الهيئة السعودية للتخصصات الصحية
Saudi Commission for Health Specialties

الجمعية السعودية للكيمياء السريرية
Saudi Society for Clinical Chemistry

Guidelines For Venous Blood Collection

For Clinical Laboratory Investigations

FIRST EDITION MAY 2018

PREPARED AND EDITED BY THE PREANALYTICAL WORKING GROUP (PAWG)

Dr. Waleed Al-Tamimi, King Abdulaziz Medical City, Riyadh

Dr. Rana M. Hasanato, King Khalid University Hospital, Riyadh

Dr. Maysoon S.Mutabagani, King Fasial Specialists Hospital, Riyadh

Ms. Hind Abdulhakim, King Fahd Armed Forces Hospital, Jeddah

Dr. Ali Binhawan Military Hospital, Khamis Mushait

Dr. Ali Omar Hajazi, Kingdom Hospital, Riyadh

Dr. Aparna Ahuja, BD, New Jersey

Mr. Franklin Q Lim, King Fahad Medical City, Riyadh

Mr. Meshaal Hamed Al Malki, Al Hada Military Hospitals Taif

Dr. Sumedha Sahani, BD, Dubai

Mr. Muhsen Alkurdi, BD, Riyadh

Ms. Rabab Bajahmom, Johns Hopkins Aramco Healthcare, Dhahran

Ms. Safia Banajh, King Fahad Medical City, Riyadh

Ms.Ramou Sarr, King Abdulaziz Medical City, Riyadh

Mr. Nawaf Al-Otibi, King Abdulaziz Medical City, Riyadh

Dr. Salam M. Saadeddin, Prince Sultan Military Medical City

Dr. Musaed Alshalan, Prince Sultan Military Medical City

MESSAGE TO THE READER

The fundamental criteria for blood collection for the purpose of conducting clinical laboratory procedures are:

- That the blood specimen collected must be of good quality and appropriate for the laboratory tests required to be performed.
- That the individual whose blood is being collected must be comfortable and must come to no harm as a result of the blood collection procedure.
- That the healthcare worker collecting the blood specimen must be protected from exposure to the blood through needle stick injury or any other means.

International guidelines for blood collection have been published by nodal bodies such as the W.H.O. and CLSI. However, adoption and implementation of these in the healthcare arena varies for several reasons, and the three criteria stated above are frequently not met. Given the fact that training and practices differ in every country and setting, it becomes imperative to provide guidelines that take into consideration differences in culture, health services infrastructure, understanding of the procedure, training skills and availability of materials. This would ensure that best practice guidelines that are relevant for the country are easily available, the use of which would progressively support correct and safe venous blood collection.

The Kingdom of Saudi Arabia (KSA) has several nodal bodies at the government level that provide a regulatory framework for all healthcare institutions and facilities. These include CBAHI, Ministry of Health (MoH) and Saudi Commission for Health Specialists (SCFHS). KSA also has a unique consideration in terms of supporting a large number of pilgrims throughout the year; the inflow peaks in specific periods. To support the healthcare needs of pilgrims, the health system in KSA has dedicated and voluntary resources; suitable training for those assigned blood collection responsibilities is desirable and efforts are made to provide the same.

The Saudi Society for Clinical Chemistry has taken the initiative for creating recommendations for Guidelines for Venous Blood Collection for KSA, keeping in view the absence of national guidelines for this important procedure. As such, Clinical Chemistry test procedures are the most frequently ordered and performed laboratory tests with the greatest propensity to impact patient safety, making this laboratory specialization one of the key stakeholders in measures to improve practice.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the Saudi Society for Clinical Chemistry in preference to others of a similar nature that are not mentioned.

These guidelines were produced to improve the quality of blood specimen collection and the safety of phlebotomy for health workers and patients, by promoting best practices in phlebotomy. I would like to take this opportunity to thank all members of the Preanalytical Working Group of the Saudi Society for Clinical Chemistry for their hard work to review this guideline. I would like also to thank members of BD (Becton Dickinson) company for their efforts and full support to make this guidline existence.

Last but not least, we hope that this guideline will be accepted and reviewed by our professional colleagues all over the world and we will welcome comments and suggestions for improvement in our consistent endeavor to develop and advance healthcare system in our country.

Dr. Waleed Altamimi
Chairperson,
The Preanalytical Working Group of the
Saudi Society for Clinical Chemistry

CONTENTS

Introduction 07

Prerequisites for Healthcare Professionals performing Blood collections 09

- **Personnel Categories** 09
- **Qualifications** 10
- **Certifications** 10

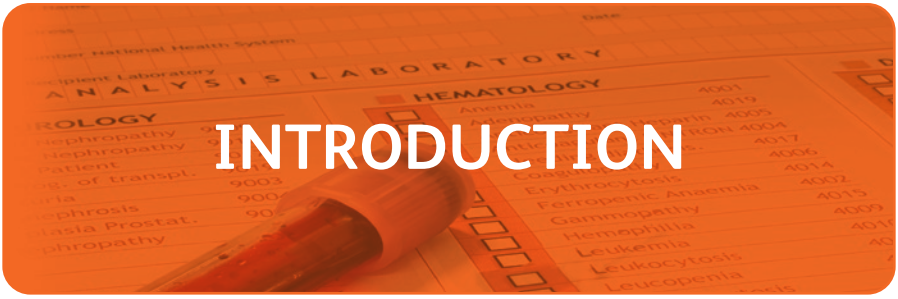
Best Practices in Venous Blood Collection 11

- **Location, Equipment and Supplies** 11
  1. Properties of Blood Collection Area 11
  2. Venipuncture Chairs 12
  3. Specifications of Locker / Trolley / Tray of Blood Collection 13
     - Locker / Trolley 13
     - Blood Collection Trays 13
  4. Supplies Used in Blood Collection 13
     - Gloves 14
     - Tourniquet 14
     - Antiseptics with and without Alcohol 15
     - Cotton and/or Gauze Pads 15
     - Needles, Holders and Winged Blood Collection Set 16
     - Syringe Systems 17
     - Evacuated Blood Collection Tubes 18
     - Adhesive Bandages 20
     - Sharps Container 20
     - Test Manual 21
     - Other Supplies 22

Procedures of Blood Collection **22**

1. Hand Hygiene 22
2. Review of Tests Requested for the Patient and Preliminary Preparations 23
3. Patient Identification 23
4. Examination of the Patient State Suitability for Blood Collection 25
5. Preparation of the Equipment 28
6. Positioning the Patient for Blood Collection 28
7. Wearing Gloves 29
8. Selection of Venipuncture Site 29
9. Applying Tourniquet 30
10. Asking the Patient to Clench Fist 30
11. Selection of the Proper Vein 30
12. Cleaning Venipuncture Site 31
13. Anchoring the Vein 32
14. Performing Venipuncture 32
15. Observing Blood Flow, Releasing the Tourniquet and the Fist 32
16. Order of Draw by the Tube Specifications and Tube Filling 33
17. Removing and Mixing the Tubes 34
18. Removing the Needle, Ensuring Safety & Pressure on Venipuncture Site 34
19. Tube Labelling 35

References **38**



INTRODUCTION

Laboratory test results have a critical role in providing clinical decision support for the patient. Two-thirds of decisions to be taken about diagnosis, drug therapy initiation, treatment follow-up, hospitalization and discharge of the patient depend on laboratory test results.[1] However, errors in laboratory test results are one of the most significant reasons for inappropriate clinical decisions that may influence patient outcomes, and are directly or indirectly a rising cause of malpractice claims. A laboratory test is an extremely complex process and composed of three phases: preanalytical phase, analytical phase and postanalytical phase.[2-4] Preanalytical phase is the phase which commences outside of the laboratory but must be under the control of the laboratory; it includes selecting and requesting tests which are applicable for patient's clinical status and collecting, transporting, processing, and preparing the specimen in accordance with the analysis.[2] The process always begins and ends with the patient. Preanalytical phase can be further divided into three stages, namely, before, during and after collecting the sample.[5]

The focus in terms of reliability of laboratory test results and malpractices has traditionally been on the analytical phase, i.e., the actual analysis and generation of clinical or diagnostic information specific to the sample analysed. However, in recent years, with deeper understanding of what can go wrong, there is a consensus that most of the errors related to laboratory test results root in staff practices and appear in the preanalytical phase, occurring before the specimen reaches the laboratory bench.[6-8]

Venous blood collection is one of the most frequent interventional procedures in healthcare. It consists of numerous well-defined steps, all of which must be followed in order to ensure correct and safe specimen collection as each step has the potential to adversely impact patient safety. In addition, the procedure exposes healthcare workers to the risk of needle stick injury, and the environment to contamination. Among the error sources are: misidentification of the patient/specimen - thus test results are not the results of the real patient;[9] alterations in analyte concentrations due to prolonged tourniquet application; contamination of the specimen with intravenous fluids and / or contrast media;[10] insufficient patient preparation, for instance, effect of the patient's fasting or physical activity status on several blood analytes;[11-12] insufficient specimen volume, which changes the additive to blood ratio and may affect results; and many more.[13] Besides factors that can affect actual sample quality, some poor practices may threaten the safety of both patient and healthcare worker[14], for example, inadequate disinfection of venipuncture site or contamination of a disinfected site due to touching the site after the disinfection step. In addition, the lack of use of personal protective equipment (PPE) by the phlebotomist or improper sharps disposal may cause exposure to blood borne pathogens.

The current document provides a comprehensive overview of all the steps necessary for a standardized blood collection procedure using closed blood collection systems. These recommendations for developing national guidelines are based on CLSI GP41-A6 and W.H.O. blood collection guidelines. Prevailing national regulations have been taken into consideration in these guidelines where relevant. In addition, some user instructions related to blood collection products [BD-Becton Dickinson and Company (Franklin Lakes, NJ, ABD)] and [Greiner Bio-One (Kremsmünster, Avusturya)] that are widely used in our country are also included.

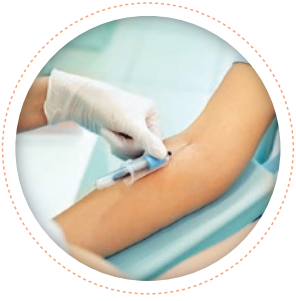
PREREQUISITES FOR HEALTHCARE PROFESSIONALS PERFORMING BLOOD COLLECTIONS

PERSONNEL CATEGORIES

Personnel categories authorised to collect blood from pateints are physicians, nurses and phlebotomists. This is dependent on the roles and responsibilities defined by the institution or healthcare facility. Generally, outpatient blood collections are performed by phlebotomists; inpatient blood collections are performed by nurses and, in many facilities, by phlebotomists as well; physicians in Emergency Department and Critical Care Units perform blood collections. In instances of difficult vein access, nurses and phlebotomists call upon physicians for collecting blood from alternative sites such as femoral vein.

QUALIFICATIONS

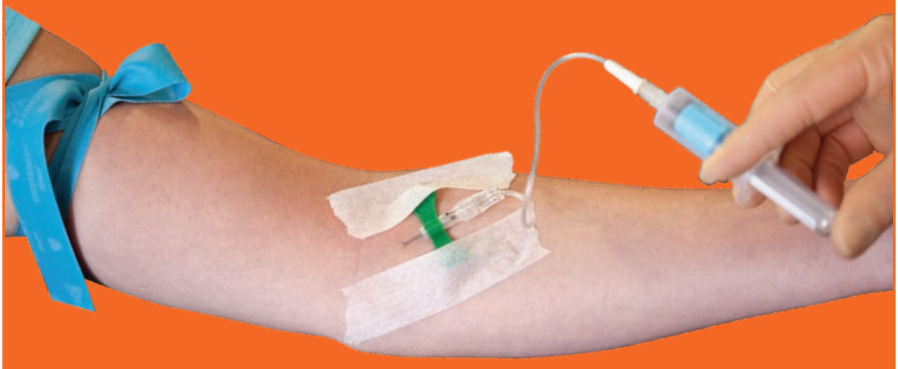
All physicians and nurses are qualified to perform blood collection procedures. Individuals hired as phlebotomists must hold a Bachelor degree in Medical Laboratory Technology or a science stream. The Saudi Commission for Health Specialists (SCFHS) has introduced courses to support the qualification and training of Phlebotomists.



LICENSES AND CERTIFICATIONS

In KSA, individuals hired as phlebotomists or assigned phlebotomy as part of their job profile must be licensed by SCFHS, generally following a licensing examination. It is mandatory for all healthcare workers involved in direct patient work to be licensed. Additional formal certification is not mandatory; however, efforts towards continuous professional development by SCFHS and a few private groups include training, which may be accompanied by certification.

BEST PRACTICES IN VENOUS BLOOD COLLECTION



LOCATION, EQUIPMENT AND SUPPLIES

1. Attributes of a Blood Collection Area

PHLEBOTOMY STATIONS:

Venous blood collection must be performed in a clean, silent, well-lit area which is reserved for this procedure.[15-16] This may be in the form of individual rooms adjacent to each other, or a larger hall divided into small cubicles that are semi closed or fully closed, or bays that are separated by opaque, waterproof curtains. Such a layout accommodates a single patient per cubicle or bay and ensures patient privacy. For inpatients in a ward setting, bed curtains may be used during the blood collection procedure to provide privacy.

LIGHT:

In a typical hospital, clinic or outpatient blood collection setting, natural light – even if present – is not enough for the purpose of illuminating the site of potential venepuncture. Ceiling lights or wall-mounted lamps that provide a warm glow and are positioned such that the path of light is not obstructed by the phlebotomist performing the procedure, are ideal.

WATER SUPPLY:

Availability of a sink or wash basin with running water is recommended. Ideally, one should be available at every phlebotomy station to provide access to good hand hygiene measures. If not available, effective hand sterilization lotions in easy to use dispensers must be present. The newer antiseptic rubs are alcohol-free in order to prevent excess drying of the skin, which itself may cause breach in the skin and the risk of infection. Whether water is used or an antiseptic hand rub, the wearing of PPE in the form of gloves by the staff performing blood collection is a must.

2. Venipuncture Chairs

Venipuncture chairs of various specifications are available; adjustable ones are best. [17] A type that ensures maximum comfort and safety to the patient, with provision for resting the extended arm at the elbow level, preferably with a downward slant is required. Additionally, a chair with a mechanism for raising the height and tilting backwards is recommended. Adjustable with its specifications.

The phlebotomy chair must be placed such that the phlebotomist can access the patient easily. In addition, there must be sufficient space behind the chair to enable it to be reclined in case the patient loses consciousness during the blood collection procedure in order to support patient and protect him/her against falling. [15-16]

3. Specifications of Locker / Trolley / Tray in which Equipments for Blood Collection are Kept

- **LOCKER / TROLLEY**
  They are to be arranged in a manner that the phlebotomist can use it safely and the equipment should be seen clearly and reached easily.[15-16]

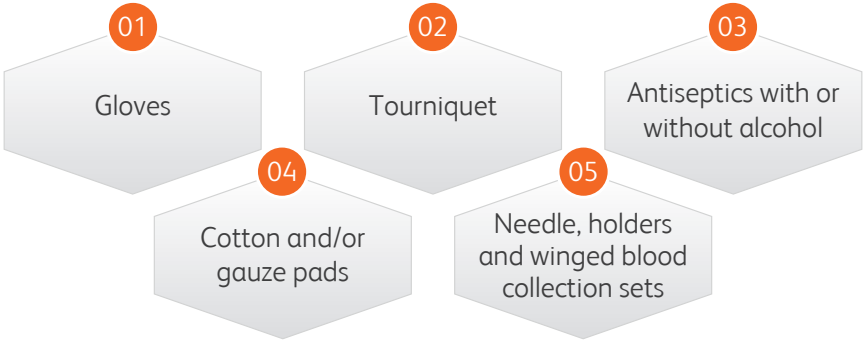
  In case of using trolley, it is recommended that the trolley can move easily and silently on all kinds of surfaces.

- **BLOOD COLLECTION TRAYS**
  They should be light in order to be carried easily and should have sufficient area on which the materials that will be used can be put with ease and should have a segment for the sharps container.

4. Supplies to be used in Blood Collection

Prior to blood collection, working area should be prepared, necessary materials should be easily reached and be controlled with respect to their expiry dates. A well-arranged working area provides the continuity of all processes uninterruptedly.

Every blood collection locker/trolley or tray should involve the following materials:



06 Syringe systems

07 Evacuated blood collection tubes

08 Adhesive bandages

09 Sharps container

10 Test manual

11 Other supplies (ice, aluminium foil, etc.)

- **GLOVES**

The gloves that will be used by phlebotomists should be for single use or disposable and fit the hand of the phlebotomist. It may be latex, vinyl, polyethylene or nitrile.[15]

CAUTION: Serious hypersensitivity reactions and anaphylactic shock cases have been reported in healthcare workers who have latex hypersensitivity. People who have such a hypersensitivity must avoid using latex gloves.[18] It is beneficial to interrogate patients about their latex sensitivity.

- **TOURNIQUET**

There should be tourniquet or a material to be used as tourniquet in order to increase intravascular pressure and stabilise the vein. False access into the veins that become evident or a potential damage to the nerves can be prevented by applying tourniquet.[15]
Tourniquets which are elastic, cloth-type and with a click provides ease of use.

CAUTION: Cleanliness of tourniquets is extremely important. There are studies demonstrating that tourniquets may be potential sources of Methicillin-Resistant Staphylococcus Aureus (MRSA).[19]

- **ANTISEPTICS WITH OR WITHOUT ALCOHOL**

Antiseptic agents should be used in order to disinfect the area to be used. As antiseptic agent, 70 % isopropyl or ethyl alcohol should be used. If blood culture sample will be collected, ready to use pads impregnated chlorhexidine is recommended to be used.

CAUTION: In blood samples which are contaminated with povidone iodine, test results of potassium, phosphorus and uric acid may result in falsely high concentrations.[16]

CAUTION: While collecting samples for alcohol measurements, non-alcohol based disinfectants (such as chlorhexidine) should be used. If alcohol-based disinfectant is absent, the site where the sample is collected should be allowed to dry for 30-60 seconds in order to minimise the risk of interference.[20]

- **COTTON,R GAUZE AND STERILE PADS / SWABS**

For cleaning the site where venous blood sample will be collected, gauzes which are previously folded (e.g. sizes 5 x 5 cm or 7.5 x 7.5 cm) or small pieces of cotton soaked with an antiseptic agent with or without alcohol should be used.

CAUTION: Fibres of cotton balls may remove platelet plugs which have been formed in venipuncture site accessing for venous blood collection. Therefore, it is not recommended to use these swabs following blood collection.[15]

- **NEEDLES, HOLDERS AND WINGED BLOOD COLLECTION SETS**

Needles are classified between 19G-23G according to their size numbers (gauge) and encoded with different colors. Size (gauge) number is inversely correlated with needle's diameter. Large size number corresponds to needles with narrow diameters and small size number corresponds to needles with wide diameters. Needle tips or winged sets with fit sizes in accordance with the site where blood collection is performed, its physical characteristics and blood volume to be collected should be used. Blood collection materials should involve single use, sterile needle tips with different sizes.

As per the EU Council directive (2010/32/EU), all medical devices produced for healthcare workers must be designed as safety engineered with the purpose of ensuring adequate safety and preventing occupational accidents.[21]

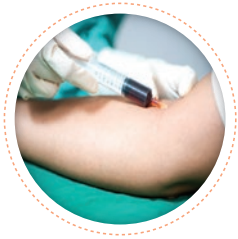
CAUTION: If needle size is greater than the size needed, it may tear the vein and cause hematoma. If needle size is small, blood cells may disrupt (hemolysis) during blood collection and cause false laboratory test results.[15]

With respect to ensure safety of workers, in order to prevent needle stick injuries, it is recommended to use needles which blocks or withdraws itself automatically during its removal from the skin after it is used.[22]

It is extremely important that the holders are completely compatible both with the needle and blood collection tubes used. Regarding the holders, being out of keeping with needles will cause air ingress into the tubes which is likely to result in foaming of samples. It is recommended to use single use or disposable holders, if appropriate.[16]

CAUTION: It should not be forgotten that holders which are not disposable may be contaminated with bacteria or blood. It should be kept in mind that this may create risks for phlebotomists.[16]

During pediatric phlebotomy or in cases that necessitate drawing blood from one of the dorsal veins of the hand, it is recommended to draw blood with winged blood collection sets.[16]



- **SYRINGE SYSTEMS**

Syringe collections must be avoided unless strictly necessary.

CAUTION: Syringe collections are not recommended as they may cause a number of preanalytical changes in the blood specimen during collection.

The tendency to draw strongly upon the piston to fill the syringe rapidly can cause rupture of red blood cells, leading to hemolysis.

So also, while discharging blood from the syringe into one or more tubes, there is a tendency to do so rapidly, particularly if this is done by piercing the tube stopper. This not only contributes to hemolysis and foaming, but also does not guarantee that the correct volume of blood is filled according to the capacity of the tube.

In tubes that contain additives, under filling and overfilling change the blood: additive ratio, that could lead to clotting of blood and potential errors during analysis.

Citrate tubes used for blood collection for coagulation studies particularly need the exact specified volume of blood to ensure the recommended blood: additive ratio in order to get accurate results.

The common method of discharging blood into tubes is by removing the needle from the syringe and opening the tube stopper, which greatly increases the risk of needlestick injury and other contact with the blood. Soiling of outer wall of tubes and blood spills may also occur, posing a risk to other healthcare workers and the environment.

Opening tube stoppers not only increases exposure of the phlebotomist to blood-borne pathogens, but also compromises the vacuum in evacuated tubes; the evacuated tube is not used as intended and blood volumes are frequently incorrect for the quantity of additive present.

If syringe collection is unavoidable, blood transfer into tubes must be done using a safety engineered blood transfer device (BTD). Containing any additive, sample/additive ratio may be affected by less or more amount of blood sample transferred.[15] This ensures that the phlebotomist is not at risk of needlestick injury or exposure to blood in any way.

Syringe collections are the largest contributors to needlestick injuries among healthcare workers, as also to poor specimen quality leading to preanalytical errors.

- **EVACUATED BLOOD COLLECTION TUBES**

Proper selection of evacuated tubes to be used in venous blood collection is among the particular issues related to the preanalytical phase in order to have reliable laboratory test results. These tubes are sterile and produced conveniently to blood collections in previously determined volumes.[15]

With respect to providing proper blood/additive ratio, tubes should be kept under controlled temperature and humidity conditions suggested by the manufacturer and care must be taken not to exceed expiration date.

CAUTION: Tubes exceeding expiration date must not be used.
Tubes that are commonly used in blood collection and their specifications are given in Table 1.

Table 1. Tubes commonly used in blood collection & their specifications

Sample type	Tube type	Additive	Cap color
Blood culture (Whole blood)	Blood culture bottle with variable content	None	Variable
Serum	No-additive tube (glass) Tube with clot activator Tube with gel/clot activator	None Clot activator gel/clot activator	
Plasma	Tube with lithum or Sodum heparin Tube lithum heparin and gel Tube with mechanical separator	Lithum or sodum heparin Gel lithum heparin Mechanical separator lithum heparin tube	
Glucose tube	Glucose tube Coagulation tube Heparin tube	Sodium fluoride/potassium oxalate; Sodium fluoride/ EDTA Sodium fluoride/ Sodium heparin iodacetate/ lithium heparin Sodium citrate (9:1) Sodium heparin Lithium heparin	
Whole blood	Tube with EDTA	EDTA K2 EDTA K3	
	ESR (sedimentation) tube	Sodium citrate (4:1)	

EDTA; Ethylenediamine tetraacetic acid, ESR; Erythrocyte sedimentation rate, (9:1), (4:1); blood/additive ratio

Tubes are produced using glass or plastic material. It is recommended to use tubes made of plastic material with respect to healthcare worker's safety.[15]

- **ADHESIVE BANDAGES**

Following blood collection, sterile adhesive bandages (must be hypoallergenic) and/or gauze should be present in order to provide bleeding to stop.[15]

CAUTION: In infants under 2 years of age, adhesive bandages may cause skin irritation. In addition, since infants have the risk of removing the tape from the skin and swallowing it, it is not recommended to use adhesive bandages.[23]

- **SHARPS CONTAINER**

Sharps bins are containers made of impenetrable material that is durable and not susceptible to perforation, tear and crush, is impermeable to water and leak proof, and is impossible to open and be rummaged. It is ideally made up of reinforced synthetic polymer or fibre material. It may aslo be made of plastic laminated cardboard in the form of a strong carton. In compliance with W.H.O. directives, it is mandatory for sharps containers to have an international biohazard sign as well as the statement "**Attention, Sharps Waste**" on all visible surfaces of the container. Further, a maximum filling of 3/4 of the capacity is permissible, following which the container must be sealed and discarding as per the policy and procedure of the institution. Containers must not be pressed, opened, emptied and recycled after filling.[24]

• TEST MANUAL

A clinical laboratory test manual containing succinct and comprehensive information for all test procedures must be available to any staff performing blood collections for submission to a laboratory. The preanalytical requirements must specify, at a minimum, need for patient preparation (e.g., fasting for 12 hours)sample type, tube/additive type, tube capacity, minimum blood volume acceptable, specimen transport conditions required, specimen rejection criteria and turn around time. Additional information on availability of preliminary test results and the time period for the same, if applicable, is desirable. Good laboratory systems ensure these best practices and these are stipulated by the majority of regulatory authorities.

• OTHER SUPPLIES

For some analytes, it is needed to transfer and centrifuge the sample under particular conditions.

ICE: Samples collected to test for analytes which lose their activities or degrade with temperature (ammonia, lactate, pyruvate, gastrin, renin, parathyroid hormone, catecholamines, adrenocorticotropic hormone, free fatty acids, acetone, ACE) should be kept in chilled environment.[15-26] With this purpose, there should be ice or refrigerated cabinet system.

CAUTION: It is recommended to put the sample into ice-water mixture to keep it cold. It is not recommended to keep the sample directly on ice or dry ice in order to avoid hemolysis. If samples are kept in cold for more than 2 hours, potassium should not be tested.

ALUMINIUM FOIL: Samples collected to test for analytes which lose their activities or degrade with light (bilirubin, carotene, methotrexate, porphobilinogen, porphyrins, pyridoxal 5-phosphate, vitamin A, B1, B2, B3, C, E and K1) should be transferred to the laboratory in a manner that they are covered with aluminium foil and kept in dark until the analysis.[15-27]

PROCEDURES OF BLOOD COLLECTION

1. Hand Hygiene

Phlebotomist must disinfect his/her hands with water, soap or alcohol-based solution or foam prior to the first contact with the patient. By this procedure, contamination of all surfaces touched by the phlebotomist during the contact with the patient is prevented.

If hands are washed with water and soap, soap should be rubbed covering all surfaces of the hands and fingers at least for 15 seconds and after rinsing with water they should be dried with a single use disposable towel.[28]

For decontaminating by scrubbing with alcohol-based solution, hands should be rubbed until they dry completely in a manner that the solution should contact all over the hands and fingers.

2. Review of the Tests Requested for the Patient and Preliminary Preparations

Tests requested by the clinician may be written and/or in electronic media. Necessary clinical pre-information and demographic information should be in written request forms and/or included in electronic media - Hospital Information Management System (HIMS) and Laboratory Information Management System (LIMS).

It is recommended that the information needed to be included in test request forms and/or electronic media should be arranged according to the requirements of ISO 15189.[25] Test request forms and/or electronic media should include the following information:

- Full name (first, second & surname), gender, date of birth, contact information (full address and phone number), TR identity number of the patient and the patient number.
- Clinician who requested the test and his/her contact information.
- Tests requested.
- Diagnosis, prediagnosis and other information that can be used in laboratory analysis and results interpretation (tests which require special preparation, drug treatments that the patient is receiving, etc.).
- Blood collection date and time.

3. Patient Identification

Patient authentication is a must for the phlebotomist in order to be able to be sure that the sample is collected from the right person. Dormant but conscious inpatients must be asked definitely, and must not rely on patient dossier or patient's record tags on/near the bed.[15]

1) Authentication of conscious and reachable patients.[15]

- At least (tow patient identifiers) the name and surname should be asked for patients who are outpatient or conscious inpatients (date of birth and/or TR identity number may also be asked). Name and surname of the patient should be asked directly (What is your name and surname?).
- Accuracy of information gotten from outpatient should be matched with the information written on the request form, labels of sample container and/or electronic records and accuracy of information gotten from inpatient should be matched with the patient's wristband.
- If inconsistency is observed between the two information, responsible person for phlebotomy unit or ward responsible nurse should be informed about the issue and blood sample is not to be collected definitely.

2) Authentication of the patients who is conscious and communication is not possible (children, foreign national or disabled persons).[15]

- At least (tow patient identifiers) the name and surname of outpatient and inpatient should be asked (date of birth and/or TR identity number may also be asked) to patient's relative (legal nominee, translator).
- Accuracy of information gotten from outpatient should be matched with the information written on the request form, labels of sample container and/or electronic records and accuracy of information gotten from inpatient should be matched with the patient's wristband.
- If inconsistency is observed between the two information, responsible person for phlebotomy unit or ward responsible nurse should be informed about the issue and blood sample is not to be collected definitely.

3) Authentication of sleeping, confused or comatose patients.[15]

- A patient who is sleeping must be awakened before blood collection. At least (tow patient identifiers) the name and surname should be asked to patients (date of birth and/or TR identity number may also be asked). Name and surname of the patient should be asked directly (What is your name and surname?).
- In comatose or confused patients, authentication should be made by controlling wristband information.
- Accuracy of information gotten from the patient should be matched with the information written on the request form, labels of sample container and/or electronic records and accuracy of information gotten from inpatient should be matched with the patient's wristband.
- If inconsistency is observed between the two information, ward responsible nurse should be informed about the issue and blood sample is not to be collected definitely.

NOTE: patient identification for blood bank testing and blood transfusion request must be performed by TWO different health care provider.

4. Assessment of Patient Status Suitability for Blood Collection

In order to have true test results, it is critically important to interrogate and prepare the patient before blood collection. It may be needed that the patient should be in fasting or full, comply with particular treatment protocols, and blood should be collected after the patient rests for a certain time, etc. (Table 2).

Table 2. Query of the suitability of the patient prior to blood collection

Query	Question	Test	Explanation	Cap color
Fasting (8-12 hours)	When was the last time you eat?	All Biochemistry laboratory tests	Many of the laboratory tests are affected by the nutrients taken within the diet. In addition, lipemia emerges in samples collected in the postprandial period may also cause false results in laboratory tests that are not related to fasting. Since most of the drinks include glucose as an ingredient, it may falsely elevate the glucose levels tested. Therefore, before collecting blood, the patient can be allowed only to drink water.	28, 29, 31
Patient's position	Resting for 15 minutes prior to blood collection or not?	All laboratory tests	Physical activity of the patient increases releasing of various hormones stimulating protein, lipid & carbohydrate synthesis (catecholamines and corticosteroids). In test requests including these hormones, special attention should be paid to patient's resting.	32
Treatment	Are you receiving any anticoagulant (blood thinner) drug?	Coagulation tests: PT, INR, thrombophilia screening tests (lupus, anticoagulant, protein S, C, activated protein C resistance)	If the patient has received any anticoagulant drug, blood should not be collected.	33

Query	Question	Test	Explanation	Cap color
Treatment	Did you receive oral or IV ferritin drug within the last 10 days?	Serum ferritin	Using ferritin drug before giving blood or discontinued treatment a short while ago leads to get false high ferritin results.	32
Treatment	What is the name of your drug? When did you receive the last dose?	All drug levels (monitoring therapeutic drugs)	In order to monitor therapeutic drugs, blood should be collected after the drug reaches a stable level in blood. Hence, blood sample should be collected just before the next dose.	34
Treatment	When did you receive the last dose of your levothyroxine drug?	TSH, free T4, total T4	For levothyroxine dose received before giving blood affects TSH, free T4 and total T4 concentrations, it should not be taken.	35
Female hormones	Which day you are in your menstrual cycle?	LH, FSH, E2, progesteron e, hCG	Concentrations of female reproductive hormones vary according to the day of menstrual cycle.	32
Treatment	What time did you eat your meal? Did you receive your treatment (insulin or oral antidiabetic agent)?	Glucose (postprandial)	When postprandial glucose concentration is measured, the patient should maintain his/her regular diet and regular drugs. Behaviours out of usual practices cause false glucose test results.	36

5. Preparation of the Equipment

According to the qualification of the test requested, all of the equipment and materials should be prepared before blood collection.

- Blood collection tubes with different volumes and containing different additives may be used according to the requested test qualifications. Tube volumes should be in accordance with the number of tests.

CAUTION: In person from whom blood is collected frequently, blood collection may cause anemia.[39]

- Needles with proper sizes (21G, 23G, 25G etc.) are used according to the physical characteristics and location of the vein, blood volume to be collected as well as patient age. Needles of different sizes should be carried.

CAUTION: Improper needle sizes may cause hemolysis of the sample.[39]

- Winged blood collection set for collecting blood sample from children and patients who have fragile & damaged veins
- Needle holder
- Tourniquet
- Cotton
- Disinfectant agent with (ethanol, isopropyl alcohol) or without alcohol (benzene)
- Adhesive bandages
- Sharps container

6. Positioning the Patient for Blood Collection

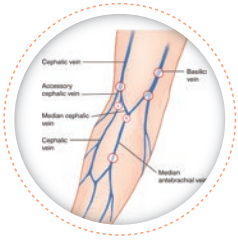
Patient's arm should place on the armlet of the chair in a stretching position. Arm should be supported very well by the armlet and not be bended from the elbow.

Regarding a patient who is laying down, it should be ensured that he/she is comfortable in decubitus position. If he/she needs an

additional support, a pillow should be placed under the arm where venous access will be performed. The patient should be asked to stretch his/her arm from the shoulder to the wrist to create a straight line.[15]

7. Wearing Gloves

Phlebotomists must wear gloves. New gloves must be used for each patient. Gloves should be warn before applying tourniquet.[15-16]



8. Selection of Venipuncture Site

Anterior view of the elbow and interior part of the arm where there are large veins localizing just under the skin (antecubital fossa) are the preferred sites in blood collection. If these veins are not suitable, veins in the dorsum of the hand may be preferred for venous blood collection.

CAUTION: While selecting a venous blood collection site, it should be paid attention to the following considerations:[15]

- Avoiding areas recovered from burn (areas with large scars).
- Before collecting blood from the arm on the side of mastectomy, clinician should evaluate the patient with respect to complication of lymph stasis.
- Samples collected from a site with hematoma may result in error. Blood should not be collected from a site with hematoma whatever its size is. If other sites are not available, blood should be collected from the site where hematoma ends.
- Sample should be collected preferably from the arm with intravenous vascular access.
- From the arms with cannula, fistule, vascular grafting, blood should be collected after the assessment of the clinician.

9. Applying a Tourniquet

In order to increase intravascular pressure, tourniquet must be applied before venous access. Increasing intravascular pressure eases palpation (tactual perception) of the vein. Tourniquet should be applied 7.5-10.0cm (3-4 fingers) above the site of vascular access.[15-16]

CAUTION: Tourniquet application should not exceed one minute because it can locally cease blood circulation (stasis) with hemoconcentration and infiltration of blood into the tissue. If it prolongs, all protein-based analytes, blood cell volumes and other cellular element levels result in higher values as false results.[15-16]

If the time for vein selection and cleaning and vascular access lasts for more than 1 minute, it is recommended to release tourniquet & reapply after two minutes in order to minimize hemoconcentration effect.[15]

10. Asking the Patient to Clench Fist

The patient is asked to clench his / her fist as this makes the veins more apparent and easier to be accessed by a needle. It aslo helps in patients with deep or collapsed veins to improve the selection of a suitable vein for venepuncture. The patient must not to be asked to open and close the fist repeatedly (pumping action) as it may cause increase in some blood analytes.[40]

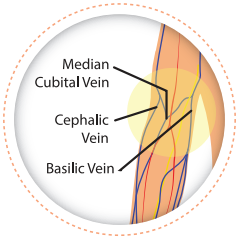


Figure 1

11. Selection of the Proper Vein

Although the antecubital veins' location varies from person to person, the most common patterns in front arm can be seen in Figure 1.

Figure 1. The most common vein patterns in front arm.

Vein used in blood collection should be selected with caution. Consistency of the vein that is to be used in blood collection should be determined by palpation. Index finger should be used in palpation, thumb should not be used because pulsation in the thumb will cause misdeterminetion.[41]

CAUTION: There pass brachial arteries and major nerves in the antecubital area. Perforation of the arteries and nerve damages are among the most common risks of venous blood collection.[15] If it is suspected that arterial access is happened (eg. fast hematoma forming or filling the tubes faster than expected), phlebotomy procedure must be interrupted immediately. The site should be applied direct pressure until bleeding stops for at least five minutes.

If the patient feels a sensation described as throbbing pain or tingling as electrification or pins-and-needles sensation, phlebotomy should be interrupted and another site should be selected.[15]

Venous blood collection from the dorsum of the hand

In cases when the antecubital region is not suitable for phlebotomy (newborns, children, patients in whom the vein cannot be seen, etc.), veins in the dorsal region of the hand can be used for blood collection.

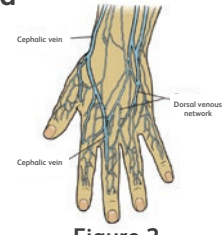
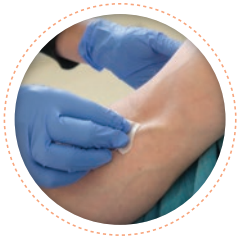


Figure 2

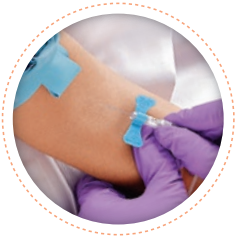
Figure 2. Veins of the dorsum of the hand suitable for blood collection.



12. Cleaning Venipuncture Site

After determining the proper vein to be used in blood collection, venous access site has to be disinfected with the purpose of preventing microbial contamination of the patient and the sample (Disinfect time 20-30 sec). With this purpose, 70% isopropyl alcohol or sterile ethanol swab or gauze should be used.

Skin should be swabbed with rotational movements from the center to the periphery. (No touch after disinfect with alcohol, if you do clean again).[15-16]



13. Anchoring the Vein

Vein is fixed by stretching the skin with the thumb, 2.5-5 cm beneath the site.

CAUTION: Due to the high risk of injury for the phlebotomist, stretching the skin above the site is not recommended.

14. Performing Venipuncture

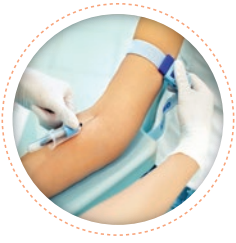
After fixing the vein, the patient should be informed about the vein is just being accessed.

CAUTION: Phlebotomist should get ready for sudden and unexpected loss of consciousness that may develop in the patient.

After informing the patient, venipuncture should be done with <30° angle (Figure 3). Following venipuncture, the needle should be held stable as far as possible and not allow the needle to move within the vein.

Figure 3. Proper angle for venipuncture

Figure 3



15. Observing Blood Flow, Releasing the Tourniquet and the Fist

Tourniquet is extremely important in making the veins explicit during venous blood collection. However, as soon as blood flow begins into the first sample tube, tourniquet must be released and the patient must release the fist.

CAUTION: Long term tourniquet application causes hemoconcentration and hemolysis in blood sample.[43-44] Hemolysis and hemoconcentration cause false results for some analytes.

16. Order of Draw by the Tube Specifications and Tube Filling

Samples should be collected into the tubes as following order in Table 3, in patients whose blood samples are to be tested for more than one analytes at a time.[45-46-47] The purpose of this order is to prevent chance of contamination among tubes containing additives.

Table 3. Blood collection order and number of inverting the tubes required to obey for sample tubes according to the specifications of the tests requested

Colour Code	Tube Type	Determinations	Inversion Times
Blue Purple	Blood Culture	Aerobic followed by anaerobic	8 - 10
Light Blue	Sodium Citrate	Coagulation determinations on plasma specimens	3 - 4
Black	ESR	Erythrocyte sedimentation rate (ESR) determinations	8 - 10
Red	Serum	Serum determinations in chemistry	5 - 6
Gold	SST™ II Advance	Serum determinations in chemistry - with gel separator	5 - 6
Orange	RST	Serum determinations in chemistry - with Thrombin based clotting agent & gel separator	5 - 6
Lime Green	Barricor™	Plasma determinations in chemistry with mechanical separator	8 - 10
Green	Heparin	Plasma determinations in chemistry	8 - 10
Light Green	PST™ II	Plasma determinations in chemistry with gel separator	8 - 10
Lavender	EDTA	Whole blood hematology determinations	8 -1 0
Pink	Cross Match	Crossmatch tubes for blood transfusion patients	8 - 10
Grey	NaF/NaEDTA	Glucose determinations	8 - 10
Royal Blue	Trace Element	Trace element, toxicology and nutrient determinations	8 - 10

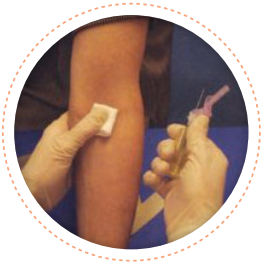
EDTA - ETHYLENEDIAMINETETRAACETIC; ESR - ERYTHROCYTE SEDIMENTATION RATE

CAUTION: Tubes should be filled until the vacuum and blood flow exhausted. Tubes containing additives (EDTA, citrate, heparin, etc.) should be filled until the volumes stated by the manufacturer and being sure the accuracy of the blood/additive ratio.

17. Removing and Mixing the Tubes

Tubes should be removed from the needle holder following the cessation of blood flow. If continuing to blood collection, the same procedure should be applied to the next tube. After completing the last sample tube, first the tube should be removed from the setting and then the needle should be removed from the arm.

CAUTION: Tubes containing any additive should be mixed gently and by inverting in accordance with the recommendations of the manufacturer (Table 3) in order to provide sufficient mixture after collecting each sample. Tubes should not be shaken in order not to cause hemolysis in samples.



18. Removing the Needle, Ensuring Safety and Applying Pressure on Venipuncture Site

After completing the venous blood collection procedure, the needle should be withdrawn by applying gentle pressure with dry gauze put on the needle tip.

19. Tube Labeling

Tubes should be labeled after patient authentication and reviewing patient suitability for phlebotomy.

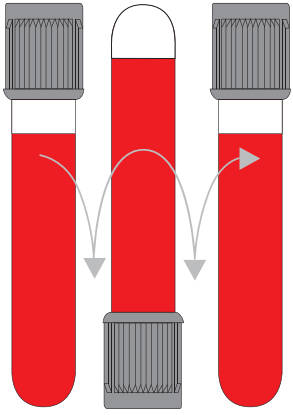
Patient barcode label should include at least the following information:

- Patient's name & surname
- Gender
- Patient number
- Laboratory number

In addition to the above items, there should be:

- Date of birth
- TR identity number
- Blood collection date and time
- Records of the phlebotomist who collects the sample should be included in process recordings, if not on the barcode label.

Figure 4. Way of inverting the tubes.[48]



CAUTION: Swab is not recommended because it removes clot stopper.

Patient should be told to apply strong pressure on the gauze and keep his/her arm straight and up and warned about not to bend his/her arm (because bending causes hematom formation). Cessation of bleeding should be controlled and hypoallergenic adhesive bandage should be applied on the blood collection site after evaluating the patient for hematoma formation.

CAUTION: If hematoma occurs and bleeding lasts for more than 5 minutes, patient's related physician shoul be informed.

In cases when the patient cannot be followed, he/she is informed about the process and may make him/her to follow the process. The patient may be noticed to inform phlebotomy unit or his/her doctor if there is hemotoma formation and bleeding lasts for more than 5 minutes.

Needles should be eliminated in a perforation-durable sharps container after activating its safety mechanism in accordance with the manufacturer's recommendations.

Most common pre-analytical errors and best practices to minimize them

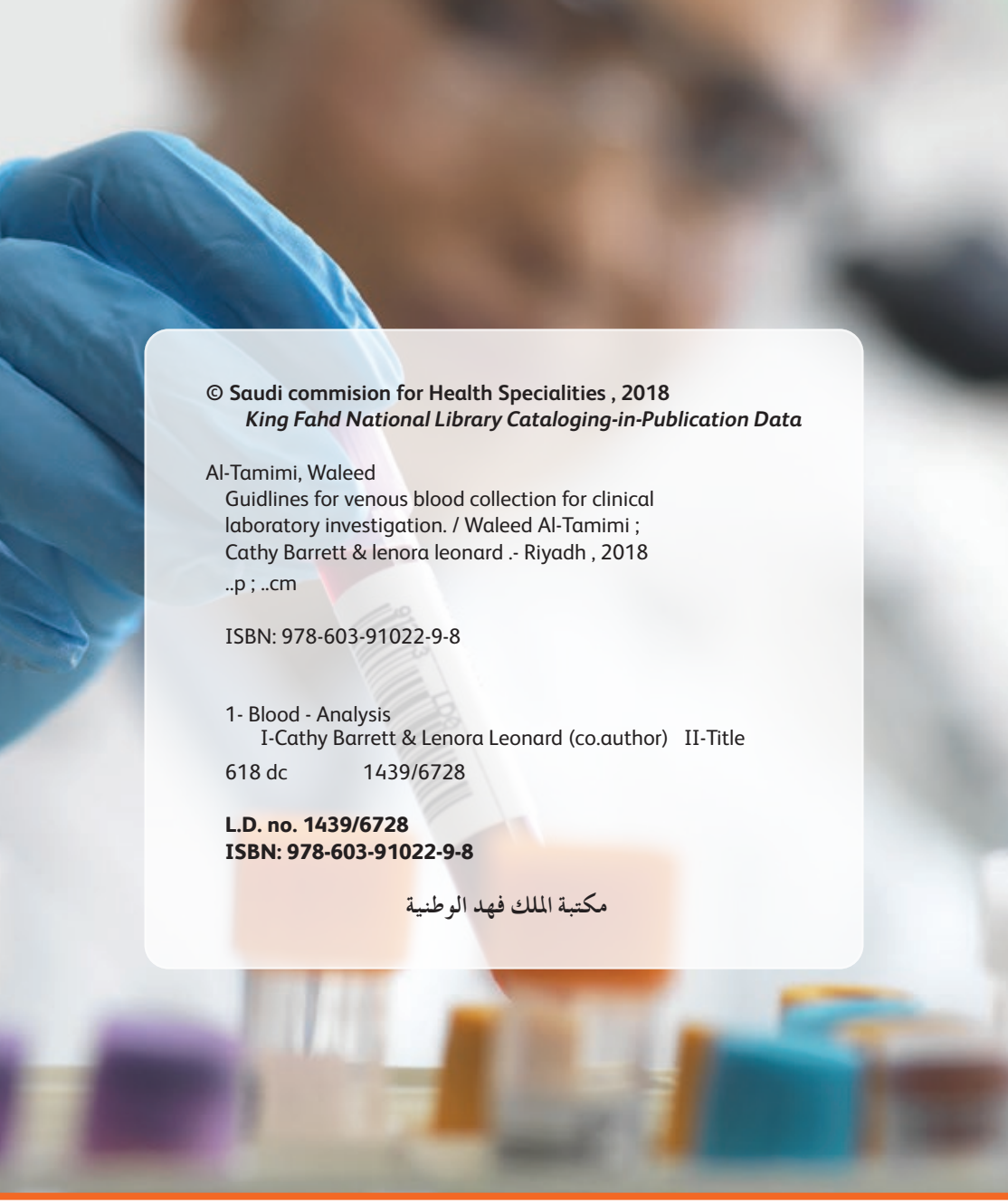
	Preanalytical error	Most common causes	Possible consequences	Best practices to minimize future errors
1	Patient misidentification (incorrectly labeled tubes or incorrectly filled forms)	Inadequate data on test requisition form. Missing patient identifiers. Labeling specimen container away from bedside.	Mishandled therapy (e.g. wrong blood transfusion leading to acute hemolytic reaction). Specimen collection from wrong patient leading to delayed diagnosis or misdiagnosis.	Bar-coded wristbands. Use at least two patient identifiers while taking blood specimens.3 Use biometric information (fingerprints, iris scanning).18 Check requisitions against results. Label the specimen collection.
2	Lipemic specimens	Test collection after heavy meals. Pre-exiting metabolic disorder	Interference of fat with optical reading of instrument, wrong electrolyte values	Prepare patient properly before specimen collection (overnight fasting). Specify patient condition (e.g. hyperlipoproteinemia) on test requisition form.
3	Hemolysis	Forcing blood through needle of syringe. Collecting blood through intravenous line. Vigorous shaking of specimen before clotting.	Falsely high values of AST, potassium and LDH, Interference with spectrophotometric assays18.	Avoid vigorous mixing/ agitation of blood specimen. Do not apply tourniquet for more than one minute since this can cause localized stasis and rupture of red blood cells. Prefer closed system for blood collection. Use transfer devices to transfer blood from syringe. Use luer-lok access device and discard tube when drawing from line.
4	Incorrect specimen volume	Incorrect phlebotomy technique. Difficult venous access (pediatric patients, debilitated patients).	Erroneous lab result due to improper additive-to-blood ratio. Specimen rejection . Redraws.	Fill evacuated blood collection tubes to the stated draw volume.
5	Clotted plasma specimen	Inappropriate mixing of tubes	False leucopenia Aberrant red cell indices. Instrument downtime due to probe clogging.	Follow manufacturer›s guidelines for tube mixing.

REFERENCES

1. Plebani M. Errors in clinical laboratories or errors in laboratory medicine? Clin Chem Lab Med 2006; 44: 750-9.
2. Da Rin G. Pre-analytical workstations: A tool for reducing laboratory errors. Clin Chim Acta 2009; 404: 68-74.
3. Piva E, Plebani M. Interpretative reports and critical values. Clin Chim Acta 2009; 404: 52-8.
4. Plebani M. Exploring the iceberg of errors in laboratory medicine. Clin Chim Acta 2009; 404: 16-23.
5. Chaigneau C, Cabioch T, Beaumont K, Betsou F. Serum biobank certification and the establishment of quality controls for biological fluids: examples of serum bio-marker stability after temperature variation. Clin Chem Lab Med 2007; 45: 1390-5.
6. Lippi G, Salvagno G, Brocco G, Guid G. Preanalytical variability in laboratory testing: influence of the blood drawing technique. Clin Chem Lab Med 2005; 43: 319-25.,
7. Boone DJ. How can we make laboratory testing safer? Clin Chem Lab Med 2007; 45: 708-11.
8. Wallin O, Söderberg J, Guelpen B, Grankvist K. Patient-centred care-preanalytical factors demand attention: a questionnaire study of venous blood sampling and specimen handling. Scand J Clin Lab Invest 2007; 67: 836-47.
9. Lippi G, Blanckaert N, Bonini P, Green S, Kitchen S, Palicka V, et al. Causes, consequences, detection, and prevention of identification errors in laboratory diagnostics. Clin Chem Lab Med 2009;47:143 – 53.
10. Lima-Oliveira G, Lippi G, Salvagno GL, Montagnana M, Manguera CL, Sumita NM, et al. New ways to deal with known preanalytical issues: use of transilluminator instead of tourniquet for easing vein access and eliminating stasis on clinical biochemistry. Biochem Med 2011;21:152 – 9.
11. Simundic AM, Cornes M, Grankvist K, Lippi G, Nybo M. Standardization of collection requirements for fasting samples: for the Working Group on Preanalytical Phase (WG-PA) of the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM). Clin Chim Acta 2014;432:33 - 7 .
12. Kackov S, Simundic AM, Gatti-Drnic A. Are patients well testing? Biochem Med 2013;23:326 - 31.
13. Favaloro EJ, Funk DM, Lippi G. Pre-analytical variables in coagulation testing associated with diagnostic errors in hemostasis. Lab Med 2012;43:1 - 10.
14. De Carli G, Abiteboul D, Puro V. The importance of implementing safe sharps practices in the laboratory setting in Europe. Biochem Med 2014;24:45 - 56.
15. Clinical Laboratory Standards Institute. Procedures for the collection of diagnostic blood specimens by venipuncture; approved standard- sixth edition. CLSI document GP41-A6. Clinical Laboratory Standards Institute, Wayne, Pennsylvania, USA, 2007.

16. WHO guidelines on drawing blood: Best practice in phlebotomy. http://whqlibdoc.who.int/publications/2010/9789241599221_ eng.pdf.
17. TR Ministry of Health General Directorate of Healthcare Services, Department of Quality and Acreditation in Healthcare, Healthcare Services Quality Standards-Hospital Set Version 5. http://www.kalitesaglik.gov.tr/content/files/duyurular_2011/2/011/2014/sks_hastane_versiyon_5_08.07.2015.pdf.
18. Köse S, Mandiracioğlu A, Tatar B, Gül S, Erdem M. Prevalence of latex allergy among healthcare workers in Izmir (Turkey). Cent Eur J Public Health 2014;22:262-5.
19. Leitch A, McCormic I, Gun I, Gillespie T. Reducing the potential for phlebotomy tourniquets to act as reservoir for meticillin-resistant Staphylococcus aureus. J Hosp Infect 2006;63:428-31.
20. Accurate Result in the Medical Laboratory. Editors: Amitava Dasgupta, Jorge L. Sepulveda. Translation , Editor; Turan Turhan. Palme Publishing, 2015.
21. Official Journal of The European Union. Council Directive 2010/32/EU. Prevention from sharp injuries in the hospital and healthcare sector. Official Journal of The European Union, No. L134 of 1 Haziran 2010, sayfa 66-72.
22. WHO guideline on the use of safety-engineered syringes for intramuscular, intradermal and subcutaneous injections in health-care settings, 2015. www.who.int/injection_safety /global-campaign/injection-safety_guideline.pdf.
23. Clinical Lboratory Standards Institute. Procedures and Devices for the Collection of Diagnostic Capillary Blood Specimens; Approved Standard- Sixth Edition. CLSI document GP42-A6. Wayne, PA: Clinical and Laboratory Standars Institute; 2008.
24. The Ministry of Environment and Forestry, Regulations of Medical Waste Management. www.resmigazete.gov.te/eskiler/2005/07/20050722-16.htm.
25. International Organisation for Standardisation. ISO 15189:2012 Medical Laboratories-Requirements for quality and competence Medical laboratories, 2012.
26. BD- Special handling of chilled specimens. www.bd.com/vacutainer/pdfs/plus_plastic_tubes_instructions_lightsensitive_VS5732.pdf.
27. MLabs Specimen collection and transport guidelines. http://mlabs.umich.edu/files/pdfs/POL-SPECIMEN_GUIDELINES.pdf.
28. Guidelines of Healthcare Professionals' Hand Hygiene and Hand Disinfection. MOH Directorate of Basic Health Services, 2008.
29. Lima-Oliviera G, Salvagno GL, Lippi G, Gelati M, Montagnana M, Danese E, et al. Influence of a regular standardized meal on clinical chemistry analytes. Ann Lab Med 2012;32:250-6.
30. Calmarza P, Cordero J. Lipemia interference in routine clinical biochemistry tests. Biochem Med 2011;21:160-6.
31. Şeneş M, Zengi O, Şeker R, Topkaya BÇ, Yücel D. Lipemi interferansına karşı kolay bir çözüm: Polietilen glikol-dekstran sülfat. Turk J Biochem 2005;30:187-93.

32. Won CS, Oberlies NH, Paine MF. Mechanisms underlying food-drug interactions: inhibition of intestinal metabolism and transport. Pharmacol Ther 2012;136:186-201.
33. Tietz Fundamentals of Clinical Chemsitry, 6th Edition. Burtis CA, Ashwood ER, Burns DA. Saunders/Elsevier 2008.
34. Favaloro EJ, Funk DM, Lippi G. Pre-analytical variables in coagulation testing associated with diagnostic errors in hemostasis. Lab Medicine 2012;43:1-10.
35. Lucas C, Donovan P. "Just a repeat"- When drug monitoring is indicated. Aust Fam Physician 2013;42:18-22.
36. Ain KB, Pucino F, Shiver TM, Banks SM. Thyroid hormone levels affected by time of blood sampling in thyroxine-treated patients. Thyroid 1993;3:81-5.
37. American Diabetes Association. Postprandial blood glucose. Diabetes Care 2001;24:775-8.
38. Thavendiranathan P, Bagai A, Ebidia A, Detsky AS, Choudhry NK. Do blood tests cause anemia in hospitalized patients? The effect of diagnostic phlebotomy on hemoglobin and hematocrit levels. J Gen Intern Med 2005;20:520-4.
39. Dugan L, Leech L, Speroni KG, Corriher J. Factors affecting hemolysis rates in blood samples drawn from newly placed IV sites in the emergency department. J Emerg Nurs 2005;31:338-45.
40. Baer D, Ernst DJ, Willeford SI, Gambino R. Investigating elevated potassium values. MLO Med Lab Ods 2006;38:24-31.
41. Mbamalu D, Banerjee A. Methods of obtaining peripheral venous access in difficult situation. Postgrad Med J 1999;75:459-62.
42. www.anatomyatlases.org/firstaid/DrawingBlood.shtml.
43. Statland BE, Bokelund H, Winkel P. Factors contributing to intra-individual variation of serum constituents: 4. Effect of posture and tourniquet application on variation of serum constituents in healthy subjects. Clin Chem 1974;20:1513-9.
44. Saleem S, Mani V, Chadwick MA, Creanor S, Ayling RM. A prospective study of causes of haemolysis during venipuncture: tourniquet time should be kept to a minimum. Ann Clin Biochem 2009;46:244-6.
45. Calam R, Cooper MH. Recommended "Order of Draw" for collecting blood specimens into additive containing tubes. Clin Chem 1982;28:1399.
46. Ernst DJ, Calam R. NCCLS simplify the order of draw: A brief history. MLO 2004;36:26.
47. Salvagno G, Oliveira GL, Brocco G, Danese E, Guidi GC, Lippi G. The order of draw: myth or science? Clin Chem Lab Med 2013;51:2281-5.
48. BD PAS EMA Production Catalogue 2011



King Fahd National Library Cataloging-in-Publication Data

Al-Tamimi, Waleed
Guidlines for venous blood collection for clinical laboratory investigation. / Waleed Al-Tamimi ; Cathy Barrett & lenora leonard .- Riyadh , 2018
..p ; ..cm

ISBN: 978-603-91022-9-8

1- Blood - Analysis
I-Cathy Barrett & Lenora Leonard (co.author) II-Title
618 dc 1439/6728

L.D. no. 1439/6728
ISBN: 978-603-91022-9-8

مكتبة الملك فهد الوطنية

الجمعية السعودية للكيمياء السريرية
Saudi Society for Clinical Chemistry

info.sscc.sa@gmail.com
www.sscc.med.sa