

# Use Of Technology in Phlebotomy, Serve as Patient Safety in Healthcare Diagnosis?

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*Research-based paradigm shows that the phlebotomy technique is a fundamental screening technique. The use of technology in phlebotomy becomes a reinforcement for patient safety in the health care system. Through this technique, multiple medical tests are performed, which is helpful in medical diagnosis, so it becomes the first and most crucial step in a clinical laboratory. One of the most common means for diagnosis is through medical laboratory testing uses venous and arterial blood. Vein finder helps the phlebotomist to locate the vein and prevent discomfort and pain in the patient. Therefore, this review addresses a view on the modern aspect of phlebotomy. In this regard, the paper describes the impact of qualitative and quantitative aspects of phlebotomy. It also describes patient compliance and its management regarding clinical and practical issues. We also try to review its devices, advanced biotechnological tool, and procedure in terms of scientific findings and provide effective vein accessions for blood collection.*

**Keywords:** Phlebotomy, Venepunctures. Patient safety, Vein finder

## **Introduction**

Phlebotomy is one of the most common procedures in the clinical laboratory. Skilled phlebotomists, nurses or medical practitioners performed it. Executed by unskilled phlebotomists, nurses & medical practitioners becomes mortal for the patient. The essential tools are a tourniquet, the needle /vacutainer, anticoagulant tube. A needle/vacutainer tip has a cutting sharp, evacuated tube system that grants a higher safety for the operator and its environment because the blood specimen circulates in a closed system (1,2). It should address patient safety, involves iatrogenic accessions to the vein lumen, and complications through this procedure employing vein accessions in blood collection. (3,4). A review will guide qualitative and quantitative phlebotomy, and it also introduces basic and advanced biotechnology tools for the

Phlebotomy. Virtual reality (VR) and cold vibration reduce pain and address the reliability of quantitative and qualitative blood testing. Vein finder visualises the anatomy of the superficial veins accessions. It also addresses the preanalytical errors (5) & aspects of modern phlebotomy. Strategies in biomedical waste management discuss here.

## **Patient Safety Compliance**

In health care reduction, reporting & analysis accentuate patient safety & this act as regulation for other types of harm that often lead to complicated patient safety

events.([http://en.wikipedia.org/wiki/patient\\_safety](http://en.wikipedia.org/wiki/patient_safety)) Patient safety means the impediment of healthcare errors and the elimination or mitigation of patient injury caused by healthcare errors. According to the gate control theory of pain, two things may happen either gate is open or the gate can be closed. Signals can pass through & will be sent to the brain to perceive the pain in an open gate. Non-noxious alpha-beta fibres are activated and inhibit the alpha-delta & c fibre .when the gate is closed & signals are deterred from travelling to the brain, C fibres pique the pain . The patient experiences fear of being hurt, losing blood or fainting anxiety. Approx 2% of adults have a phobia toward needles (defined as trypanophobia). Trypanophobia & other needle pricks can cause an autonomic reaction called

vasovagal reaction (VVR). the patient feels an increase in the heart rate and blood pressure resembling a fight-or-flight, and then suddenly drops called vasovagal syncope) (6,7).

The applied tension technique is a strategy that involves the muscles tensing to raise the blood pressure and contrast the fainting to reduce specific behavioural (10,11).

Work on patient safety began with the launch of the world alliance for patient safety in 2004 & challenges.

Clean care is safer care (2005)

Safe surgery saves lives (2008)

Medication without harm (2017)

Patient safety aims to enhance patient reliability to reduce risk and harm to achieve better health outcomes. (who, int/news-room/factsheet/detail/patient\_safety)

WHO plays a pivotal role in the production of technical guidance and resource. Professional patient safety curriculum guides to promote global solidarity& global patient safety network.Global patient safety collaborative developed by WHO.

WHO also launched a patient safety programme. As a result, the length of work shifts for medical professionals & other hospital employees adjusted over time. Medical residents who are acutely and continuously exhausted are more likely to make mistakes.

Medical residents & other healthcare professionals get ample sleep. ([http://books.nap.edu/open\\_book.phd?record-id=12508&pageRT](http://books.nap.edu/open_book.phd?record-id=12508&pageRT))

## PHYSIOLOGY AND ANATOMY

Phlebotomy is used constantly and focuses on prioritising the efficiency of blood draws. Drawing blood from a vein is referred to as arteries because veins run superficially and have a thinner wall.

The site to draw blood is the cubital fossa of the forearm. The cephalic Vein(CV), Basilic Vein (BV), Median Cubital Vein (MCV)&Median Antebrachial Vein (MABV) are sites for venepuncture. Their distribution and connections are four types (I to IV) classic type, N type, M-type and O type, according to the dominance of CV or BV for the calibre of the vessel Classic and N-type variations of MCV found in humans. Cephalic and basilica veins are present in the cubital fossa. During venipuncture cephalic vein tends to roll share proximity to the lateral antebrachial cutaneous nerve. Basilic vein lying close to the bronchial artery and medial antebrachial cutaneous nerve. (<http://doi.org/10.18295/squmj/2016/17.01.018>.) MCV roll due to the presence of perforating deep vein anchors to the bicipital aponeurosis

They are present in the dorsal surface of the hand, where veins lay superficially because of the poor connective tissue and muscles.

MCV has a pain tolerance threshold higher among the upper limb sites, thus resulting in the lowest perceived pain intensity (14). Therefore, it may be eligible in those subjects with deep or small veins or with a particular issue of painful reactions. However, veins at this site have greater mobility due to the poor surrounding connective tissue, and

Palpations represent the basic approach to identifying the site for venepuncture, vessel elasticity, depth and consistency of the surrounding tissues. Due to venous stasis tourniquet was applied several inches overhead.

### **Clinical Complications of Phlebotomy**

Haemoconcentration, spurious hyperkalaemia and spurious haemolysis are some clinical complications of phlebotomy. (16). Venous stasis, which also favours tissue hypoxia, produces a change in pH .it affects the electrolytes balance, potassium. EDTA contamination causes an abnormal reduction of serum calcium in the factitious electrolyte imbalance. The effective chelation action of calcium plays a vital role in both prothrombin time and activated partial thromboplastin time (APTT) test in coagulation profile testing (17,18). The needle bore size & the withdrawal force is the main factor of SH. Phlebotomy carries out in large vein lower the risk of hemolysis. A 23 G needle could be as safe as a 21 G.needle bore size&its withdrawal force is the main factor of SH. It can affect tests like lactate dehydrogenase& aspartate aminotransferase. Draw EDTA tubes at the end whenever any other weaker anti-coagulant is to collect blood, as in the case of lithium-heparin.

### **Tool of phlebotomy**

Phlebotomy employing veins accessions aimed at blood collection phlebotomy was essentially a therapeutic resource to cure diagnostic basis of diseases (3,4). Two types of systems are used for blood collection, open & closed. The blood I exposed to the environment in open .it including a hypodermic needle & syringes & a winged steel needle also. Blood drawn passes directly into the tube without exposure to the environment or healthcare professionals in a closed system. Closed systems proved to be safer than open systems (WHO guidelines for blood collection). “Epicranial” or “hypodermal needle pierces the skin and breaches the vein wall, often 21 G needle, which corresponds to 0.82 mm outer diameter and 0.51 mm inner diameter shaft on average, is used for venipuncture.23 G needle, 0.64 mm outer diameter and 0.34 mm inner diameter shaft on average, is a better choice for paediatric blood collection. Epicranial needles, 4 cm used for venepuncture with the shaft inserted for about 2 cm into the tissues (20) Rubber stop is recapped when the tube is removed from the holder, thus preventing the sample from leaking out after completing the procedure. Evacuated tube system used in multiple tests. A single-use disposable tourniquet seems to be valuable. (21,22). Skin piercing can cause distress, pain and phobia, especially in children, mentally ill patients, and s in adults. Vein finder device is a blessing for everyone in the medical field, beginners &experienced medical practitioners, effective vein visualisation for blood collection. Vein finder device is a helpful tool that lets you reduce the pain while passing a cannula (<http://www.techtimes.com>) commercially available vein finders are vein seek pro, Vein seeks android and vein scanner pro request. It accesses your smartphone. camera to enable image processing to highlight veins in this access. (<http://www.vein seek.com>) an artery visualised if it falls within the viewing depth of vein finder up to 10mm&peripheral veins up to 15 mm. Due

to the depth of the artery in many patients, it is not visible in the projected image ([http://www.core stream ameica.com](http://www.corestreamameica.com))

### **Present Challenges in Phlebotomy.**

We know the mode, device, tool, and type of phlebotomy so, we have to discuss the present challenges, and hurdles for this technique in health care.

Two types of patients come into the hospital, outpatient (OPD) and in-patient (IPD) in clinical wards and emergency medicine OPD patients' blood collection in the blood collection centre. A phlebotomist has a clear idea of whom we take first nurses /medical practitioners should concern with children, women and senior citizens. Patients in emergency medicine are counselled and diagnosed by CMO/Medical practitioner and then admitted to their department. After proper medication and lab investigation, patients were shifted to the respective ICU ward, CCU and clinical ward according to the clinical condition of the medical disease.

**1. Blood drawing process & Incorrect labelling of the tubes** -incorrect use of barcoding of test tubes that increase the compliance of the patient

**2. Sample transportation** .quick anthe d in packaged environment (in an ice box) that maintains the temperature and integrity of the sample, it is tightly three-layered sealed packaged,as covid 19 norm for the packaging of a blood sample.

**3.Storage of the sample** Blood sample are processed immediately at a hospital where a large no of the patient comes it is not feasible for samplet storage come under this challenge.

**4.Sample authenticity for the report.**Nurse/medical practitioners have criteria of sample rejection acceptance, Clotted samples rejected.Does one big question arise if the blood sample is not authentic, most hospitals collect a single blood sample, and stored it in a duplicate blood sample? One is kept in the respective blood collection lab, to avoid patient distress and another for the lab.

**5 .Reporting a blood sample.** The report will be authentic as per the test criteria.

**6. Biomedical Waste Management (BMW).** Lots of transmission through biomedical waste disposal, solid & liquid waste occur. Biomedical waste produces a lot of hurdles towards society and our environment also. Dumping of waste in the soil causes soil pollution. A large no of incineration techniques produces harmful & carcinogenic gasses that cause air pollution. During the coronavirus pandemic, an unpredictable pile of biomedical waste (BMW) gathers at the top. India produces 710 tonnes of biomedical waste daily (Snehal et al.2022 challenges and measures)

In India, 270,416 hospital supply facilities (HCF) produce 614 tonnes of biomedical waste daily (Rajak et .al.2021) &(CPCB2018,2019 &)government of India website) Medical waste is disposed of authentically by the infection control team of respective

The lack of training of healthcare professionals is also a hurdle to the inappropriate disposal of BMW. Poor organizational management and lack of work ethics & attitudes of health care professionals towards B.MW segregation, transport& disposal.

## Future perspective in phlebotomy

Phlebotomy has new concerns in terms of the following points:

**1. Training and education of phlebotomist-**Training for all staff carrying out phlebotomy is essential. It develops a cognitive understanding of anatomy & awareness of the risks from blood exposure & the consequences of poor infection prevention and its control in health care professionals. Regular in-service training & supportive supervision are effective. It gives theoretical and practical knowledge of blood sampling and blood drawing (45) Certificate of competence I issued after completion of the training programme,

**2. Standard Operating Procedures (SOPs)-** SOPs required for each step are essential. It should be written and readily available to health care professionals. Patient Consent (Recommendation on increasing patient confidence)(Annex F) in healthcare facilities should provide a piece of patient information. The procedure is told in such a way so the conscious patient decides, helps the patient to relax and may reduce discomfort. If the patient is mentally incapacitated (e.g. through mental illness, organic impairment, or traumatic or drug-associated loss of consciousness), essential blood sampling may be carried out without permission, per the institutional or national policy. Patient's clinical notes documented (Implementing best phlebotomy practice 4). If the patient is unconscious or unable to give informed consent, the next of kin or legal guardian (by a court of law) can permit to take a blood sample.

## **4. Recommendation on health care professionals and patient safety policies**

in all hospital facilities & phlebotomy areas, a post-exposure prophylaxis protocol must be facilitated. Policy on PEP should offer support for exposure to HIV, HBV and HCV (47). The point of contact (both during the day and at night) where staff may receive assistance, support & care, including PEP and the benefits of prompt reporting for prevention. Occupational injuries should be reported in a system that accidents, and medical management with to improve reporting of exposures and near misses. The benefits of PEP for HIV may be started as soon as possible; no later than 72 hours after exposure (47) source patient and the exposed individual should undergo rapid testing to avoid unnecessary treatment. Based on the test result or if the risk assessment requires it, antiretroviral therapy prophylaxis should be given. ideally within the first hours, and certainly no later than 72 hours after the exposure. Hepatitis B immunization working facilities should be provided,

completing the three-dose series, the health care professional tested to verify seroprotection (i.e. a concentration of antibodies to hepatitis B surface antigen of at least 10 milli-international units per millilitre [10 mIU/ml]). Follow-up of repeat serology testing after exposure to a patient positive for hepatitis B surface antigen, known to have responded to the vaccine. Titres will decrease over time, even in those who are seroprotected, but the vaccinated person remains protected. National guidelines on PEP for HBV exposure consulted. Detailed instructions on hepatitis B immune serum globulin (HBIG) and immunization against HBV are available from WHO (47). The fourth dose of the hepatitis B vaccine to those who completed their immunization tested 1–2 months after the vaccination and had a hepatitis B surface antibody titre below 10 mIU/ml.

## **5. Monitoring and evaluation**

A monitoring and evaluation system should be in place to provide surveillance of the management of phlebotomy services & in adverse conditions to document improvements. The indicators to use include number of workers of sharps exposures and other occupational injuries occurring among health workers in the past 12 months, the number and rate of patients with adverse events in response to phlebotomies such as haematoma, syncope, infection or nerve damage. number of reported cases of bloodborne pathogens transmitted during phlebotomy (disease surveillance for hepatitis B and C, and HIV) as part of a public health surveillance system that is capable of receiving and responding to reports of cases and clusters of infections; number (and percentage) of phlebotomy sessions where essential equipment was not available and phlebotomy sessions were cancelled; number (and percentage) of laboratory test results lost due to errors or poor quality; for example – blood culture contamination rate, blood transfusion adverse events, haemolysis, number of specimens with illegible or missing paperwork or labels, number of a specimen that could not be processed due to inadequate sample volumes, number (and percentage) of trained staff in the health-care facility working in phlebotomy, number (and proportion) of juniors who are supervised by trained staff

**6. Vein finder for visualization of vein & artery.** The principle of a vein finder device is based on reflection & transillumination.

**Reflection light-based vein finder.** Light from the source was reflected & captured by the camera. It requires lower light intensity and less power consumption for battery-operated devices & enables a compact design vein finder.

**Transillumination light-based vein finder.** The light penetrates the skin and tissue of the site & image will be captured by the camera in(34). The image in trans illumination is due to the presence of deoxyhemoglobin in venous blood that absorbs the red light and illuminates the veins as dark in the red light and illuminates the vein as dark lines on the skin surface to locate the vein (36,37)

it is composed of two-stage

1. infrared (IR) light penetrates the human tissue.
2. Deoxyhemoglobin in the venous blood absorbs more incident infrared light than the surrounding tissue(31).

Trans illumination devices require higher light intensity that uses more power and non-compact with the arm placed between the light source sample, projecting a vein image of the dorsal hand using the NIR vein finder prototype. Recently near-infrared electromagnetic spectrum used in development due to a low-cost but efficient type of vein finding NIR technology for about 4500 USD (portable) to 27,000 USD (non-portable).

**IMPORTANCE-** Despite the dedicated and highly skilled medical practitioners/nurses/phlebotomists, multiple attempts are often unavoidable & can be traumatic challenges that necessitate the improvement of steps in performing cannulation .it including the development and use of a vein finder to assist in locating veins and as the site for a different procedure which aims to lessen missed vein during needle insertion of the first trial by medical practitioners

The reflected vein finder requires lower light intensity and less power consumption suitable for battery-operated devices & enables a compact design vein finder.

The reflected vein finder requires lower light intensity and less power consumption suitable for battery-operated devices & enables a compact design vein finder. Veins are either very small or deep.

Patent age (elderly or pediatrics) in the elderly, vein access was challenging due to the change in its vein structure as thin and fragile people lose elasticity. Pediatrics have smaller peripheral veins and more content subcutaneous fat prone to vasoconstriction.

Darker skin color causes difficult viewing of the vein Obesity level causes multiple attempts at needle insertion to lead to pain, discomfort, dissatisfaction, delayed treatment, and hematoma formation

There are three main unresolved issues regarding the NIR technology application site for real-life and clinical practice.

- What about its training??
- Cost effectiveness technical concern about vein visualization??
- Technical concern about vein visualization?? (Difficult peripheral veins; turns on the light M.Lampert M.pit truth, British journal of anaesthesia)

Both NIR technology &ultrasound guidance are helpful in the visualization of a peripheral vein. The NIR is helpful in the visualization of a peripheral vein, the NIR is useful for superficial veins not deeper than 5-8mm and easily collapsible veins. Ultrasound is helpful for a deeper vein. The effectiveness of both technologies for better visualization on reduced time cannulation will be essential to guarantee that we are going in the right direction.

In the hospitalized patient, nursing staff and physicians may access central venous lines for specimens is acceptable to draw blood specimens when first introducing indwelling venous devices before connecting the cannula to the intravenous fluids.

**Use of Virtual reality**-virtual reality is now consumer-ready and nearing ubiquity. Its ability to create a distraction. Most children tend to create a distraction or develop an excitement for the game of pretending such that they can ignore painful stimuli. Its immersive effect distracts the brain, leading to momentary relief &enhancing the treatment of the patient.

A basic VR system consists of a VR headset, a pair of eyeglasses and a mobile phone running a VR application clipped in the front of the headset. (technology for improved health service, virtual reality for pain management in paediatric patients)

## DISCUSSION

The purpose of this comprehensive review was to identify the best practice and technology that is relevant to phlebotomy. In Germany, a training program available on CD-ROM called Diapro. The program contains text and examples to train future medical professionals.

Phlebotomy is drawing or removing arterial or venous blood in various diagnostic tests. There are potential uses for phlebotomy in the pre-hospital environment. These include the sampling for arterial blood gas analysis, cardiac marker, and electrolyte testing in the field, aiding diagnosis and patient monitoring. Gerhard (11) found that a blood gas analyzer performed in the pre-hospital environment using a portable blood analyzer gave more objective information regarding in-patient oxygenation, carbon dioxide and acid-base balance than pulse oximetry or capnometry(**pre-hospital phlebotomy and point of care testing relevance and implication for professional emergency care practice** in improving clinical outcomes and serving as a patient safety vein finder play a pivotal role for a patient in health care.

Haemoglobin is the primary component of the blood, especially of the red blood cells, which have an oxygen-carrying capacity (46). The median cubital is considered the best site for venepuncture because it is well-anchored, large, and prominent (47) introduction of a vein finder is to help in the location of the vein positioning during phlebotomy,. A Methicillin-Resistant Staphylococcus aureus (MRSA) and other pathogens can occur a repeatedly use of the same tourniquet for venepuncture. (48). With the vein finder device. A disposable type is not feasible in the current non-contact model can address this concern on how to prevent possible transfer of contamination. Vein finder specifically aims to lessen the missed peripheral subcutaneous vein during blood collection and intravenous insertion for medication.

HCV treatment requires frequent venous blood sampling due to poor experience with phlebotomy was directly linked to the decision to access it. In all three qualitative research. received stigma from staff, for example, "as soon as I told the consultant what drugs. I was on the sort of like/recoiled (50) it extended to the disapproval of practices such as self-phlebotomy (51) of having blood taken was prevalent across the study service user described how phlebotomy makes them petrified (49) or makes patients cry(51). In these studies, most participants were happy to undergo initial testing, but due to multiple testing and distress in this, it led them to leave the treatment pathway

Emergency departments serve as the primary access point to the health care system. medicine and the incidence of clotted samples visible sometimes. Emergency medicine is an environment where staff work for short periods, a prone area to ensure the optimal phlebotomy techniques . The main difference in this area is that the standard practice to cannulate the patient and then draw the blood sample from the cannula. The pushing blood through fine lines causes hemolysis, cannula-drawn blood sample shows more hemolysis. (REF. Annals of Clinical Biochemistry) 49.1 The analytical phase has been previously defined as the Dark side of the moon in laboratory medicine because it is unfamiliar and often overlooked by laboratory managers involved with quality assurance. (13,15 phlebotomy part of the dark sides in the clinical laboratory struggle for quality. laboratory medicine Vol 43). A tourniquet is a universally accepted practice to facilitate vein location(27.28). Nevertheless. Venous stasis due to prolonged tourniquet placement affects the concentration of several analytes, tourniquet time., request for first clenching, excessive friction during skin cleaning, sequence of vacuum tube usage, and mixing of tube content.

In early childhood, experience a painful event remembered for a period of life as children lack coping mechanisms. Unlike adults, unfortunately, hospitalized children undergo several painful procedures for diagnosis and treatment. Heel prick phlebotomy and bone marrow aspiration are examples of needle-related medical diagnoses not only affect the coping mechanism but also become the deciding factor for a future response towards the painful event (6,7) In children, it causes a general awareness syndrome (8\_11) due to pain phobia an intervention like virtual reality., cold vibration, blowing soap bubbles act as effective methods in diminishing procedural Pain (32 36.)

## CONCLUSION

1.Because it was more durable and cost-effective than the modern era, we frequently believed that the ancient era was superior. After a pandemic, we can no longer deny the truth that



education and health are the foundation of any healthcare system. With modern technology, patient safety is improving. For many years, phlebotomy was performed without the use of modern equipment. Everyone understands "health is wealth" in medical diagnosis. Medical professionals use patient counselling to interpret medical findings and identify illnesses. Without laboratory tests, there is no medical issue that we can diagnose. Technology makes information clear and simple to access and lessens people's fear of painful needlesticks. We should all concur that the world is experiencing phobia due to the respiratory disease pandemic. The virus's pathogenesis and transmission. counselling and new medical testin

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Yogesh Ashok Sontakke 2 , Dinesh V Kumar 3 1Junior Resident, Department of Anatomy, Jawaharlal Institute of Postgraduate Medical Education & Research, Dhanvantri Nagar, Pondicherry, India, 2Additional Professor, Department of Anatomy, Jawaharlal Institute of Postgraduate Medical Education & Research, Dhanvantri Nagar, Pondicherry, India, 3Assistant Professor, Department of Anatomy, Jawaharlal Institute of Postgraduate Medical Education & Research, Dhanvantri Nagar, Pondicherry, India.

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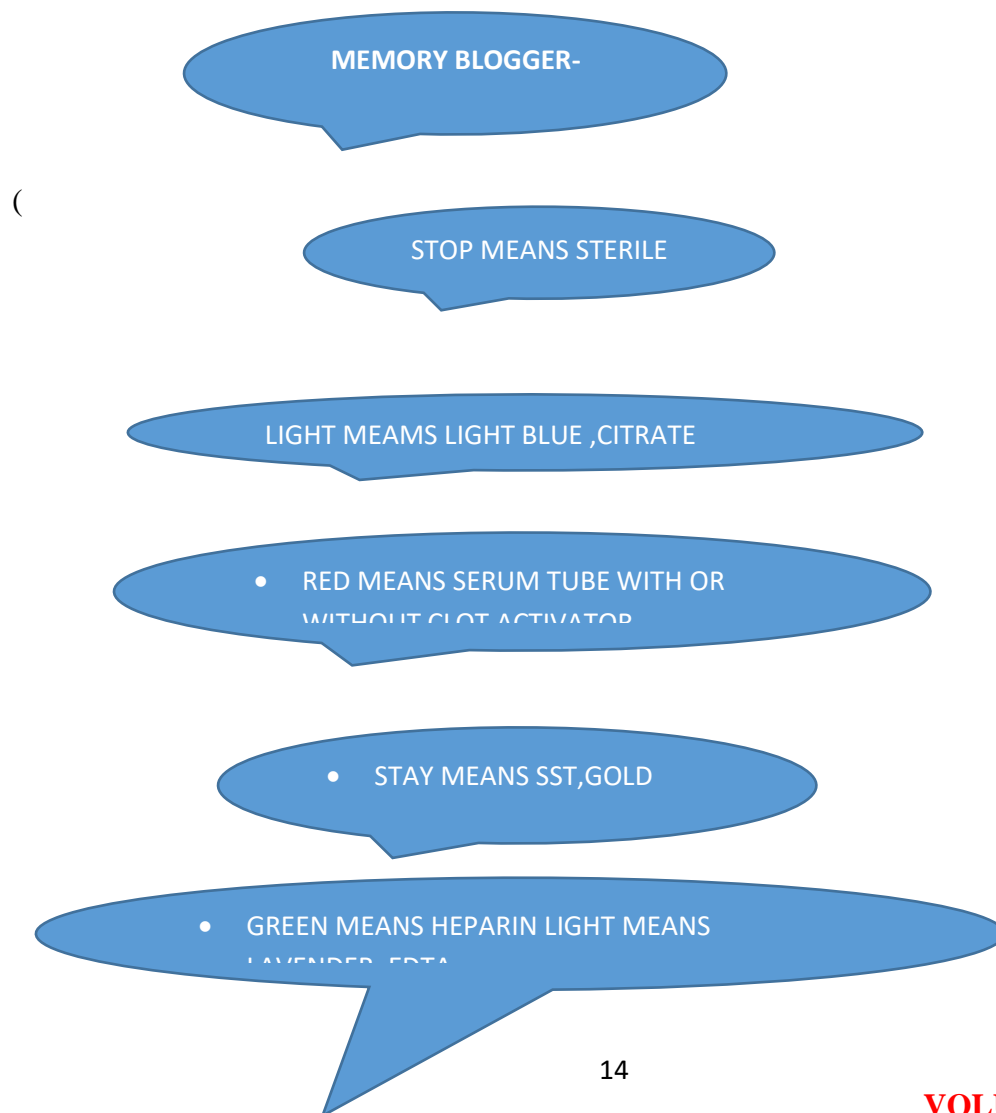
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Order of draw



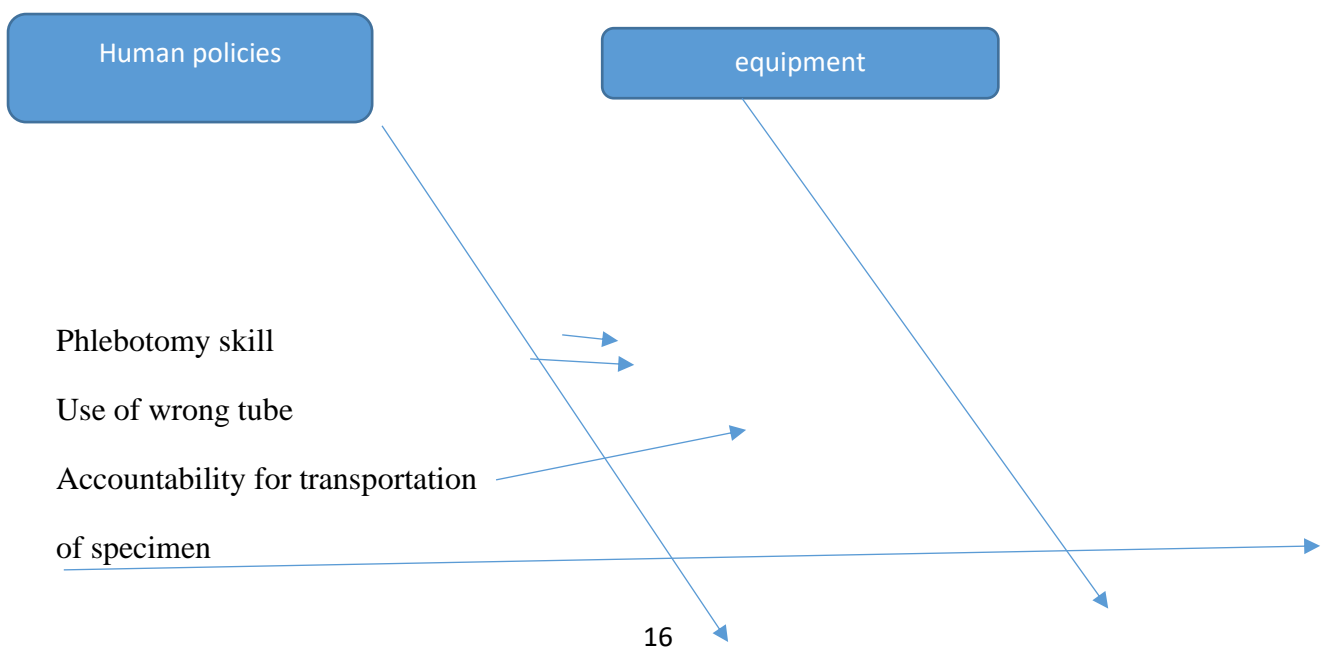
- GO MEANS GRAY OXALATE

(Courtesy-Phlebotomy basics)

Order Of Use	Type Of Tube/Usual Colour	Additive	Mode Of Action	Uses
1	Blood Culture Bottle(Yellow-Black striped tubes)	Broth Mixture	Preserves viability of microorganisms	Microbiology-aerobes, anaerobes fungi
2	Non-additive tube			
3	Coagulation tube(Light Blue top)	Sodium Citrate	Forms calcium salts to remove calcium	The coagulation test(APTT and prothrombin time )requires a full Draw
4	Clot activator(red top)	Clot activator	Blood clots and the serum is separated by centrifugation	Chemistries, immunology and serology, blood bank(cross-match)
5	Serum separator tube(red-grey tiger top of gold)	None	Contains Gel at the bottom from serum on centrifugation	Chemistries, immunology and serology
6	Sodium heparin(dark green top)	Sodium heparin or Lithium heparin	Inactive thrombin and thromboplastin	For Lithium Level Use Sodium heparin, for ammonia level use either

7	PST(light green top)	Lithium heparin anticoagulant and gel separator	anticoagulants with lithium separate plasma with pst gel at bottom of the ube	Chemistries
8	EDTA(purple top)	EDTA	Forms calcium salts to remove calcium	Haematolgy,blood bank(cross-match)requires full draw
9	Blood tube (pale yellow top)	Acid-Citrate-dextrose(ACD,ACDA or ACDB)	Complement inactivation	HLA tissue typing, paternity testing, DNA studies
10	Oxalate/fluoride(light grey top)	Sodium fluoride and potassium oxalate	Ant glycolytic agent preserves glucose for up to Five Days	glucose requires full draw (May cause haemolysis if short draw)

**Sample rejection criteria**





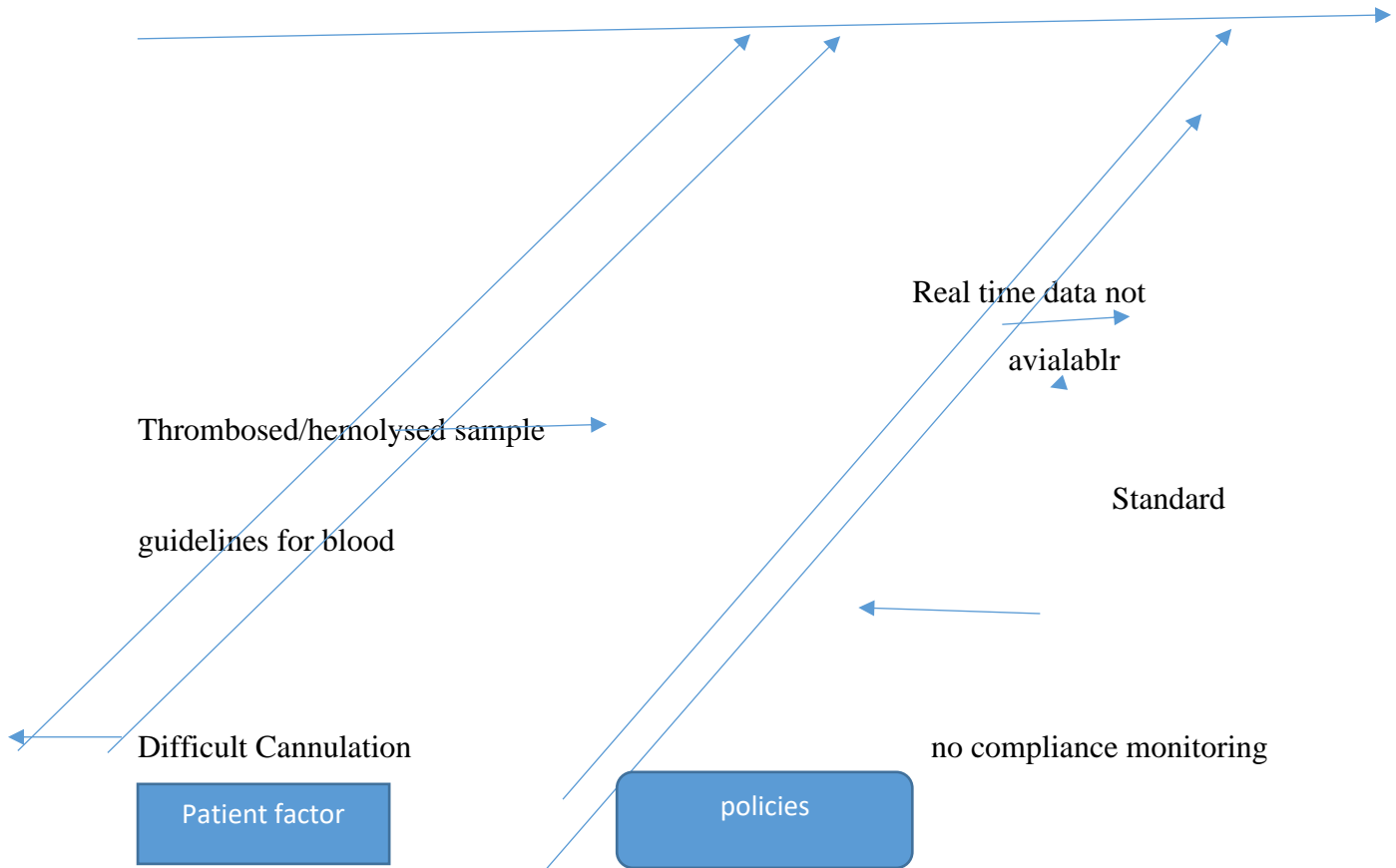
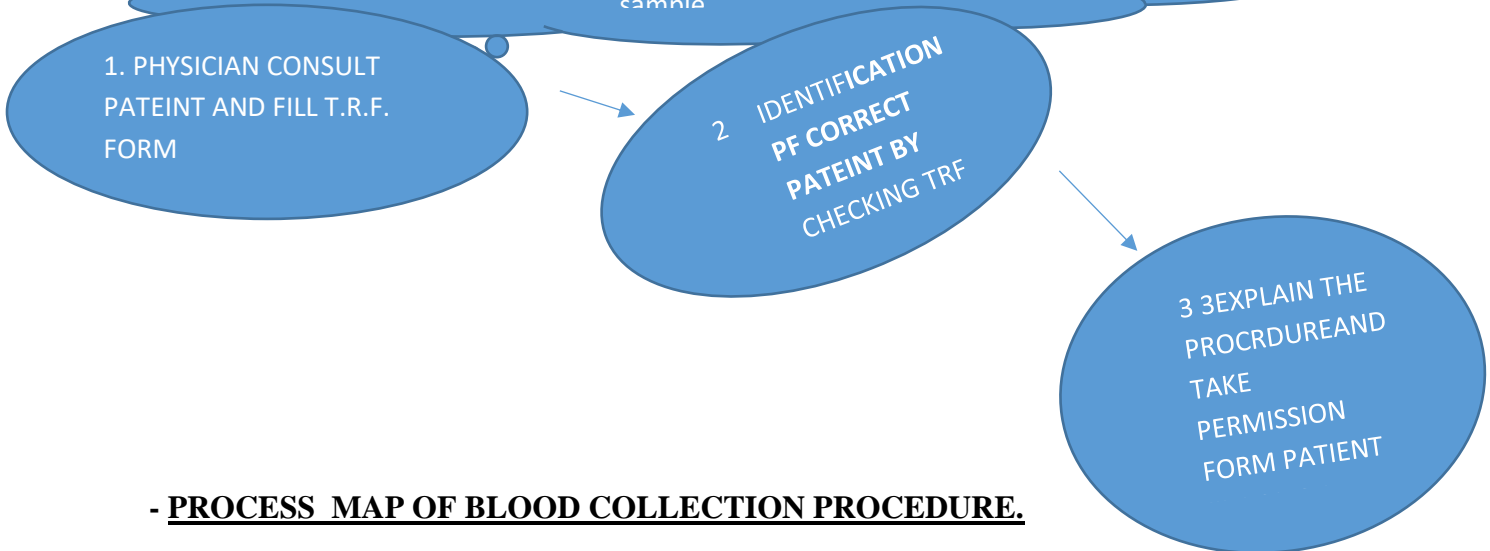
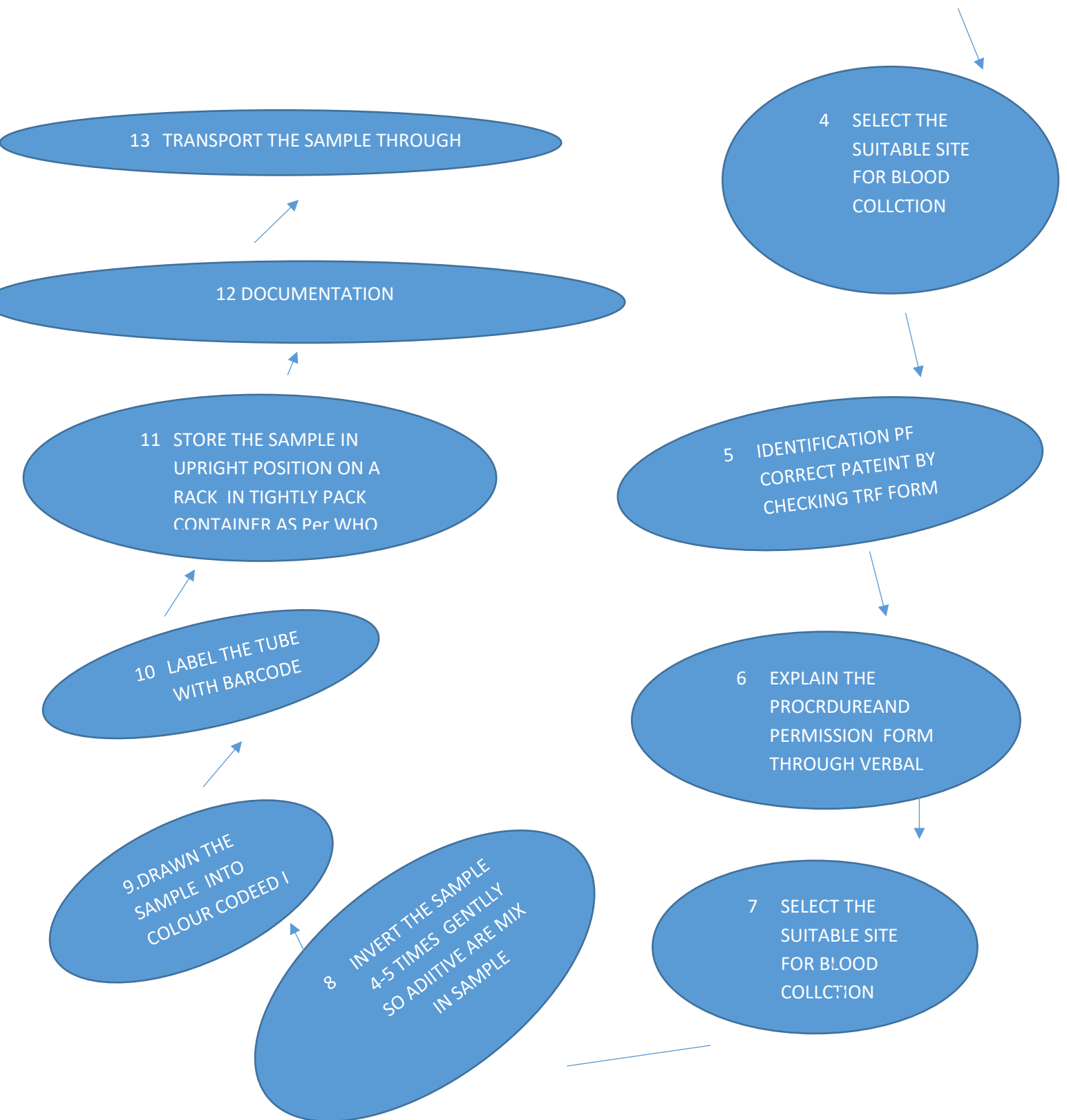
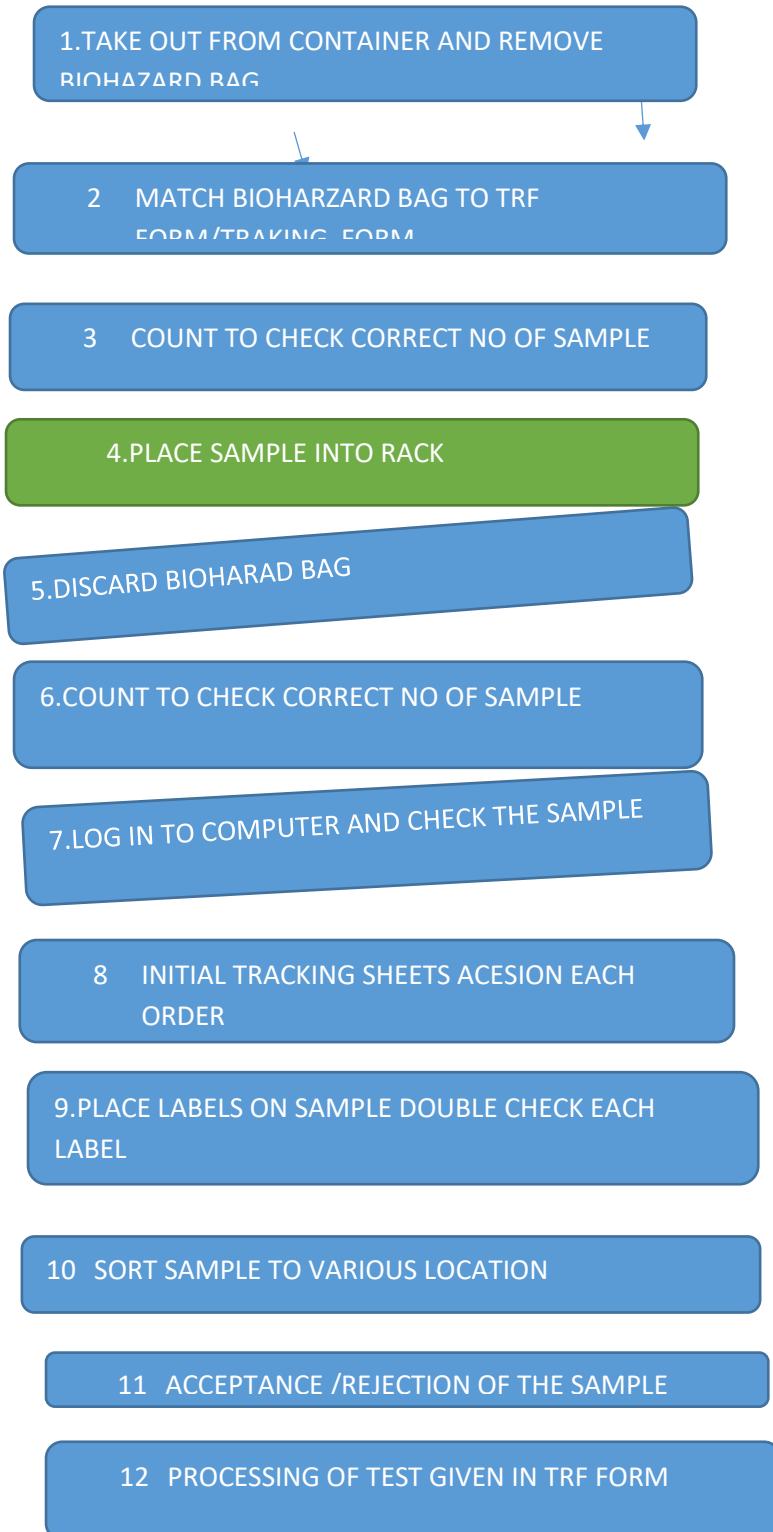


FIGURE1 -Cause & Effect diagram displays reasons for rejected sample



**- PROCESS MAP OF BLOOD COLLECTION PROCEDURE.**





13 REPORTING OF SAMPLE

14 B.M.W OF THIS SAMPLE

**Flow chart –Process flow chart of sample processing &disposal**

- LEECHES
- STEEL TUBE
- HYPODERMIC NEEDLE/SYRINGES
- VACCUM EXTRACTION SYSTEM
- VEIN FINDER

**EVOLUTION IN TOOL OF BLOOD COLLECTION**

Vein finder



VACCUM EXTRACTION SYSTEM



HYPODERMIC NEEDLE/SYRINGE



STEEL TUBE



Leeches

Figure 3 Evolutionary tool in phlebotomy

