specific)
- Relevant clinical history/provisional diagnosis
- Investigations requested
- Date and time of collection
- Sign of phlebotomist

Patient Identification

- The most serious error is failure to properly identify the patient.
- Two patient identifiers must be present. Name and identification number are the most common.
- Mis-identification of the patient may lead to inappropriate testing or inaccurate result reporting.



Patient preparation

- Prior to sample collection for chemistry, certain pre-analytical variables need to be considered.

For example: for glucose and cholesterol test patient need to be fasting for at least 10- 12 hours (overnight fasting) prior to venipuncture.

- Patient's posture : Specimens should be drawn with the patient seated comfortably in an appropriate chair or lying down.

Gabriel Lima-Oliveira, Patient posture for blood collection by venipuncture: recall for standardization after 28 years, https://doi.org/10.1016/j.bjhh.2017.01.004

Labeling of tubes

Manual labeling:

- Handwritten labels and request forms leads to highest frequency of errors.

- Hand written labels are-

  laborious

  time consuming

  leading to potential transcription errors

Labeling of tubes

- This can be eliminated by barcode technology.

Barcode labelling

Wrong way of labelling

Right way of labelling

Labeling of tubes

- Blank tube loaded in independent drawers in front.
- Prints label
- Prepares patient kit as soon as data received from LIS/HIS.
- Wrong tube loading detector.

Advantages:

- Verifies correct labelling
- Decreased labelling errors
- Less human intervention
- Increases speed of labelling
- Cost effective

Automated Phlebotomy tube labeller

Proper venipuncture technique

Equipments required:

- PPE (Personal protective equipment)
- Disinfectants
- Tourniquet
- Needle holder
- Needles
- Butterfly needles
- Evacuated tubes
- Cotton swabs
- Band-Aid
- Sharp disposal container
- Waste disposal bags

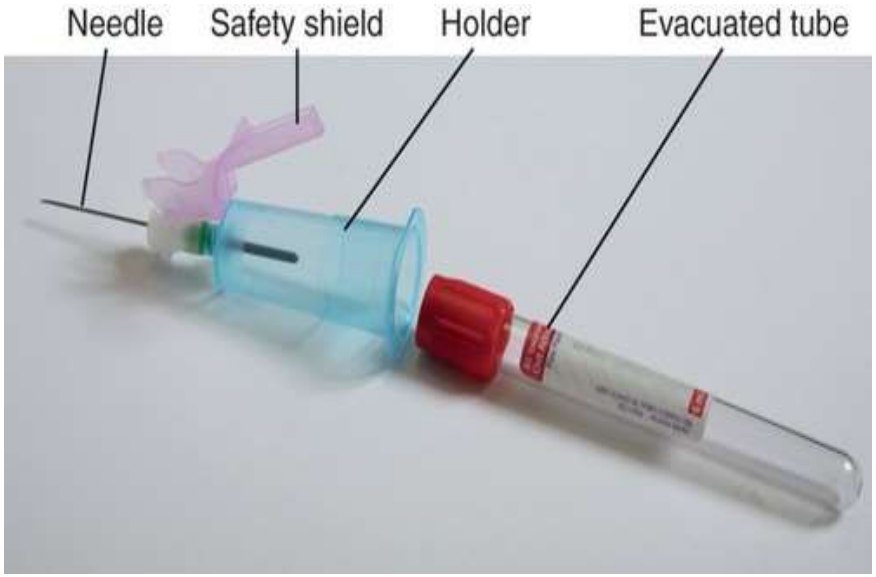
Multi sample needles

- Needle Size / Gauge: Diameter of the needle.
  Size :16G – 25G colour coded
  Routine: 21/22G Children: 23G
  The larger the number the smaller the diameter.

Multi sampler blood collection needle

- Double pointed needle. The hub screws into the needle holder. Open with a twist motion.

- Provides a simple, effective way to collect blood and reduce the possibility of accidental needle stick injury.



safety-engineered, multisample blood collection

Evacuated tubes

Colour code guides to choose appropriate additive.

- Used to collect blood sample.
- Plastic tubes sealed with a rubber stop and contains preformed vacuum.
- Blood is drawn automatically into the tube by vacuum until the required amount is collected.
- Grants a higher safety to user & environment.

ORDER OF DRAW

- To avoid cross-contamination of additives between tubes
- To ensure accuracy of test results

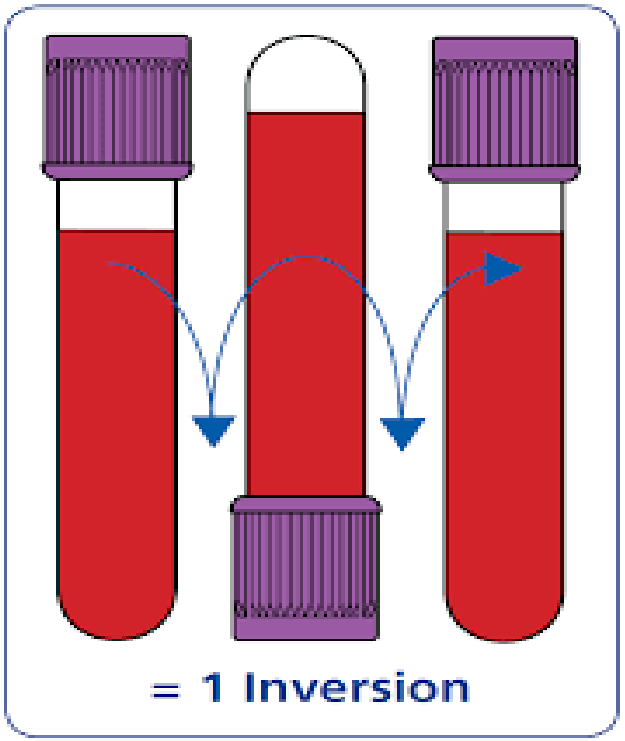
1) Blood culture
2) Sodium citrate (Coagulation/ESR)
3) Serum tubes with or without clot activator or gels
4) Heparin tube with or without gel
5) EDTA tube (Ethylenediaminetetraacetic acid)
6) Sodium fluoride/potassium oxalate

DO NOT TRANSFER

Expiry date should be regularly checked.

Proper mixing

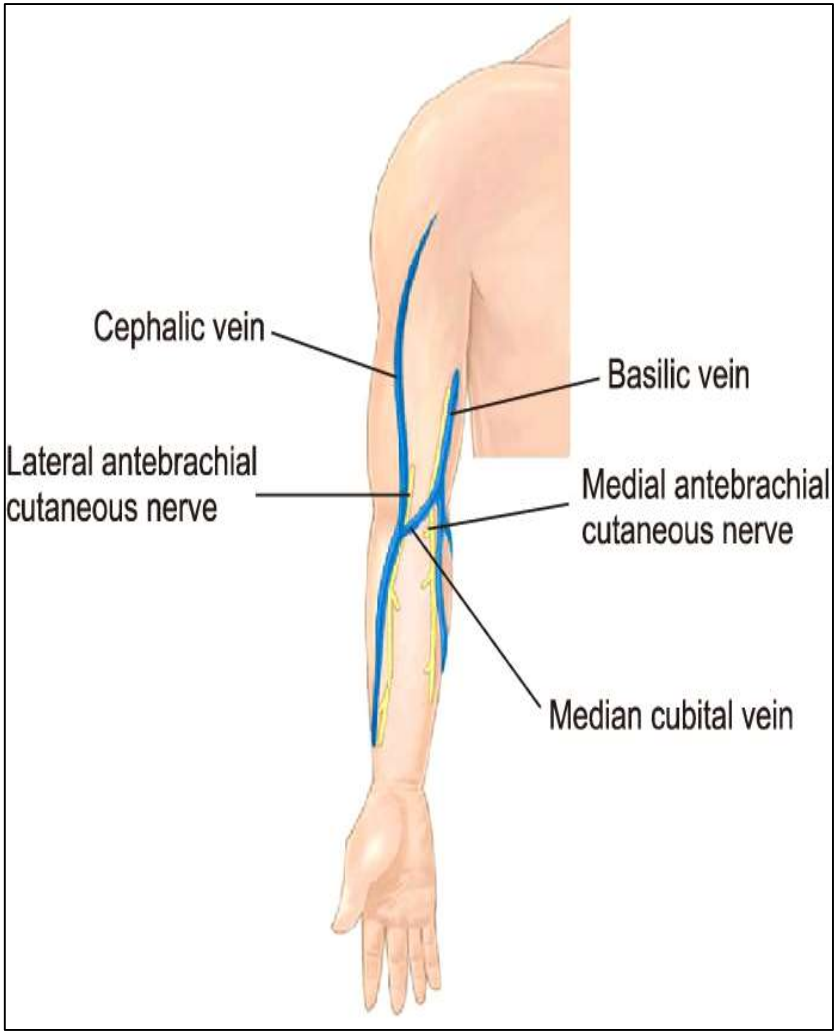
- Blood should be mixed with anticoagulant as insufficient mixing can cause clotting of sample.
- Mix blood by 8-10, end to end inversion of tubes.
- Avoid shaking of blood.



Site selection

Different veins can be selected for phlebotomy such as,

- Median Cubital vein
- Cephalic vein
- Basilic vein (avoid if possible as it is closest to the brachial artery and median nerve)
- Wrist veins (top and side only)

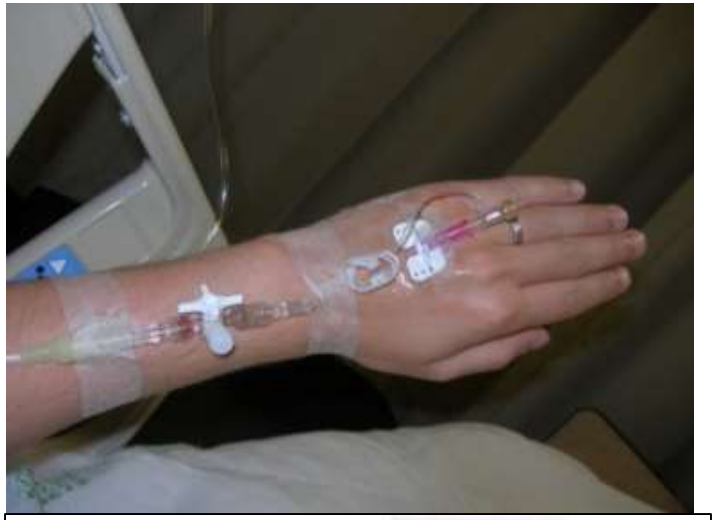


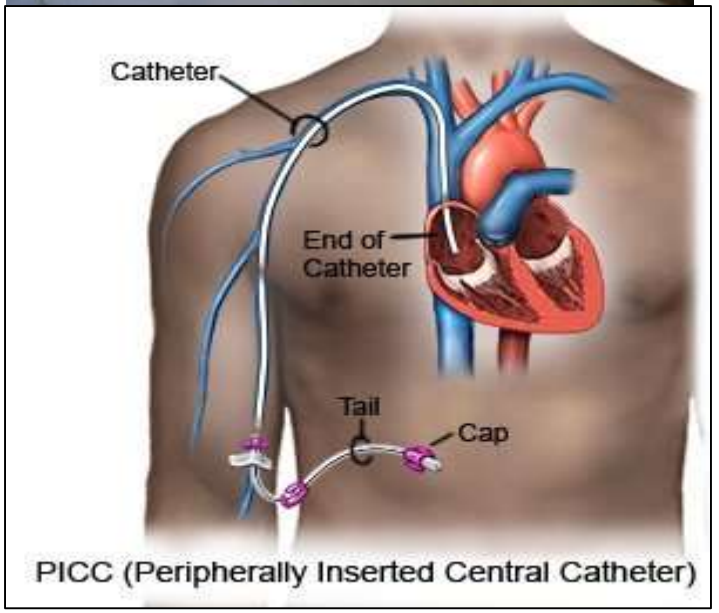
Sites to be avoided

Avoid the arm with:

- Extensive scarring
- Hematoma
- Skin infection
- On the same side of mastectomy
- Intravenous (IV) infusion,

(Try other arm or if blood is obtained from IV or PICC line, discard first 2ml prior to collection. Documentation to be done.)





PICC (Peripherally Inserted Central Catheter)

Tourniquet application and time

- Tourniquet tied too close to vein puncture site - hematoma.
- Tourniquet is tied too high (>3-4 inches above venipuncture site) - veins may not become prominent
- Tourniquet left for > 1 min - hemoconcentration, affecting some test results.
- Tourniquet should be released as soon as blood flow is established.

Site preparation

Prior to venipuncture-

- The site should be cleansed with
  70% isopropyl alcohol,
  2% tincture of iodine
- Cleansing in concentric circles.
- Allow to air dry. Do not blow the site.

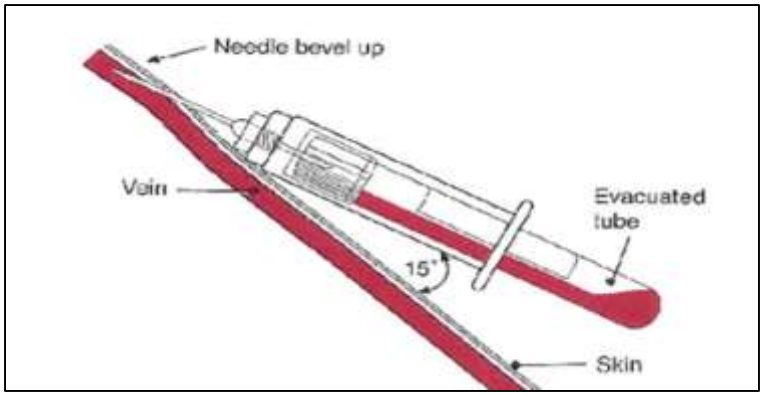
Note:

Alcohol if not dried - -hemolysis.

Tincture iodine -- may falsely increase levels of potassium, phosphorus or uric acid in laboratory testing.

Venipuncture

- Select appropriate needle
- Perform venipuncture
- Collect the blood in evacuated tubes.
- Release tourniquet
- Apply dry cotton swab over the needle and remove it gently, push safety shield over the needle
- Discard the needle in sharp container
- Check that bleeding has stopped
- Discard this cotton swab in yellow biohazard bag
- Apply band-aid
- Let the patient wait for 5-10mins.



Correct specimen volume

Blood samples for Coagulation assays
9part blood + 1part Sodium citrate

Underfilled tubes

↓

Excess

Sodium citrate

↓

Consumes Ca+2 present in reagents

↓

Prolongation of PT & APTT

Overfilled tubes

↓

Lowers

Sodium citrate

↓

Micro clots in sample

↓

Shortening of PT & APTT

Blood collection: Hct > 55%

- For coagulation testing:

  When the haematocrit >55%

  (polycythaemia, dehydration, burns, heart or kidney problems, diarrhea, smoking, high altitudes etc.)

  The blood:citrate ratio should be adjusted as follows:

$$C = (1.85X10^{-3}) (100–HCT) V$$

where C is the volume of sodium citrate in ml,

V is total volume (3ml)

HCT is the hematocrit in %.

Specimen handling and transporting

- Staff must be trained in the safe handling practices and decontamination of spills.

- Laboratory requisitions must be protected from contamination with specimen during transport.

- Proper transport ensures quality of sample and minimizes potential biohazards to staff handling the specimens.

Specimen handling and transporting

Some specimens should be transported without delay for testing.

Eg:

- Arterial blood gases (ABG) and Ammonia -

  transported on ice bag

  analyzed within 15-30mins of blood collection.

- Coagulation assays –

  transported at RT (20-25ºC)

  analyzed within 2hrs of blood collecton.

Proper handling and transport of specimen

- **Temperature**: Temperature logger for maintenance and record of cold chain during transport.

  ABGs, Ammonia – on ice

- **Transport container**:

  All specimens must be placed into leak-proof, non-breakable containers and labeled in accordance with the hospital guidelines.

Sample transport

Pneumatic transport system

Sample rejection

Quantity not sufficient

Clotted sample

Hemolysed sample

wrong anticoagulant

Mismatched sample

Sample processing

Centrifugation:

- Biochemical analysis:

➢ Specimens for serum or plasma chemistry testing should be centrifuged and separated within 2 hrs of collection at 3000 rpm for 10mins.

- Coagulation assays:

➢ Coagulation samples to be transported within 1hour of collection.

➢ Centrifuged at 2000g for 10mins to obtain Platelet-poor-plasma.

Minimizing pre-analytical errors

- **Steps labs can take:**

- Phlebotomy education.
- Using appropriate technology.
- Choosing appropriate equipments.
- Adhering to standard guidelines.
- Developing clear, written procedures.
- Validating any new instrument or procedure.
- Monitoring quality indicators in the lab.

Conclusion

Good laboratory practices

Compliance with quality policies
(for error prevention)

Reduction in pre-analytical errors

VICTORY LIES IN CAREFUL PREPARATION

Thank You