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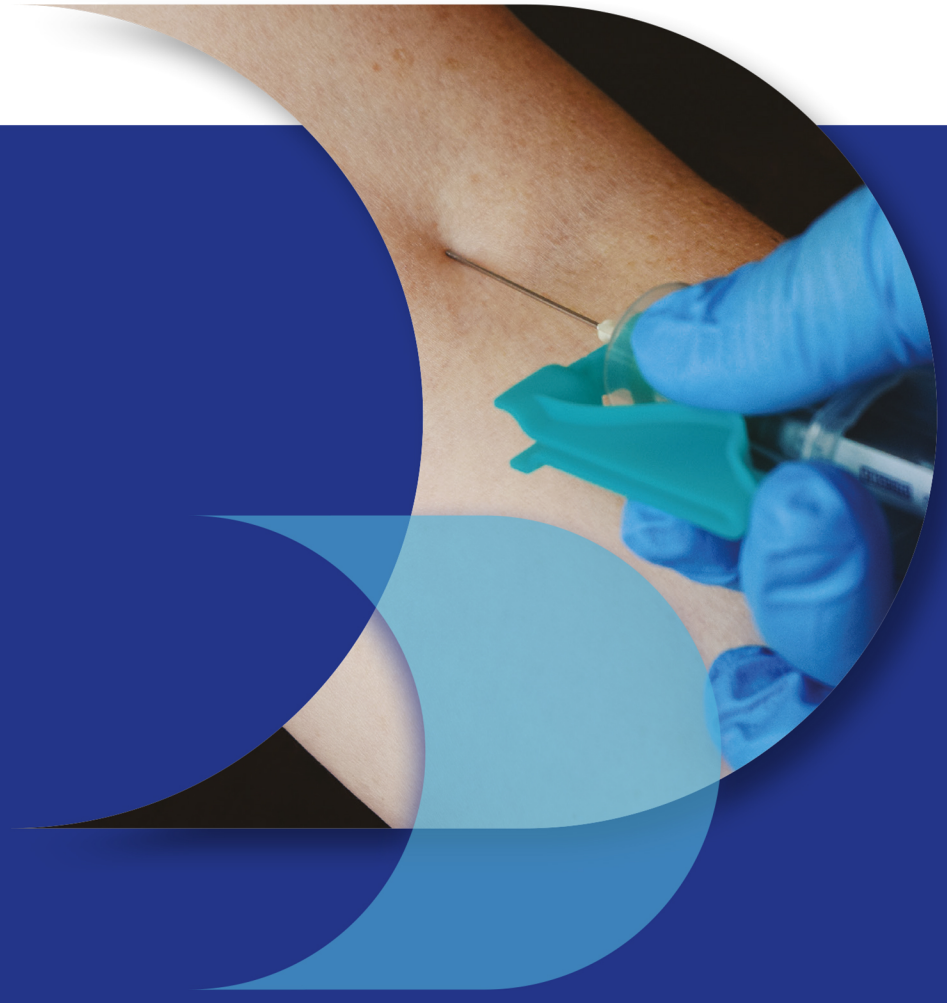
BLOOD COLLECTION GUIDE BY VENIPUNCTURE FOR ANALYTICAL PURPOSES



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Readers should consult the original French document for the official text if needed.

FOREWORD

This document is the English translation* of the OPTMQ (Ordre professionnel des technologistes médicaux du Québec) guide with regards to blood collection by venipuncture for analytical purposes. This guide replaces the sixth edition of the rules of practice "Blood collection by venipuncture for analytical purposes" of the OPTMQ. This guide was developed by the OPTMQ and is published jointly with the Ordre des infirmières et infirmiers auxiliaires du Québec (OIIAQ), the Ordre des sages-femmes du Québec (OSFQ), the Ordre des technologues en imagerie médicale, en radio-oncologie et en électrophysiologie médicale du Québec (OTIMROEPMQ) and the Ordre professionnel des inhalothérapeutes du Québec (OPIQ). A copyright license has been granted to the OIIAQ, the OSFQ, the OTIMROEPMQ and the OPIQ.

In order to fulfill their mandate which is to protect the public, the professional regulatory bodies oversee the practice of their respective professions, by general supervision and by the education of their members. The regulatory bodies ensure that their members maintain their competencies and have access to appropriate tools to guide them in the exercise of their functions

Professionals must have the competencies required to practice their profession. These competencies translate into knowledge, know-how and knowing how to be and act. Although his role, participation and responsibility vary according to the profession concerned as well as the institution and the sector of activity, the health professional must know and comply with the policies and procedures in force at his workplace. The exercise of professional judgment also requires the capacity to apply established policies and procedures with all the necessary diligence as well as the adaptability required by the circumstances.

This guide specifies the competencies related to blood collection by venipuncture for the purpose of analysis, in order to ensure the collection of biological samples representative of the patient's condition at the time of collection, to minimize the inconvenience that could be caused by this intervention and to promote the safety of all parties. In addition, institution can use this document as a reference that they can integrate into their quality management approach.

This document does not intend to create any new obligations not prescribed by law. The information contained in this document is not exhaustive and does not replace the regulations in effect. This document is valid as long as no contrary or incompatible regulatory or legal framework modifies it directly or indirectly in any way. Given the rapid evolution of technology, it will be subject to revision, and any suggestions that may improve the content will be considered with interest.

When a reference mentioned in this document is not dated, it means that it is refers to the most recent edition of the document. The hypertext Internet links in this document were operational when this guide was published. It should be noted that the title of "health professional" designates both men and women.

FOREWORD (continued)

In this document, the term "laboratory" refers to an entity that includes, laboratory personnel, managers and laboratory management, among others.

In this document, the term "collaborators" designates the OIIAQ, the OSFQ, the OTIMROEPMQ and the OPIQ.

In this guide, the mention of a supplier, a company, a product or a service does not mean that the OPTMQ and its collaborators vouch for this said supplier, company, product or service; as well as not mentioning a supplier, a company, a product or a service should not be interpreted as a disavowal.

* In the event of any discrepancy between the English and French versions, the French version shall prevail.

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Abbreviations and acronyms

aPTT : Activated partial thromboplastin time

ASSTSAS : Association paritaire pour la santé et la sécurité du travail du secteur affaires sociales

CAN/CSA : Canadian Standards Association/Association canadienne de normalisation

CISSS : Centre intégré de santé et de services sociaux

CIUSSS : Centre intégré universitaire de santé et de services sociaux

EDTA : Ethylenediaminetetraacetic acid

G : measuring unit of the size of a needle

HBV : hepatitis B virus

HBC : hepatitis C virus

HIV : human immunodeficiency virus

ISO : International Organisation for Standardization

OIIAQ : Ordre des infirmières et infirmiers auxiliaires du Québec

OPIQ : Ordre professionnel des inhalothérapeutes du Québec

OPTMQ : Ordre professionnel des technologistes médicaux du Québec

OSFQ : Ordre des sages-femmes du Québec

OTIMROEPMQ : Ordre des technologues en imagerie médicale, en radio-oncologie et en électrophysiologie médicale du Québec

PHAC: Public Health Agency of Canada

PPE : personal protective equipment

PT : Prothrombin time

T.M. : technologiste médical- medical technologist

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1.0 Introduction

The quality and the preservation of the integrity of blood samples taken by venipuncture are essential for obtaining reliable test results. To obtain reliable results, a preparation stage, or preanalytical phase, respecting recognized quality criteria must precede the analytical phase.

The venipuncture blood collection is part of the preanalytical phase of the overall laboratory services production process. This phase includes preparation of the patient, unequivocal verification of his identity and the prescription, the choice of the optimal time to collect the sample and the appropriate tube, the actual collection as well as transportation, stabilization and storage of samples under appropriate conditions until the time of analysis. In the laboratory, this phase ends with the validation of the quality of the samples received and their preparation for analysis.

At this preanalytical stage, the health care professional must be aware of the main factors and risks that may affect the outcome and accuracy of the analysis. These factors may also depend on the patient's condition (e.g., circadian rhythm, pregnancy) or on modifiable factors such as diet, medication, or patient position during collection. These parameters are of fundamental importance for the accuracy and correct interpretation of the results. In addition, lack of adequate safety rules may cause irreparable harm to patients and healthcare professionals.

2.0 Scope

This guide deals with blood collection by venipuncture for analytical purposes. It is intended for individuals responsible for blood sample collection, instructors and managers of blood collection services, whether these are carried out in a public institution, in private practice facility or at the patient's home.

Venous blood collection for therapeutic purposes or as part of blood donation is not covered in this guide.

3.0 Definitions

Terms specific to venipuncture blood collection [1]	
Additive	Substance added to a tube to promote or prevent blood clotting.
Analyte	Substance to analyze.
Antecubital fossa	Triangular depression on the anterior side of the elbow. Also called the elbow pit.
Anticoagulant	Substance that halts or prevents blood clotting, used in the treatment of thromboembolic diseases or added to a blood sample to prevent blood clotting.
Blood: anticoagulant ratio	The ratio between the volume of blood added to a tube and the amount of anticoagulant present in the tube.
Blood culture	Inoculation of a small amount of blood into a suitable culture medium, for the purpose of detecting pathogenic microorganisms circulating in the blood.
Clot	A mass of coagulated blood made up of an insoluble fibrin network that entrap blood cells.
Clot activator	A mass of coagulated blood made up of an insoluble fibrin network that entrap blood cells.
Gauge	Inner diameter of a needle; expressed in G units.
Hematoma	Collection of blood in a tissue, often under the skin, due to vascular damage. Also called ecchymosis, bruise.
Hemoconcentration	Increased concentration of macromolecules in the blood due to a decrease in plasma volume.
Hemolysis	Destruction of red blood cells.
Hemostasis	The physiological phenomena that stop bleeding or the therapeutic measures taken to stop bleeding.
Lateral	Between two anatomical structures, the one furthest from the median sagittal plane (middle) of the body. Also called external.
Licensed professional	A member of a professional regulatory body who is authorized to perform certain activities, under the Professional Code, specific laws or regulations.

Lymphostasis	Significant decrease or cessation of lymph circulation.
Medial	Between two anatomical structures, the one closest to the median sagittal plane (middle) of the body. Also called internal.
Personal protective equipment (PPE)	Equipment or clothing worn by personnel to provide a barrier against infectious substances, chemicals and toxins in order to reduce the risk of exposure to them [(2)].
Prescriber	Health professional empowered by law to prescribe diagnostic and therapeutic measures.
Puncture	Intervention which consists of inserting an instrument into a cavity of the human body to remove its content or to insert a substance into it.
Puncture site	Limb or region of the body where the puncture is performed.
Sample	Part of a liquid or organic tissue taken from a patient for analysis.
Sample integrity	State of a sample which has not been altered, degraded or denatured [(3)].
Tourniquet	Elastic tie used to interrupt the circulation of blood in a limb by external compression.
Tube holder (barrel)	Plastic cylinder opened at one end, into which the tube to fill is inserted for a needle to be pushed into it, which is screwed in place at the other end.
Unique patient identification number	Numeric or alphanumeric code used to identify a precise person in a database.
Vascular access device	Any device (such as a catheter) positioned to provide access to a blood vessel for blood collection, administration of medication, or performing certain procedures.
Venipuncture	Blood collection using a needle punctured into a vein [(3)].
Venous blood collection	All the steps necessary to obtain a good quality and correctly identified venous blood sample.

Winged blood collection set	Needle with two small wings used for gripping and positioning, with tubing of variable length and a connector to link it to a tube holder. Also called butterfly needle.
General Definitions	
Analytical process	A series of steps that include processing and analyzing the sample to measure or detect analytes or screen for diseases.
Policy	A statement or written document that clearly indicates the organization's position and values in regard to a given topic [(4)].
Postanalytical process	A series of steps that follow the analysis and include reviewing the results, validating, interpreting, transmitting and archiving the analysis report, as well as storing the analyzed samples [(6)].
Preanalytical process	A series of steps beginning with the prescription, including subsequently verifying the identity of the patient and his preparation, collecting, stabilizing, transporting and receiving the sample in the laboratory and ending with the start of the analytical process [(6)]
Procedure	Documentation and technical instructions explaining all the steps to follow to carry out an activity. The expressions *standard operating procedures* (SOP) and *documented procedures* can also be used.
Process	« A set of interrelated or interacting activities that use input elements to produce a desired result. » [(5)] ISO 9000 :2015, 3.4.1.
Quality	Degree of excellence or the extent to which a service meets the needs and expectations of customers while respecting generally accepted standards [(4)].
Quality management system	All of the planning, management, controls, and quality assurance activities intended to ensure or maintain quality.
Traceability	Process for retrieving the history, implementation or location of what is being examined [(5)].

Validation	« Confirmation, through the provision of objective evidence that the requirements for a specific intended use or application has been fulfilled. » [5] ISO 9000 :2015, 3.8.13.
Verification	« Confirmation, through the provision of objective evidence that the specified requirements have been fulfilled. » [5] ISO 9000 :2015, 3.8.12.
Meaning of the terms «*shall*», «*should*» and «*can*»	
Shall :	In this document, the term "shall" indicates the obligation to respect or apply the prescribed requirements, either because they are required by the regulations in force or because they relate to a competency which the healthcare professional must have. The expression "must" has the same meaning.
Should :	In this document, the term "should" means that the statement is based on scientific facts and that it is recommended to respect or apply it.
Can :	In this document, the term "can" means that the statement is considered valid and that its application is desirable.

4.0 Quality Management system

ISO 15189: *Medical laboratories – Requirements for quality and competence* is a recognized standard, which is applied in biomedical laboratories for the development of quality management systems [6] [7] [8].

This guide presents certain requirements taken from ISO 15189 to inform the reader of the points applicable to venipuncture collection. However, it is not intended to be an interpretation of this standard; for more information, the reader must refer to the latest edition of the standard.

As prescribed by the ISO 15189 standard, the laboratory shall set up a quality management system to ensure the quality of its preanalytical, analytical and postanalytical processes. This system covers all stages of the process, from the prescription of the analysis to the transmission and archiving of the test results. The quality management system includes the implementation of control measures which include, among other things, the management of non-compliant cases, incidents and accidents, corrective and preventive measures, quality indicators, audits and purchases [6].

For more information on quality management systems, consult the following documents :

- INTERNATIONAL ORGANIZATION FOR STANDARDIZATION. ISO 15189 (F) *Medical laboratories - Requirements for quality and competence* [6];
- ORDRE PROFESSIONNEL DES TECHNOLOGISTES MÉDICAUX DU QUÉBEC. *Quality management guide in biomedical laboratories* [9].

5.0 Health and safety measures

The *Act Respecting Occupational Health and Safety* establishes safety requirements for the employer and the worker [10]. This Act deals with matters such as required training on health and safety, and the information that the employer must provide to staff. It is the responsibility of the healthcare professional to be aware of the prevention program and any information in relation to his work and to participate in training activities offered to him [11].

The health professional shall practice his profession safely. He shall follow the health and safety policies and procedures in effect at his working institution. He shall adopt the necessary measurements to ensure his protection and that of others, and he shall use the material and equipment in a safe manner [11]. The healthcare professional shall assess the risks inherent to each intervention and use the appropriate personal protective equipment (PPE) (gloves, gowns, masks, etc.) [12].

To find out more about the safety measures to be observed when collecting blood by venipuncture and in the biomedical laboratory, consult the following documents :

- *Act respecting occupational health and safety* [10];
- *Regulation respecting occupational health and safety* [13];
- *Laboratory safety - CSMLS guidelines* [14];
- *CAN / CSA-Z15190 Medical laboratories - Requirements for safety* [15];
- PUBLIC HEALTH AGENCY OF CANADA, *Canadian Biosafety Standard* [2];
- PUBLIC HEALTH AGENCY OF CANADA, *Canadian Biosafety Handbook* [16].

In addition, anyone involved in the handling or collection of blood specimens, body fluids and other specimens should follow the recommendations published by the Public Health Agency of Canada and described in the following documents :

- *Routine practices and additional precautions for preventing the transmission of infections in healthcare settings* [12];
- *Hand hygiene practices in healthcare settings* [17].

5.1 Pathogenic agents

Certain pathogenic agents such as the human immunodeficiency virus (HIV) and hepatitis B (HBV) and C (HCV) viruses may be present in blood samples (18). All samples shall therefore be considered as potentially infectious. Standard precautions (which include universal precautions for blood and body fluids) shall be followed when handling these samples [12] [14]. In the event of an accidental needlestick, rapid follow-up must be carried out in accordance with the procedure in force. For more details on post-exposure prophylaxis, consult the "*Guide pour la prophylaxie et le suivi après une exposition au VIH, au VHB et au VHC*" (Guide for prophylaxis and follow-up after exposure to HIV, HBV and HCV) from the MSSS [18] at the following link :

http://publications.msss.gouv.qc.ca/msss/fichiers/2018/18-338-01W.pdf .

5.2 Hand hygiene

Hand hygiene is the single most important measure to prevent the spread of infection in healthcare [17].

Hands shall be washed or disinfected before and after any contact with a patient or his environment and after any situation that may involve a risk of exposure to a biological liquid, which includes following glove removal [3] [12] [14] [15] [17] [19] [20].

According to the references consulted, the use of hydro-alcoholic solutions is an acceptable method for sanitizing the hands [3] [12] [17] [21].

According to the Public Health Agency of Canada [17], washing hands with soap and water is preferable in the following situations :

- to remove visible soil or organic material;
- when multiple uses of hydro-alcoholic solutions lead to a buildup on the skin (note: the hydro-alcoholic solution still remains effective in such situation);
- at the point of care, after treating a patient with a norovirus infection or spore-forming pathogens such as *C. difficile*;
- during outbreaks or in facilities where the level of transmission of norovirus infections or spore-forming pathogens such as *C. difficile* is high;
- immediately after using the toilet.

5.3 Glove use

As prescribed by PHAC [12], wearing gloves is not a substitute, for hand hygiene, but is considered an additional protective measure. In terms of basic practices, the need to wear gloves depends on the patient's point of care risk assessment (PCRA), environment and interaction. Gloves are used to reduce the transmission of microorganisms from one patient to another or from one area of the body to another, as well as to reduce the risk of exposure of the healthcare professional to blood, body fluids, secretions and excretions, mucous membranes, exudative wounds and non-intact skin; they are also worn to handle objects or touch visibly or possibly soiled surfaces. The gloves do not eliminate all risk of contamination, as the hands can be contaminated if the gloves worn are punctured or when the gloves are removed. Therefore, hands must be washed or disinfected after removing gloves.

Gloves shall be changed between each patient. Disposable gloves are for single use only, they shall not be washed [12].

To maintain their protective effect, gloves must remain intact during the intervention; the part of the glove covering the fingertip must not be cut or removed [22].

For more information on wearing gloves, consult the following documents from the Public Health Agency of Canada:

- *Routine practices and additional precautions for preventing the transmission of infection in healthcare settings* [12];
- *Hand hygiene practices in healthcare settings* [17].

5.4 Ergonomics

It is important for the employer to assess the physical (e.g., restrictive postures, repetitive movements) and cognitive (e.g., work overload) requirements of the various tasks in order to make any necessary corrections, if needed [23]. Ergonomic considerations should be part of the material purchasing policy. The physical design of the work environment requires that attention be paid, among other things, to the size differences of the employees likely to work in the environment as well as to their manual preference (left or right-handed). Acquiring adjustable equipment and devices can be an interesting option for patient and healthcare professional comfort [24]. The requirements for phlebotomy chairs are presented in point 10.8.

The ASSTSAS (Association paritaire pour la santé et la sécurité du travail du secteur affaires sociales) has created a technical data sheet for the layout of the blood collection station [25] which can be consulted at the following link : http://asstsas.qc.ca/publication/laboratoire-poste-de-prelevement-ftl6.

5.5 Waste management

Blood tubes and materials that have been soiled with blood, fluid or biological tissue shall be discarded in accordance with the *Regulation respecting biomedical waste* [26] [27].

Any pointed, sharp or breakable objects that have been in contact with blood, liquid or biological tissue shall be discarded in puncture-resistant containers. The standard CAN / CSA-Z316.6 *Sharps injury protection – Requirements and test methods – Sharps containers* sets out requirements for single use sharps containers [(28)].

In addition, follow these precautions to prevent injury [(29)] :

- place the approved container for contaminated sharps in an area easily accessible to the healthcare professional and near the location of production;
- place the container in a stable area to prevent it from tipping over;
- do not fill the container above the maximum filling line;
- never recap the needle, unless using an appropriate device;
- do not compress or transfer the contents of the sharps container;
- close the container when it is full.

6.0 Personnel

As prescribed by the ISO 15189 standard, the management of the facility shall ensure the presence of a sufficient number of staff with the required training and skills necessary to provide quality blood collection services [(6)]. Since blood collection by venipuncture is an activity reserved for members of certain professional regulatory bodies, the allocation of tasks shall be carried out in accordance with the procedures governing the exercise of this interprofessional practice [(30)].

The training of the healthcare professional shall cover each step of the blood collection process. In addition to learning, collection methods, necessary tools must be given to the professional for him to understand the consequences of not respecting the steps of the collection process and to be able to deal with possible incidents. It is aimed to make professionals competent, responsible, conscientious and concerned with the patient's well-being and the quality of the analysis results obtained [(31)] [(32)].

Healthcare professionals who perform venipuncture shall be able to intervene with the patient in case of discomfort or complication, in accordance with their scope of practice. For some professionals, their scope of practice may involve having received and maintained training in cardiopulmonary resuscitation (CPR). Each professional should consult their professional regulatory body to find out their requirements [(33)]. For staff required to move patients for venipuncture, training on the principles of safe patient transfer (PDSB) is desirable in order to reduce the risk of injury to staff and patient. In addition, training on the customer approach is recommended.

As prescribed by the ISO 15189 standard, a continuing education program shall ensure the maintenance of competencies of personnel involved in management and technical processes [(6)].

7.0 Teaching and reference material

In order to perform their daily work as well as for orientation and continuing education, health professionals shall have access at all times to the reference material necessary for the performance of their duties [3] [6].

8.0 Accommodations and environmental conditions

As prescribed by the ISO 15189 standard, the facilities used for the collection of biological samples must include separate reception / waiting and collection areas. Facilities shall be designed to ensure the safety, confidentiality, comfort and needs of patients and accompanying persons. The facilities where the blood is collected must allow these activities to be carried out without invalidating the results of the analyses or affecting the quality of the exams [6] [23]. These facilities must be accessible to people with reduced mobility and stretchers [34].

Venous blood collection tubes and blood samples are sensitive to temperature and humidity [35]. Therefore, there shall be surveillance, monitoring and recording of these parameters and other conditions specified by the manufacturers in case their variability could affect the quality of the samples or the health of the personnel [6]. To find out the humidity and temperature ranges to be observed, consult the manufacturer's information sheet of the tubes used.

The following subsections mainly apply to specially adapted rooms for blood collection. Some requirements may not apply in other locations and circumstances, such as in the operating room and home care services.

8.1 Waiting room layout

Waiting rooms should be well ventilated and spacious enough to ensure that the spacing between seats minimizes direct contact between patients [3].

These waiting rooms should be equipped with hydro-alcoholic solution dispensers and disposable masks. Appropriate signs should inform patients who may have respiratory tract infections to wear a mask and consult the reception if they know they have a potentially transmittable disease [3] [36].

8.2 Blood collection room layout

The layout of the blood collection room should be planned in such a way as to offer the following elements [3] [23] :

- easy access for patients and staff;
- patient comfort, security, confidentiality and privacy:
  - a bed or stretcher located in an area where it's possible to monitor patients with conditions that are considered a medical emergency;
  - appropriate furniture that is easy to disinfect and ensures patient safety if he/she loses consciousness, and which makes blood collection easier for staff and the patient by its ergonomic design;
  - an emergency response kit, whose content shall be verified periodically and replaced before its expiry date;

- an emergency services telephone number (or an emergency button) to quickly get help if needed;
- nearby restroom;
- access to hydro-alcoholic solutions (whose alcohol concentration is between 60 and 80%) for staff collecting blood samples [37];
- a sink available for staff collecting blood samples to wash their hands;
- the materials and equipment necessary for the collection, stabilization, transport and storage of samples;
- an appropriate space for storing all the necessary material for collection of blood samples, which avoids cross-contamination with the contaminated material.

9.0 Document management

In quality management systems, documentation refers to policies, processes and procedures. As prescribed by the ISO 15189 standard, documented procedures shall be developed for all the preanalytical activities performed [6]. It is the responsibility of the healthcare professional to be aware of these procedures and to comply with them, while using professional judgment when required by the situation.

These procedures shall be accessible to all personnel who perform blood collection by venipuncture. They shall be part of the sample collection manual (see point 9.1) [6].

9.1 Sample collection manual

As prescribed by the ISO 15189 standard, the instructions for the collection and handling of samples shall be documented and applied by laboratory management and be accessible to those responsible for collecting samples [6]. These instructions can be included in a sample collection manual.

The biomedical laboratory must be responsible for developing the manual, which must be part of an approved document control system that is reviewed at specified intervals [6].

The sample collection manual shall include, but not be limited to, the following [3] :

- copies or references to the following:
  - lists of laboratory tests offered;
  - turnaround time for obtaining the test results;
  - consent or refusal forms, if applicable;
  - information and instructions provided to the patient for his own preparation before sample collection;
  - information for users regarding medical indications and the appropriate selection of methods offered;
  - sample acceptance and rejection criteria;
  - safety precautions for toxic or hazardous materials that are provided for self-collection of samples (e.g., 24-hour urine collection containers to which preservatives have been added);

  - any additional requirements regarding samples handling between the time of collection and its arrival in the laboratory (e.g., requirements for transportation, storage, protection of samples from light, refrigeration, warming and immediate delivery);
  - a list of preanalytical factors that can affect the results;
  - the opening hours and telephone numbers of the blood collection service or the biomedical laboratory;
  - sample delivery points;
- directives or instructions on the following points:
  - how to complete the prescription or its electronic equivalent (including recording clinical information, e.g., medication history);
  - observing the patient's condition and the blood collection site, and selecting the material (if applicable) in order to optimize the integrity of the sample and the patient's well-being;
  - handling patients with communication challenges;
  - unequivocal and detailed identification of the patient;
  - the type and amount of blood samples to be collected, including, if applicable, the appropriate volume of blood to be collected according to the volume of additive in a tube;
  - the collection of samples with the description of the material and any necessary additives;
  - timed collections;
  - labeling of samples;
  - recording of the date and time of the collection, and of the identity of the person collecting the sample;
  - the safe disposal of materials used for collection;
  - storage of examined samples;
  - acceptable delay periods for the request of add-on tests.

10.0 Material

The material shall be verified before use and not used beyond the expiration date [(3) (22)].

The managers shall put at the disposal of health professionals all the necessary material for blood collection and transportation of samples to the biomedical laboratory. The choice of material shall be based on the needs of the different areas of activity where samples are collected [(3) (22)].

10.1 Needles and winged blood collection sets

Needles and winged blood collection sets (commonly called butterfly needles) shall be [22] :

- sterile;
- individually wrapped in protective sheaths;
- gauge size (G) adapted to the size and condition of the vein as well as the collection technique. The higher the caliber, the smaller the internal opening diameter of the needle. The length of the needles generally varies between one inch and one inch and a half.

Table 1 presents the sizes of needles **most often** used to draw blood by venipuncture.

Table 1. Needle sizes commonly used for venipuncture

Caliber	Application
20 G	Large veins
21 G	Normal sized veins
22 G	Small veins
23 G (butterfly)	Difficult veins, delicate blood collection or for certain patients (newborns, children, elderly patients)

The use of a very small needle may cause hemolysis (see section 14.2.1 on the effects of hemolysis) [38]. The 25G caliber needle should be used with caution and be reserved only to specific cases [22].

Note : Collection with a winged blood collection set is described in point 11.14.2.

10.2 Antiseptics

Various antiseptics can be used [19] [22], taking into account the patient's allergies when selecting the appropriate one from the following list:

- 70% isopropyl alcohol (in bottle or alcohol pad);
- iodized polyvidone;
- 2% chlorhexidine digluconate in 70% isopropyl alcohol (chlorhexidine alcohol). This antiseptic should be used with caution in premature infants and children under two months of age, as it may cause irritation or burns [22] [39] [40] [41] [42].

This list is not exhaustive; comply with the recommendations in effect in the workplace.

10.3 Tube holders

The tube holders shall correspond to the diameter of the tubes used, be clean and **free from any visible contamination** [22].

It is recommended to use single-use tube holders and to discard them without detaching the needle and take a new one for each new patient [12] [22] [43]. If such tube holders are not available, the tube holder should be disinfected using the prescribed technique by the Infection Prevention and Control Committee or the manufacturer [3].

Check the tube holder threads before each use and change the tube holder when necessary [22].

The tube holders are designed to be used with needles and tubes from the same manufacturer. If the sample is collected with components from different manufacturers, it shall be validated for compatibility before use [22] [43].

The model of tube holder chosen should be suitable for the intended use (e.g., tube holders for smaller volume tubes) and be safe for the person collecting the sample [43]. It is recommended to use tube holders fitted with integrated safety devices (e.g., integrated needle ejection device or needle cover upon withdrawal from the vein), which protect the phlebotomist from accidental needlestick injuries with used needles [22].

10.4 Carts

These are carts designed to move easily and quietly on all types of surfaces. They should have the following characteristics [22]:

- a frame made of stainless steel or resistant synthetic material, allowing adequate maintenance and decontamination;
- wheels 10 cm to 12 cm diameter to facilitate the entry and exit from elevators;
- shelves with edges, large enough to store all the material in a functional way.

When not in use, carts shall be stored in a location that does not expose them to contamination [43].

10.5 Gauze pads

Clean gauze pads, sterile or non-sterile can be used. It is not recommended to apply a cotton ball to the puncture site because the ball may dislodge the platelet plug when it is removed [22].

10.6 Rigid containers for soiled needles

- According to the standard CAN / CSA-Z316.6 *Sharps injury protection - Requirements and test methods - Sharps containers*, the containers used to collect needles must be [28] :
- leak proof;
- puncture resistant;
- marked with a maximum visible fill capacity indicator not to be exceeded;
- resistant to manual opening once the closure mechanism is activated;
- labeled with the words « Biomedical waste ».

10.7 Permanent ink marker

Permanent ink markers are used to write the required information on the labels of the collection tubes.

10.8 Armchairs or phlebotomy chairs

To ensure patient comfort and safety, these armchairs or phlebotomy chairs should be [22] [44] :

- equipped with adjustable surfaces allowing the ideal positioning or to recline the patient;
- of ergonomic design.

However, these armchairs or phlebotomy chairs shall [22] [44] :

- ensure patient safety in the event of discomfort [3] [22] [25];
- be covered with materials that allows the decontamination of all their surfaces [36].

10.9 Gloves

Gloves made of various materials shall be available. The choice of gloves shall also be based on the patient's sensitivity to latex or other material [12].

People who develop dermatitis with latex gloves can try gloves made of other materials or wear cotton gloves under the disposable gloves [39]. Washing hands thoroughly after using gloves can help avoid sensitization. Wait till the hands are completely dry before putting on the gloves, as they can irritate wet skin. The application of a protective cream or lotion to the hands improves the condition of the skin, provided that this product is compatible with the hand hygiene products and gloves used [45].

Information on glove use is given in point 5.3.

10.10 Tourniquet

The choice of the tourniquet should be based on the patient's sensitivity to latex or other materials [22] [39].

It is recommended to use single-use tourniquets. If such tourniquets are not available, the tourniquet shall be disinfected using the technique prescribed by the Infection Prevention and Control Committee or the manufacturer [3] [12] [22].

A sphygmomanometer can also be used. However, only appropriately trained healthcare professionals should use such a device, taking care not to exceed the patient's diastolic pressure [22].

10.11 Ice or other cooling device

Ice or another cooling device may be necessary if the patient has a discomfort or to maintain the integrity of the sample which must be kept cold during transport.

10.12 Bed or other resting furniture

A bed, a stretcher or any other piece of furniture that allows the patient who is at risk of fainting or discomfort to lie down [3] [22]. This piece of furniture shall be covered with material that allows for its full decontamination [36].

10.13 Transport material

The material necessary for sample packaging shall be provided [3].

10.14 Bandage and adhesive tape

The bandage or adhesive tape is applied to the puncture site to protect it and help stop the bleeding with gentle pressure [22].

The choice of bandage and adhesive tape shall be based on the patient's sensitivity or possible allergies [22] [39].

10.15 Collection trays

This tray should be [22] :

- lightweight;
- compact;
- large enough to hold all the necessary material;
- made of a material allowing for its decontamination [36].

In order to avoid contaminating the patient's environment, the trays shall not be placed in a contaminated area of the laboratory or stored in an area likely to contaminate them.

10.16 Towels and absorbent pads

Towels and absorbent pads can be helpful if blood samples need to be placed on an uncontaminated or slippery surface.

10.17 Blood collection tubes

The collection tubes shall be [22] :

- sterile;

- designed to collect the determined blood volume;
- diversified to meet the test requirements;
- discarded after their expiration date.

The order of draw is presented in point 11.15.1.

The tubes shall not be opened before collection to preserve the vacuum and sterility [43].

10.17.1 Tube information sheet

The healthcare professional should have access to a technical sheet regarding the tubes used, including the following information [3] :

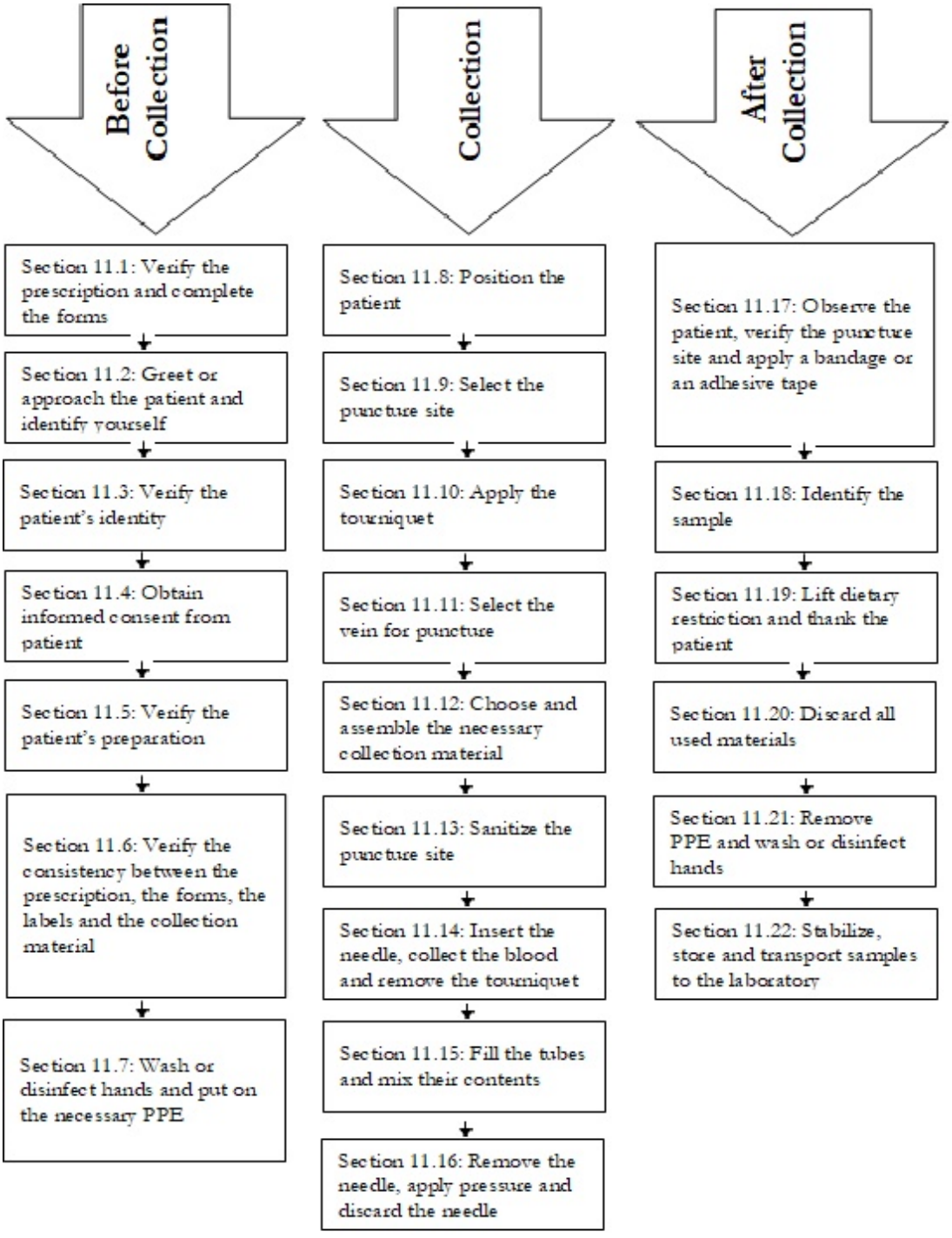
- different tubes offered;
- prescribed order of draw;
- additives;
- the recommended number of inversions;
- the conditions of use and the sources of interference which may interfere with the analysis.

A wall poster makes it easier to consult this type of information.

Note : Some collection tubes contain additives (e.g., gel, anticoagulants) which may interfere with the analysis [46] [47]. It is important to know the product and the limitations indicated by the manufacturer or updated in most recent publications.

11.0 Venipuncture steps

Performing venipuncture requires both knowledge and dexterity. The professional who performs this type of collection shall follow the following steps. **Refer to the corresponding sections for more details.**



A table summarizing the important points of each step is presented in Annex 1. Illustrated description of the steps to follow is given in Annex 2.

11.1 Verify the prescription and complete the forms

The prescription for a laboratory test, or its electronic equivalent, must be drawn up by a person legally empowered to prescribe examinations or laboratory tests [30].

Make sure you understand the prescription. In doubt, verify the prescription with the prescriber or an authorized person [3].

The professional regulatory bodies whose members may prescribe analyses and examinations have adopted regulations which specify the elements to be included in the individual prescription [48] [49] [50] [51] [52] [53]. A list of professionals authorized to prescribe biomedical analyses and examinations in Quebec is available on the OPTMQ website at www.optmq.org.

Here are the elements that must appear on the individual prescription for examinations or laboratory tests according to the Regulations of the College des Médecins du Québec [48] :

- the name of the prescriber printed or in block letters;
- his license number;
- the name of the institution or clinical setting, the telephone number and the correspondence address where he wishes to be contacted in relation to this prescription;
- the patient's name;
- the patient's date of birth or Healthcare insurance number (RAMQ);
- the date the prescription was written;
- the period of validity of the prescription, when justified by a patient's clinical condition;
- if applicable, any contraindication or any other information required by the patient's clinical condition;
- the nature of the examination as well as the clinical information needed to perform or interpret the examination or analysis;
- the prescriber's signature.

Note : During a patient's stay in an institution, the prescriber can issue an individual prescription on which the name of the institution or the clinical setting does not appear, as well as the telephone number and correspondence address where he wishes to be reached in relation to this prescription [48].

The validity period of the individual prescription for examinations or laboratory analysis is not limited in time, unless otherwise specified by the prescriber [54].

According to the regulations of the Collège des Médecins du Québec, the prescriber can issue a denominated individual prescription on which he indicates an identifier of his choice, to allow the targeted patient to be linked to the result of a screening laboratory test for a sexually or blood-borne transmitted infection as part of the national public health program [48].

The Collège des Médecins du Québec has published an exercise guide entitled *Individual prescriptions written by a physician* [55], available at the following Internet address :

http://www.cmq.org/publications-pdf/p-1-2016-10-03-en-ordonnances-individuelles-faites-par-un-medecin.pdf

Verify that the prescription, forms and all material relating to the same patient bear the same identification (last name, first name and patient-specific identification number) [22] [56].

11.2 Greet or approach the patient and identify yourself

Greet or approach the patient and identify yourself by mentioning your name, professional title and carry an identification card that is easily visible to the patient [57] [58].

All contact with the patient must be characterized by a calm attitude, which reflects competence and professionalism [59]. Calmness, a smile, respect, empathy and discretion are key elements of the process. Overly familiar language shall be avoided as well as the use of nicknames [57]. Observe the patient throughout the procedure to detect any signs of discomfort [22].

Certain professional regulatory bodies have published documents that deal with the image that the professional must project [57] [58].

11.3 Verify the patient's identity

The patient's identity shall be unequivocally established before sample collection [3] [22] [56] [60] [61].

The laboratory shall develop and implement a patient identification procedure to avoid any confusion between patients with the same name [56].

11.3.1 Verification of the patient's identity during registration

The following information should be obtained at this stage and entered or verified in the registration system [22] [56].

Ask the patient or the person responding on the patient's behalf :

- to name themselves (last name and first name);
- to state their date of birth;
- to present their health insurance card if the sample is taken in a public health institution. In a private institution, ask the patient to show a valid identity card, with photo if possible;
- to give their full address (including the telephone number to reach the patient if necessary).

Record the patient's gender [22] [56].

Ensure consistency between the information given by the patient, the information on their identity card and the information registered in the computer system [22] [56].

The Ministry of Health and Social Services has produced a document *Cadre normatif pour la gestion de l'identification de l'usager* [62] which presents acceptable identifiers when a user of the public health system does not have a health insurance card. It can be viewed at the following address :

http://msssa4.msss.gouv.qc.ca/fr/document/d26ngest.nsf/1f71b4b2831203278525656b0004f8bf/7266beeb4a586e7385258367006b749e/$FILE/2018-026_Annexe%20(r%C3%A9v%202019-12-09)_Cadre%20normatif%20(2019-11-01).pdf

11.3.1.1 Patient whose identity cannot be established

A procedure must be put in place in emergency departments and hospital laboratories to facilitate the delivery of care to patients whose identity cannot be established upon their arrival at the hospital. This temporary identification procedure makes it possible to avoid identification errors and delays in the transmission of results, and to ensure the traceability of results to the right patient.

This procedure must describe the following points in particular [3] [22] [56] :

- the use of a temporary identification system established with those responsible;
- recording the patient's approximate age and gender;
- temporary identification assigned to the patient, which must appear:
  - on the patient identification bracelet;
  - on prescriptions and test requisition forms;
  - on samples.

Detailed instructions shall be provided on the steps to be followed as soon as the actual identity of the patient is known, to ensure consistency between the temporary identification and the patient's name and patient-specific identification number. A means shall be put in place to link the temporary identification of the patient to his real identity, on the samples and analysis reports and in the laboratory computer system, once it is established [3] [22] [56].

11.3.2 Verification of patient's identity at the time of collection

Immediately before the blood collection takes place, the person collecting the blood sample must validate the patient's identity again [22] [56].

Responsibility and accountability for patient and sample identification rests with the person collecting the blood.

11.3.2.1 Conscious patient able to identify himself

The identification shall include, but not be limited to, the following measures [22] [56] :

- Ask the patient to name himself (last name and first name). Never ask him, "Are you Mr. So-and-so?". Use another method if the patient has difficulty speaking or has hearing problems.
- Complete the identification using a second identifier, asking the patient to state his date of birth. If possible, as with patients in the collection room, ask the patient to show a photo ID.
- If the patient is wearing an identification bracelet, compare the information provided with that indicated on the bracelet.

  Note : this verification does not replace the verification to be carried out in the previous two points.
- Compare this information with the one shown on the prescription or test requisition form and on the labels if available.
- Correct any discrepancies **before** performing the puncture.

Never rely on the identification card posted on the patient's headboard [56].

Sleeping patient (except if under anesthesia) shall be awakened before venipuncture [22].

11.3.2.2 Unconscious, semiconscious, comatose, toddler, cognitive impairment or allophone patient

If the patient is unable to identify himself, ask the person in charge (parent, accompanying person or healthcare professional) to identify the patient and continue to verify the patient's identity in accordance with the requirements described in point 11.3.2.1 [22] [56].

11.4 Obtain informed consent from patient

Healthcare professionals shall obtain the patient's consent for all of the activities they perform [63]. Consent may be implied if the patient presents the arm for collection of blood samples.

According to the regulations in force in Quebec and the codes of ethics of professional regulatory bodies [59] [64] [65] [66] [67] [68] [69], « (…) no one may be made to undergo care of any nature, except with his free and enlightened consent (…) » In this context, venipuncture cannot be performed without the patient's prior consent, except in cases provided by law (in case of emergency, when the person's life is in danger or their integrity threatened and his consent cannot be obtained in a timely manner) [63].

A minor 14 years of age or older can consent alone to venipuncture. When the minor is under the age of 14 or is unable to consent, consent for venipuncture is given by the holder of parental authority, the representative, the tutor or the curator [63].

For more information on consent, consult the *Civil Code of Quebec* and the *Act respecting health services and social services* [7] [63].

11.4.1 Inform and reassure the patient

To inform and reassure the patient [22] :

- explain the nature of the intervention;
- make him feel safe;
- ask him if he has allergies to latex or other substances;
- ask him if he has ever had complications in previous collections;
- inform him of the possible inconvenience of the blood collection;
- certain patient-specific clinical circumstances may increase his exposure to complications during venipuncture. If this is the case, notify him of the risks related to the puncture [70];
- answer his questions limiting to the technical aspects, without speaking of a diagnosis (unless this is part of the healthcare professional's scope of practice).

Note : The practice of the profession of the members of an order also includes disseminating information, promoting health and preventing suicide, illness, accidents and social problems among individuals and within families and communities to the extent that such activities are related to their professional activities [30].

11.4.2 Refusal to be tested

If the patient refuses the blood collection [22] :

1) inform the patient about the purpose of the analysis and its necessity;

2) register the refusal following the established procedure;

3) remember that the patient has the right to refuse the blood collection at any time;

4) issue a report advising the prescriber of the patient's refusal.

11.5 Verify the patient's preparation

If the preparation requirements listed below cannot be respected and the blood sample must still be taken, the unmet requirement must be specified in the report. This statement shall accompany the analysis results so that the prescriber takes them into account when interpreting them [11] [22].

11.5.1 Dietary restrictions

For certain analyses, the patient must be fasting or have eliminated certain foods from his diet. Make sure the dietary restrictions have been respected and comply with the prescription [43] [71] [72] [73].

11.5.2 Collection at specific times or intervals

Certain samples must be taken at specific times, because of current medication or biological variations (circadian rhythm) [43] [71]. The healthcare professional responsible for venipuncture must be aware and follow the guidelines on this topic [22].

It is also important to note precisely on the requisition (paper or electronic version) the dosage of medication (if known), the time when the last dose was administered as well as the time at which the sample was taken [22].

Here are a few examples of tests that require a sample to be collected at specific times or intervals is [22] :

- tests whose results vary over time, such as the dosage of corticosteroids or the measurement of blood sugar during the glucose tolerance test;
- tests whose results are part of therapy monitoring, such as measurement of activated partial thromboplastin time (APTT) or dosing of drugs.

11.6 Verify the consistency between the prescription, the forms, the labels and the collection material

- Verify that the identification of the labels and of the form correspond to the identification of the patient (which includes the last name, first name and patient-specific identification number) [22] [56].

- Ensure that the transcribed tests on the forms or labels correspond to the prescription (if available when the sample is collected) [56].
- Select the collection material necessary for the prescribed tests [22].

11.7 Wash or disinfect hands and put on the necessary PPE

See point 5.2 for details on hand hygiene. If the patient is allergic to latex, choose the appropriate gloves [12].

If the patient has been placed in isolation, the use of other PPE may be necessary. See point 13.3 on this topic.

For more information on hand hygiene, consult the following documents :

- PUBLIC HEALTH AGENCY OF CANADA. *Routine practices and additional precautions for preventing the transmission of infections in healthcare settings* [12];
- PUBLIC HEALTH AGENCY OF CANADA. *Hand hygiene practices in healthcare settings* [17];
- INSTITUT NATIONAL DE SANTÉ PUBLIQUE DU QUÉBEC. *L'hygiène et autres mesures de prévention des infections associées aux bactéries multirésistantes* [74].

11.8 Position the patient

It is important to ensure the comfort and safety of the patient during the collection [22]. The level of certain analytes, such as aldosterone and renin, varies depending on the patient's position. It is important to follow the prescriber's instructions or the procedure in place and document the patient's position if needed [43] [71] [75].

When positioning the patient, the following must be verified [22] :

- the patient is comfortably positioned and does not risk falling if he or she has a discomfort;
- the puncture site is easily accessible;
- the phlebotomist is also positioned comfortably;
- the patient has nothing in the mouth (food, chewing gum, thermometer, etc.).

11.8.1 Seated position

- Ask the patient to sit comfortably.
- Ensure that the patient's arm is extended on an armrest and forms a straight line descending from the shoulder to the wrist.

11.8.2 Recumbent position

- Ask the patient to lay down.
- Raise the headboard if possible.

- Ensure that the arm is extended and forms a straight line descending from the shoulder to the wrist.

11.9 Select the puncture site

The puncture site shall be carefully chosen to facilitate obtaining the venous blood sample, while minimizing the risk of complications, injuries and discomfort caused by the puncture, as well as adverse effects on the results of the prescribed analytes. All venipunctures shall be performed with the constant concern of preserving the integrity of the veins [(22)]. Table 2 presents the sites to prioritize, to avoid and not to be used within the framework of venipuncture.

Table 2. Collection sites to prioritize, to avoid and not to be used

Sites to prioritize [(22)]
The antecubital fossa of the arm (anterior side of the elbow) and healthy skin surfaces (see 11.11.1 point).
In some cases, superficial veins on the back of the hand (see Annex 3).
Area where the skin is intact and without skin lesions.
Sites to avoid These places should only be used as a last resort if the sites to prioritize are not accessible [(22)].
Arms on the same side of a mastectomy or resection of the axillary lymph nodes: because of lymphostasis, the arm may be more sensitive and at greater risk of infection. Test results may also be altered [(76)] [(77)] [(78)] [(79)]. **See the note below the table**.
Lower limbs: the puncture can cause thrombophlebitis in patients with coagulopathies and tissue necrosis in diabetic patients. **See note below the table**.
Scarring or burn sites, which are more painful and vulnerable to infection: vein palpitation and needle insertion may be more difficult in these areas. In addition, if the area is insensitive, the detection of adverse reactions will be more complicated.
Sites with a hematoma: the puncture can cause discomfort and the results may be altered.
Sites with edema and lymphedema: the results may be altered.
Sites (including tattoos) where inflammation can be observed: can cause discomfort and possibly complications.
Limbs affected by a stroke or injury [(80)]: in case of numbness or paralysis, the patient might not detect an adverse reaction (e.g., nerve injury, pain, infection).

Table 2 (continued)

Damaged veins: the puncture can cause discomfort and the vein might not withstand the puncture.
Arms in which an IV fluid is being infused: the substance administered may lead to erroneous test results (see point 11.9.1).
Vascular access devices: hemolysis is more likely when blood is collected through a peripheral venous catheter (see point 11.9.2).
Certain veins, such as the lateral veins (on the side) of the wrist [81] [82] [83], the veins located on the medial (internal) side of the arm and the veins of the forearm, where the risk of accidental nerve puncture is greater [39]. These veins should only be punctured if the cephalic and median veins of the antecubital fossa are not accessible [84] [85]
Sites not to be used [22]
Arteriovenous fistula (anastomosis: surgical fusion of a vein and an artery for dialysis purposes only) and vascular graft: the puncture of these structures can threaten their integrity and lead to serious complications.
Arteries (including femoral and jugular): arterial and venous blood being of different composition, their analysis can give different results [86] [87]. In addition, arterial puncture carries a much higher risk of injury and complications (see point 12.10) [88].
Veins on the palmar side (underside) of the wrist: their puncture carries an increased risk of nerves, tendons and arteries involvement [39].
Infected sites: the results may be altered, the infection may worsen and the puncture may cause discomfort.

Note : Due to his clinical condition, the patient may be exposed to greater risk of complications if venipuncture is performed in the lower limbs, in the arm on the side of a mastectomy or resection of the axillary lymph nodes. Therefore, the professional performing the venipuncture must above all know the indications and contraindications (relative or absolute) of the venipuncture and exercise clinical judgment before proceeding. In case of doubt, he can consult the prescriber.

11.9.1 Precautions for intravenous infusion

Avoid collecting blood from an arm into which an intravenous solution is being administered, including blood or blood products. Analysis of blood taken from such an area may give erroneous results and mislead the prescriber [22] [89] [90].

It is recommended to draw blood from the opposite arm. It is also possible to consider drawing blood by capillary puncture if the prescribed analytes can be carried out on this type of sample and if the

method of collection is documented so that the prescriber takes it into account when interpreting the results [22].

If these solutions are not feasible, then it is possible to obtain adequate samples by taking the blood at a point distal to the infusion site, i.e. **below the infusion point**, as follows [22] :

1. Make sure that the intravenous solution is stopped at least two minutes before collecting the sample. If stopping the infusion is not part of the activities that the professional can perform, he must ask an authorized professional.
2. Place the tourniquet below (distal to) the infusion site and choose a vein other than the one receiving the infusion.
3. Perform the venipuncture.
4. Document in the report that the sample was collected from an arm with an intravenous solution, specifying the composition of the solution administered.
5. Inform the healthcare personnel that the sample has been collected.

Note : When defined in a policy and procedure and it is impossible to do otherwise, the sample can be obtained from a puncture point located above (proximal to) the infusion site, but it is probable that this sample will be contaminated with the infused solution and that the test results will be erroneous [22] [89] [91] [92].

When blood is collected from an arm with infusing fluids, the nature of the fluids shall be documented so that the prescriber can take it into account when interpreting the results [22].

11.9.2 Precautions to be taken when collecting from a vascular access device

It is not recommended to collect blood from a peripheral vascular access device (e.g. catheter, cannula [heparinized or sodium]) because the risk of hemolysis is increased [93] [94] [95] [96].

However, when required by the situation, the following points shall be respected [22] :

- The sample must be taken by a duly trained and authorized professional.
- If an infusion is administered using the device from which the sample is to be collected, the infusion must be stopped before proceeding to the following steps. If stopping the infusion is not part of his professional activities, he must ask an authorized professional.

- To reduce the risk of thrombosis, these devices are usually rinsed with saline or heparin. This solution shall be eliminated by discarding the amount of blood equal to twice the dead-space volume of the tubing before filling the tube for analysis [97]. The accurate calculation of the volume of blood to be discarded is particularly important in children and the critically ill patient due to the risk of iatrogenic anemia [22].
- Samples for coagulation testing shall not be collected in this way unless absolutely necessary [38] [39]. If the device is used to administer an anticoagulant and there will be coagulation testing performed on the sample collected, an amount of blood equal to six times the dead-space volume of the tubing shall be discarded [98]. Knowing the dead-space volume is particularly important to ensure the quality of the hemostasis test [22].
- After collection, the catheter must be rinsed again, according to the established technique.

  Warning: rinsing a catheter is an activity reserved for members of certain professional regulatory bodies under certain conditions [30]. Some of the regulatory bodies require that their members have obtained a certificate to carry out this activity according to their bylaws.
- It is important to document on the test requisition form the collection technique applied if it differs from the usual technique.
- Collection from a central catheter by an authorized healthcare professional may involve additional steps [39]. Follow the institution guidelines in force.

Note : Arterial blood samples cannot replace venous blood samples, as these types of blood differ in certain analytes concentration (refer to the laboratory) [86] [87]. In addition, under current regulations, only certain healthcare professionals can collect blood from an arterial access device [30].

11.10 Apply the tourniquet

The tourniquet is used to promote venous stasis and to make the vein prominent, to facilitate the insertion of the needle into the vein [22].

11.10.1 Application method

- Place the tourniquet at a distance of 7.5 cm to 10.0 cm above the puncture site (see Figures 1a and 1b) [99].
- Tighten the tourniquet just enough to cause the veins to swell [99].
- Orient the ends of the tourniquet upward (toward the shoulder) to avoid contamination of the puncture site [43].


Figure 1a & 1b : Tourniquet placement

11.10.2 Important precautions

- The tourniquet shall be loosened or removed as soon as the blood flows steadily into the tube (see point 11.14). Do not leave the tourniquet in place for more than one minute. When the tourniquet remains in place for too long, the venous stasis will result in hemoconcentration and the infiltration of blood into the tissues (extravasation) [100] [101]. This situation can alter results of analytes sensitive to hemoconcentration (see point 14.2.2) or to ischemia (such as lactate and ammonia dosage) [22] [99].
- If there is a delay in finding the vein, release the tourniquet and wait two minutes before reapplying it [22].
- If the patient has skin problems, place the tourniquet over his clothing or on a piece of gauze or other disposable material [22].

11.10.3 Ask the patient to close his hand

Ask the patient to close his hand to make the veins become more prominent and easier to puncture [22].

The patient shall not repeatedly and vigorously open and close his hand, as this may cause variation in the blood concentration of certain clinical-chemical parameters [22] [99] [102].

11.11 Select the vein for puncture

Palpate the veins and follow their course with the index finger. Avoid arteries; these have a thicker wall and pulsations can be felt. Avoid thrombosed veins, which lack elasticity and are rolling and stiff to the touch. Beware of nerves, which are hard to the touch and lack elasticity. The rotation or flexion of the wrist sometimes makes it possible to better locate a vein [43] [99].

11.11.1 Prioritize the veins of the antecubital fossa

For venipuncture in the arm, the antecubital fossa (anterior side of the elbow) is prioritized [22].

The veins of the antecubital fossa are more superficial (closer to the skin), more stable and their puncture is less painful. In addition, fewer nerves pass through this area. These veins are better supported anatomically, because they are located above a fibrous membrane which offers some protection to the underlying structures. Two veins cross the antecubital fossa: the median vein and the cephalic vein. As for the basilic vein, it crosses the medial (internal) side of the arm. Veins, arteries and nerves are located differently from one person to another. Among all the possible configurations, two stand out in the general population: the "H-shaped" configuration, characterized by the disposition of the main veins in a way that recalls an inclined capital H or a capital N, present in 70% of the population, and the "M-shaped" configuration, where the main veins form a capital M [22] [103] [104]. The H and M configurations are illustrated in Annexes 4 and 5.

It is important to recognize these veins, regardless of their configuration, in order to prioritize the veins which are the most supported anatomically and the most distant from the nerves. Although it is impossible to predict the exact path of the nerves in each arm, one must try to favor the puncture sites where the risk of accidentally injuring these nerves is minimized [22].

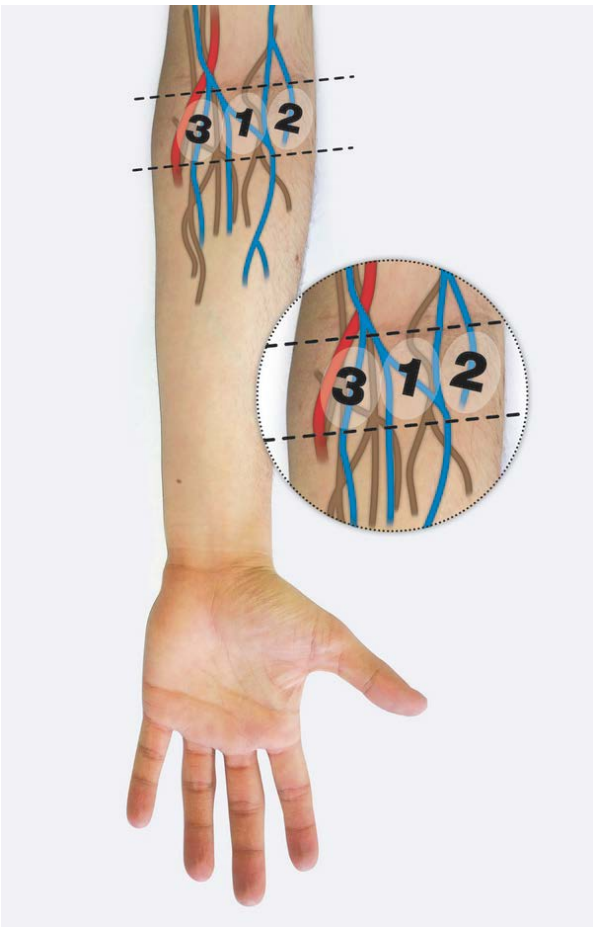


Figure 2. Areas of veins priorities

Figure 2 illustrates the location of veins in order of priority as follows [22] :

1 : in the center of the arm, median vein: medial (towards the little finger) and lateral (towards the thumb) sides of the antecubital fossa;

2 : on the lateral side of the arm (towards the thumb), cephalic vein and accessory cephalic vein [84];

3 : on the medial side of the arm (towards the little finger): basilic vein and medial side of the median vein. **Attempting to use these veins increases the risk of injuring the brachial artery and skin nerves in this area** [103]**.** This area should only be used as a last resort when a vein cannot be found in the center and on the lateral side of the arm. This is one of the reasons why it is important to use a tourniquet to select the safest vein first. It must not be forgotten that many nerves go downward to the hand. If blood is drawn from the basilic vein, avoid going too far from the antecubital fossa.

11.11.2 Technique for locating non-visible veins

Ask the patient to extend their arm downward and slide support under the elbow if necessary. If the vein is difficult to find, it can be enlarged in one of the following ways [99] :

- Leave the tourniquet in place and massage the arm upward from the wrist towards the elbow.
- Remove the tourniquet and wrap the arm in a warm towel (about 40 ^{0}C, but no more than 42 ^{0}C) for a few minutes.

11.12 Choose and assemble the necessary collection material

The list of materials to be used is detailed in point 10.0. The material should be unpacked and assembled in front of the patient to avoid giving the impression that the material was used with another patient [22].

11.13 Sanitize the puncture site

The puncture site must be sanitized to avoid contamination of the patient or the sample [22] [99] .

- Use a commercial alcohol pad or a gauze pad soaked in antiseptic solution, according to the protocol in force.
- Clean the puncture site by rubbing it in a continuous back and forth movement [105] [106] [107] [108].

  Note : Some antiseptics are applied in other ways [105]. Consult the manufacturer's instructions. The sanitization for blood culture is detailed in point 11.13.1.

- Let the skin dry and allow the antiseptic to act, to prevent the puncture from causing a burning sensation and the blood collected from hemolyzing. Do not speed up drying by fanning or blowing on the sanitized area.
- If the puncture is difficult or if the chosen vein is no longer visible and must be palpated a second time, the puncture site must be sanitized again. If it is thought that the tourniquet has been in place for more than a minute, loosen it and wait two minutes before replacing it.

11.13.1 Sanitizing the puncture site for blood culture collection

The procedure established by the institution's Infection Prevention and Control Committee prevails over the following recommendations.

Sanitize the puncture site by successively applying two antiseptics, taking care to allow the skin to dry (30 to 120 seconds depending on the antiseptic used) between each application and before performing the puncture [105] [109] [110] [111] [112].

Note : Sanitizing with alcoholic chlorhexidine rather than polyvidone iodine may reduce the incidence of bacterial contamination of blood culture samples [(109) (113)]. The precautions for using chlorhexidine are detailed in point 10.2.

Example of double sanitization of the puncture site [(110)] :

1. Thoroughly cleanse the skin (rubbing well) with a gauze pad soaked in 70% isopropyl or ethyl alcohol. Let dry.
2. Then cleanse the skin by rubbing it well (some antiseptics are applied by circular movements from the center to the periphery) with a mixture of 0.5% chlorhexidine digluconate in 70% isopropyl alcohol, or a tincture of iodine or iodized polyvidone. Let dry completely (about one to two minutes). Avoid touching, fanning or blowing on the puncture siter.

Important : In children and allergy sufferers replace disinfection with tincture of iodine or chlorhexidine with two additional disinfection with 70% isopropyl or ethyl alcohol carried out with two separate pads [(105) (110)].

11.13.2 Sanitizing the puncture site for dosage of alcohol level

Do not use a solution containing alcohol to sanitize the puncture site if the blood collected is used for measuring blood alcohol level. Instead, use soap or another antiseptic [(22) (114)].

11.14 Insert the needle, collect the blood and remove the tourniquet

11.14.1 Collection with an evacuated tube system

An illustrated description of the steps of venipuncture with evacuated tubes is provided in Annex 2 [(22) (99)].

1. Prepare the material.
2. Stabilize the vein by gently pulling the skin with the free hand, approximately 2.5 cm to 5.0 cm below the puncture site.
3. Warn the patient that you are going to perform the puncture.
4. Holding the bevel of the needle facing up, enter the vein at an angle of 30 degrees or less (see Figures 3a and 3b).

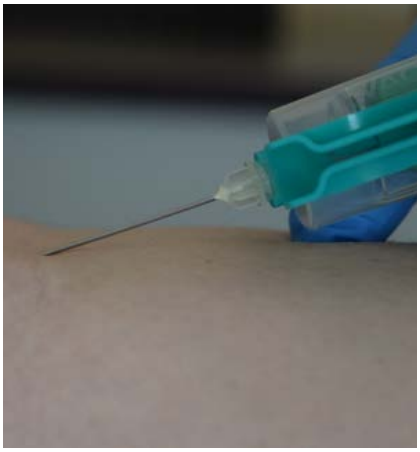


Figure 3a. Angle of 30° or less

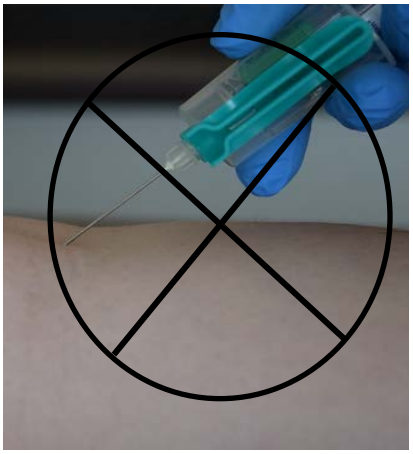


Figure 3b. Angle is too large

5. Immobilize the tube holder collar and stabilize the needle. Push the tube to the bottom of the tube holder and verify that blood flows into the tube.
6. As soon as the blood flows steadily, remove or loosen the tourniquet and ask the patient to open the hand. If the blood does not flow, take one of the measures described in point 12.1. The tourniquet must not remain in place for more than one minute (see point 11.10.2).
7. Leave the tube in place until the blood stops flowing. It is important not to remove the tube too quickly so that it is filled to its optimal level and to obtain the right blood: additive ratio.
8. When the blood stops flowing, remove the tube from the tube holder or collection system used. Hold the tube upright to check that it contains the minimum amount of blood. On some tubes, this quantity is indicated by a line. Immediately invert the tubes containing anticoagulants (see point 11.15.3). If more than one tube has to be filled, insert the next tube and repeat steps 5 to 8 (following the order draw presented in point 11.15.1).
9. Always remove the last tube before removing the needle from the vein.

Note : If the vacuum is properly exhausted in the last tube, a drop of blood could escape from the tip of the needle when it is withdrawn and lead to a risk of contamination by contact with a biological liquid. If the vacuum is not completely exhausted, removing the needle could damage the vein [(22) (99)].

11.14.2 Collection with a winged blood collection set

The use of a winged blood collection set (see point 10.1) to perform venipuncture is mainly used in children and in difficult cases in adults [(22)].

It is also used when the vein is of a smaller caliber (e.g. veins on the back of the hand) or when the integrity of the veins must be preserved (e.g., in the case of chemotherapy or multiple punctures) [43].

It is recommended that a winged blood collection set with a safety device be used to ensure the safety of the healthcare professional collecting the sample [99].

The precautions to be taken when a winged blood collection set is used to collect a sample for hemostasis analysis are specified in point 11.15.1.1.

11.14.3 Collection with syringe

For safety reasons, the use of a syringe for collection should be avoided [20] [22]. In addition, drawing with a syringe can cause clots or micro-clots to form, leading to false results or rejection of the sample [115]. However, when the veins are difficult to puncture or tend to collapse, collection with a syringe integrated into a collection tube and requiring no blood transfer is recommended [22].

As a last resort, the syringe without an integrated system may be an acceptable alternative [22].

1. Use a syringe of appropriate volume instead of the tube holder and tubes.
2. Place the tubes on a rack. Do not remove the caps.
3. Slide the plunger into the body of the syringe to ensure easy movement.
4. Perform the venipuncture as described in point 11.0.
5. Fill the syringe by slowly pulling the plunger, while respecting the natural flow rate of the blood.
6. **As soon as the collection is completed**, dispose of the needle safely and transfer the blood to the tubes using a transfer device. Pierce the rubber closure of the tubes with the tip of this device and allow the blood to flow on the wall **without pushing** on the plunger.

Transfer the blood into the tubes in the recommended order of draw for evacuated tubes and mix their contents (see point 11.15) [22].

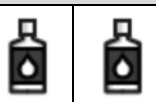
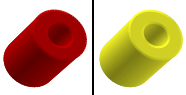
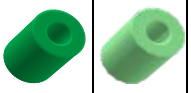
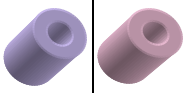
11.15 Fill the tubes and mix their contents

Caution: Never transfer the contents of one tube into another, even if both tubes contain the same anticoagulant, otherwise the blood: anticoagulant ratio will be altered, and the test results will be erroneous [22].

11.15.1 Order of draw

The tubes must be filled in the order presented in Table 3 or according to the manufacturer's instructions, in order to reduce the risk of obtaining an erroneous result following cross-contamination between tubes containing different additives [22] [47] [116] [117] [118] [119] [120] [121] [122].

Table 3. Order of draw

Cap color	Additive	Current use	Reason for tube position in the order of draw and risk of contamination
	SPS (sodium polyanethol sulfonate))	Blood culture (aerobic bottle first, then anaerobic)	Fill first to avoid bacterial contamination from other tubes.
	3,2% Sodium citrate	Hemostasis test	Fill before the tubes with clot activators to avoid activating the coagulation.
	With or without clot activator, with or without gel separator	Serum for biochemistry, endocrinology, serology tests	Fill before the tubes with anticoagulant (except sodium citrate) to prevent these chemical compounds from contaminating the tubes intended for serum tests. Note that contamination with sodium citrate is negligible.
	Sodium heparin or lithium heparin	Plasma for biochemistry tests (except if measuring sodium or lithium, as the case may be)	Fill before the tube with EDTA to prevent this anticoagulant from contaminating the tubes intended for biochemistry tests.
	EDTA (ethylenediaminetetraacetic acid) (K_2EDTA, rarely K_3EDTA or Na_2EDTA)	Lavender cap: hematology Pink cap: blood bank	Fill after any tube that can be used for measuring electrolytes.
	Potassium oxalate/Sodium fluoride (glycolysis inhibitor))	Dosage of glucose or lactate	Fill towards the end to minimize the risk of contamination of the tubes for biochemistry tests, as it contains several chemical compounds.
	3.8%Sodium citrate	Sedimentation rate by Westergren method	Fill at the end to minimize the risk of altering biochemistry tests, given the greater amount of anticoagulant it contains.

Warning: The cap colors presented in this table correspond to the colors recommended in ISO 6710 *Single-use containers for human venous blood specimen collection* [123]. Color may vary depending on the manufacturer [124].

The order of draw depends on the additive contained in each tube [22]. Contact the laboratory to find out when to fill the other tubes not mentioned in this order of draw.

11.15.1.1 Particularities relating to hemostasis testing

It is to preserve the integrity of the hemostasis sample that the sodium citrate tube is filled at the beginning of the collection process. The plastic serum tubes contain a clot activator and may falsify the results of the hemostasis test [125]. A tube without additive, clot activator, nor gel separator is the only type of tube that can be filled before the tube for hemostasis analysis [22].

To minimize the risk of tissue thromboplastin contamination and hemolysis, which may interfere with hemostasis tests, **the puncture should be straightforward with a regular blood flow** throughout the filling of the tube. Collection from a vascular access device is not recommended because it promotes the initiation of hemolysis (see point 11.9.2) [22].

Studies have established that hemostasis analyses (especially routine analyses, such as measurement of PT and aPTT) can be performed on a sodium citrate tube even if this is the first tube filled (unless a winged blood collection set has been used; see below), despite the risk of contamination by tissue thromboplastin [126] [127] [128] [129]. It is recommended that laboratories validate their procedures internally to corroborate the conclusions of these studies regarding specialized hemostasis analyses [22] [38] [130] [131] [132].

Warning : When a **winged blood collection set** (butterfly) is used for venipuncture and the first tube to be filled is for hemostasis analysis, a discard tube should be filled first to empty the air in the tubing of the unit and obtain an optimal blood: anticoagulant ratio. The discard tube used shall not contain any additives, clot activators nor gel separator, but it may be a tube with sodium citrate for hemostasis analysis [22].

11.15.1.2 Dosage of electrolytes after filling of sodium citrate tube

Although cross-contamination is always possible when filling the tube for electrolyte analysis after the tube with sodium citrate, the variations observed seem negligible and would more likely be the result of a difficult venipuncture. In addition, since the amount of sodium in the tube is minimal compared with the blood sodium levels, the contamination would have no notable clinical effect. However, the tube containing sodium citrate must be completely filled according to the recommendations to obtain the correct sodium concentration in the tube filled immediately after [22] [133].

11.15.1.3 Particularities relating to venous blood collection intended for the study of blood gas

Peripheral venous blood is suitable for measuring pH and PCO_2 for the assessment of acid-base balance [134] [135] [136].

In order to avoid contamination of the sample by ambient air, and therefore a possible alteration of the PCO_2 and of the pH [137], it is necessary to collect the optimal quantity of blood in the evacuated tube to avoid the aspiration of air due to a vacuum effect when the tube is removed from the tube holder. If the blood is drawn with a winged blood collection set (butterfly-type needle) and the first tube to be filled is intended for the analysis of blood gases, the air in the tubing must be removed by allowing a bit of blood to flow in a discard tube. If venous PO_2 analysis is requested, the blood should be drawn in a syringe and not in evacuated tubes [134] [138].

11.15.1.4 Particularities relating to blood collection intended for the dosage of heavy metals

For the determination of heavy metals (trace elements) dosage, a tube specially treated for this purpose must be used [22] [139] [140] [141]. There are several types with or without an anticoagulant. The color of the closure may vary depending on the manufacturer and the additive.

The treated tubes recommended by the Centre de toxicologie du Québec all contain an additive; clot activator or anticoagulants. They must therefore be filled following the order of draw prescribed by the additive they contain. It is preferable to fill them before any untreated tube containing the same additive [142].

11.15.1.5 Particularities relating to interferon gamma detection tests for the diagnosis of tuberculosis

Screening tests for interferon gamma allows diagnosis of latent tuberculosis infection. Two tests are currently approved in Canada: the QuantiFERON-TB Gold In-Tube test and the T-SPOT .TB test [(143)].

Some of these tests must be carried out with special tubes. Follow the manufacturer's instructions from the kit used.

In the case of the QuantiFERON-TB Gold In-Tube test, three tubes containing lithium heparin supplied by the manufacturer must be filled (zero value tube, TB antigen tube and mitogenic tube). Since they all contain the same anticoagulant, the order of draw does not matter. On the other hand, they must be filled in the same order as the other tubes containing heparin [(144)]. If the blood is drawn with a winged blood collection set and the first tube to be filled is for tuberculosis screening, the tubing must first be primed with a discard tube [(144)].

11.15.2 Particularities relating to blood cultures

Blood collection intended for blood culture from a vascular access device is not recommended due to the increased risk of contamination of the sample [109] [145] [146]. Ideally, collection should occur before starting antibiotic therapy to optimize the detection of microorganisms [110]. Follow the instructions of the prescriber in the event of any particularity not mentioned below.

11.15.2.1 Number of blood culture samples

In adults and children weighing more than 36.29 kg (80 lb), it is generally recommended to collect blood at 2 separate puncture sites. The interval between the two collections may vary depending on the clinical condition of the patient [105] [109] [110]. Consult the microbiology laboratory for requirements.

11.15.2.2 Disinfection of the septum of blood culture bottles

Thoroughly clean the septum or the top of blood culture bottles (e.g., with 70% alcohol) and allow it to dry completely (about 30 to 60 seconds) [109] [110]. Do not speed up drying by fanning or blowing on the septum or the top of blood culture bottles. Iodine-based products should be avoided because they can degrade the material composing the septum or the top of blood culture bottle [39].

11.15.2.3 Filling of blood culture bottles

Fill the aerobic blood culture bottle first, then the anaerobic bottle. Avoid introducing oxygen into the anaerobic bottle.

Most of the time, blood culture samples are collected through tubing that connects the needle to the blood cultures bottle (e.g., winged blood collection set). The use of this tubing allows:

- to hold the bottle upright to see how much blood is collected;
- to prevent the accidental reflux of the broth media into the patient's vein [109];
- to add air from the tubing to the first inoculated bottle, to create aerobic conditions.

If the sample is collected with a syringe, the anaerobic vial must be inoculated first, then the aerobic vial, to avoid injecting the oxygen present in the syringe into the anaerobic vial [147] [148].

11.15.2.4 Filling volume

The correct blood volume shall be collected to respect the blood-to-broth ratio of the blood cultures bottles [105] [109].

According to study reports, the collected blood volume is the factor that most influences the detection of microorganisms in the blood [105] [109] [110] [149]. Since aerobic organisms are more often implicated in sepsis, favor filling the aerobic culture bottle if it is impossible to fill both bottles [109].

Follow the manufacturer's instructions for blood culture bottles and the protocol in effect in the institution. In general, it is recommended to draw 30 ml to 40 ml of blood in total from adults in 2 separate peripheral sites [105] [109] [110] [150] :

- collect 20 ml of blood from the first site and distribute equally in an aerobic bottle and an anaerobic bottle (10 ml per bottle);
- collect 10 ml to 20 ml of blood from the second site and distribute it in 1 of the 2 bottles or in both (10 ml in the aerobic bottle and, if possible, 10 ml in the anaerobic bottle).

As the vacuum in the blood culture bottle allows for more than 10 ml of blood to be added, it is important to read the graduations carefully not to exceed the recommended volume (it may be useful to mark the desired level with a marker before starting the collection) [105].

With children, the volume collected should not exceed 1% of total blood volume (to estimate the maximum volume to be collected, multiply the child's weight in kg by 75, then divide the result by 100) [109].

11.15.2.5 Handling of bottles after filling

Immediately after filling, the bottles shall be gently inverted a few times to avoid clotting. Identify the bottles as described in point 11.18 (make sure to record the time of collection). Do not affix the patient identification label on top of the barcode on the blood cultures bottle. If the sample was not taken by venipuncture, note the method of collection (e.g., central catheter) [105] [109] [110].

Do not refrigerate or freeze bottles, as this may affect the growth of bacteria. Send the sample as rapidly as possible (following the instructions of the laboratory that will perform the analysis) or put it in an incubator provided for this purpose [105] [109] [110].

11.15.3 Mix the tube contents

Immediately mix the collected blood by inverting each tube as many times as the manufacturer recommends, as they are filled. To avoid hemolysis and platelet activation, never shake the tubes or invert them vigorously [22] [38] [151] [152]. Table 4 presents some example of recommendations [153] [154].

Table 4. Recommendations for the number of inversions

Additive present in tube	Number of inversions
Clot activator	5
Sodium citrate	3 to 4
Other anticoagulants	8 to 10

Important : This mixing must be done immediately after collection, delicately and by complete successive inversions [22]. Subsequently place the tubes vertically on a rack [155].

Warning: If a clot forms in a tube containing an anticoagulant, a new tube must be filled. The clot should **never** be removed from the tube, as the test results of the blood remaining in the tube will be erroneous [152].

11.16 Remove the needle, apply pressure and discard the needle

- Cover the puncture site with a gauze pad without applying pressure.
- Remove the needle slowly without changing the insertion angle.
- Apply firm pressure to the vein with the gauze pad for at least 5 to 10 seconds. The phlebotomist can ask the patient to continue pressing on his vein while labeling the tubes. The pressure applied must be more sustained if the patient is receiving anticoagulation therapy. Instruct the patient not to bend the arm to avoid the formation of a hematoma [(22)].
- Activate the safety device as soon as the needle is withdrawn. In the absence of a safety device, do not replace the cap [(22)].
- Immediately dispose of the needle in an approved, rigid, leak proof container marked "Biomedical waste" which can be sealed (the requirements on this topic are set out in point 10.6) [(22) (26)].

11.17 Observe the patient, verify the puncture site and apply a bandage or an adhesive tape

Lift the gauze pad to examine the puncture site [(22)] :

- If the puncture site is no longer bleeding, apply a bandage or an adhesive tape over the gauze pad.
- In the event of continuous bleeding, continue to apply pressure to the puncture site, then apply a bandage or an adhesive tape over the gauze pad.

Make sure the patient is well and advise them to wait at least 15 minutes before removing the bandage or adhesive tape [(22)].

11.18 Identify the sample

Accurate identification of the sample is a crucial step in the preanalytical process. The samples shall be labeled immediately after collection, in the presence of the patient [(3) (56)].

The label shall be affixed to each tube so that the patient information can be read, and the sample examined to assess the quality (filling, hemolysis, etc.). Where possible, the label shall be affixed so that the expiration date of the tube can be read. If the label has a barcode, its position on the tube shall allow the code to be read by a barcode reader [(3)].

The collection information required on the sample (date and time of collection, and identity of the phlebotomist) depends on the possibility of recording them in a information system linked to the laboratory at the time of collection.

11.18.1 Data entered in the information system

If the data of the collection (date and time of collection, and identity of the phlebotomist) are entered in an information system linked to the laboratory at the time of collection, the labels shall at least bear the patient's first name, last name and a patient-specific identification number. The date and time of the collection shall also appear on each of the tubes if several samples are to be collected from the same patient at prescribed intervals, as in the case of a glucose tolerance test [(3)].

The use of electronically generated, machine readable labels (e.g., optical) should be favored (156). These labels should be printed at the time of collection. They are equipped with an unequivocal identifier that links the sample to the data entered in the information system (e.g., barcode or RFID [radio-frequency identification]) chip [(3)].

If these labels are not printed at the time of collection, the data entered in the information system shall be verified to make sure that the date and time of the collection and the name of the phlebotomist are entered correctly once the collection is completed. If the labels also bear the date, the time of the collection and the name of the phlebotomist, this data shall be checked and corrected if necessary [(3)].

11.18.2 Data not entered in the information system

If the data on the collection (date and time of collection, and identity of the phlebotomist) are not entered in an information system linked to the laboratory immediately before or after the blood collection, the patient and collection information (patient's first and last name, patient-specific-identification number, date and time of the collection, and identity of the phlebotomist) shall be written or printed on labels affixed to each sample at the time of collection. This information shall also be transcribed on the prescription or the requisition form (if applicable) [(3)]. Table 5 presents the data that shall appear on the sample label according to the situation.

Table 5. Information that shall appear on sample labels

Data entered in the information system at the time of collection	Data **not** entered in the information system at the time of collection
Mandatory : • patient's full name • patient specific identification number Recommended : • barcode or other device allowing automated reading Optional : • date and time of collection • identification of phlebotomist	Mandatory : • patient's full name • patient specific identification number • date and time of collection • Identification of phlebotomist

11.18.3 Confirmation of the sample identification

After the identification of each sample, all sources of information shall be checked to ensure that all data is unequivocally consistent, always in the presence of the patient [157].

To do this, the phlebotomist shall compare the following points with each other:

- information provided verbally by the patient (e.g., first name, last name and date of birth);
- information on the patient identification bracelet (if applicable) or other identification card presented;
- information on each identified sample;
- information on the prescription and the requisition, if these documents are available at the time of collection;
- information contained in any other identification system (note: some institutions may have another identification system for samples intended for the blood bank);
- actual date and time of the blood collection (if they appear on the sample).

After confirming the exact match of all sources of patient information, the phlebotomist should write his initials or other identifier on each sample. By initialing the sample, the phlebotomist certifies that he has verified the accuracy of the patient and sample identification.

11.19 Lift dietary restrictions and thank the patient

If the patient is hospitalized, notify the nurse that the sample has been collected. If the patient is seen in an outpatient setting, ensure that he does not need to be fasting for other examinations before lifting the dietary restrictions.

11.20 Discard all used materials

Dispose of gloves and all other supplies soiled with blood in bags or containers marked "Biomedical waste," in accordance with the *Regulation respecting biomedical waste* [(26)].

Supplies such as gloves, bandages and gauze pads that are only stained with a few drops of blood can be discarded with regular waste [(27)].

The packaging material can be discarded with regular waste

11.21 Remove PPE and wash or disinfect hands

Meticulous hand hygiene after removing gloves is one of the best practices for preventing infection. It can also help avoid latex sensitization. Gloves shall be discarded after use [(12)].

For more information on hand hygiene and glove use, see points 5.2 and 5.3.

11.22 Stabilize, store and transport samples to the laboratory.

After collecting the venous blood and mixing the sample by inverting each tube [(22)] [(155)] :

- Place the tubes vertically on a rack to prevent the clot (in tubes without anticoagulants) from attaching to the inside of the closure, creating a fibrin strand in the serum which can cause its contamination with erythrocytes, even after centrifugation. In addition, the vertical position prevents the tubes from accidentally rolling off onto the floor.
- Observe special storage guidelines. Examples:
  - keep cold [(158)] (e.g., dosage of gastrin, ammonia [(159)], lactic acid, catecholamines);
  - do not centrifuge (e.g., complete blood count, measurement of glycated hemoglobin levels, determination of cyclosporine, etc.);
  - protect from light (e.g., dosage of bilirubin, porphyrins, vitamins, etc.) [(160)] [(161)].
- Respect the recommended time between collection and stabilization (e.g., centrifugation).

The samples shall be sent to the laboratory **as soon as possible**, in accordance with the transport and storage requirements established by the testing laboratory [(6)] [(155)].

For more information on the storage and transport of samples, consult the OPTMQ document entitled *Transport et conservation des dans le domaine de la biologie médicale* [(162)] and T*ransportation of dangerous goods regulations* from Transport Canada [(163)].

12.0 Difficulties and adverse events that may occur during and after the sample collection

Before collecting the sample, the phlebotomist must ensure that the patient is positioned comfortably, safely and appropriately to his condition. However, as certain complications may occur despite these precautions, it is important to observe the patient's condition throughout the procedure [(22)].

The following recommendations describe the minimum measures to take. Always refer to the institution's protocols. If a complication occurs, always make sure that the patient is feeling well before letting him leave the premises or leaving him alone. If the problem persists, notify the emergency department or the healthcare professional responsible for the patient [(22)].

12.1 Blood that does not flow freely into the tube

If the tube does not fill well, the following measures can be taken [(22) (99)] :

- Change the position of the needle (see Annex 6) :
  - slightly withdraw or gently push the needle; or
  - slightly modify the insertion angle.
- Change the tube. The tube may be expired, or the vacuum conditions may be insufficient.
- Reapply the tourniquet if possible. As explained in point 11.10.2, the tourniquet should **never be left in place for more than one minute**.

If the blood still does not flow into the tube despite the measures described above [(22) (99)] :

- remove the tourniquet, then the needle, and apply pressure;
- explain to the patient that the puncture must be repeated;
- choose another puncture site.

It is recommended to seek help if after two attempts, it is impossible to obtain blood.

If the blood collection proves impossible, notify the professional responsible for the patient and document the information on the requisition or in the patient's file, if available [(22)].

Caution: Do not search for the vein "blindly" with the needle; this can be painful for the patient and may damage the nerve and surrounding tissues [(22)].

12.1.1 Vein collapse

The negative pressure from the tubes can cause small and fragile veins to collapse. In such a case, take a smaller volume tube or choose another puncture site.

The use of a winged blood collection set or a system to control the aspiration of blood is helpful in this situation [(43)].

12.2 Discomfort and fainting

If a patient complains of not feeling well (dizziness or other symptoms suggesting loss of consciousness or vasovagal syncope) [22] :

- Remove the tourniquet, then the needle and apply pressure to the puncture site, if discomfort occurs during the puncture.
- If the patient is seated, ask him to lean forward to put his head between his legs or try to lay him down if possible. If he is already lying down, lower the headboard if it is raised.
- Loosen clothes if necessary.
- Apply a cold-water compress to the patient's forehead or neck.

If the patient passes out despite these measures, seek help if possible, and:

- Lay the patient down (if possible, on his side and if he is breathing) and provide the necessary care.
- Call emergency services or seek immediate medical help depending on the severity of the situation.

12.3 Nausea

- Position the patient as comfortable as possible [22].
- Ask the patient to breathe slowly and deeply [22].
- Apply a cold-water compress to the patient's forehead or neck [22].
- Remove the tourniquet, then the needle and apply pressure to the puncture site, if nausea occurs during the puncture and depending on the clinical situation.

12.4 Vomiting

- Remove the tourniquet, then the needle and apply pressure to the puncture site, if vomiting occurs during the puncture [22].
- Give the patient a container to collect vomit [22].
- If possible, give him water to rinse his mouth, but only if he is no longer nauseated [22].
- Notify emergency services or seek immediate medical help if the problem persists [22].

12.5 Convulsions

- Remove the tourniquet, then the needle and apply pressure to the puncture site, if the convulsions occur during the puncture [22].
- If possible, lay down the patient on the floor (or lower the headboard if it is raised) and move away objects that he might collide with [22].
- Document the time that the convulsion started [22].

- Put a pillow, cushion or a folded blanket under the patient's head if he is on the floor [22].
- Do not put anything in the patient's mouth.
- Protect the patient's head from injury without putting up resistance, and without impeding arms and leg movements.
- Attempt to turn the patient on his side if vomiting.
- Notify emergency services or seek immediate medical help [22].

12.6 Hematoma

If hematoma formation is observed during the puncture, immediately loosen the tourniquet, remove the needle and firmly compress the puncture site with a gauze pad [22].

The following measures can help prevent the formation of a hematoma [71] :

- Puncture only through the upper wall of the vein.
- Ensure that the needle passes completely through the upper wall of the vein. If you only partially puncture the wall, the blood escaping from the vein can spread into the tissues surrounding the vein.
- Remove the tourniquet before removing the needle.
- Maintain pressure and ensure the puncture site is no longer bleeding before applying a bandage or adhesive tape. Firmly attach a gauze pad to the skin with the bandage or adhesive tape after the puncture.
- Warn the patient not to make efforts or lift heavy objects with the affected arm for a few hours.

12.7 Allergy to antiseptics and bandages or adhesive tapes

If the patient is allergic to antiseptics or to the glue of the bandages or adhesive tapes, use another type of product [22].

12.8 Damaged vein

Carrying out several venipunctures at short intervals and at the same site can cause sclerosis of the vein and make subsequent venipunctures more difficult. Care should be taken to vary the puncture sites [99].

12.9 Accidental nerve injury

Avoid "blindly" searching for the vein with the needle. Doing so can damage the underlying nerves. Perform the venipuncture, prioritizing areas with fewer nerves [22].

The following are signs and symptoms suggestive of nerve damage [22] :

- electric shock feeling;
- severe pain;
- unusual pain;

- tingling;
- numbness;
- sudden tremor.

If the person collecting the sample notices any of these signs or the patient complains of any of these symptoms, the needle may have touched a nerve. **In such a case, the tourniquet must be loosened, and the needle removed immediately**, even if the patient insists that the collection be completed. The puncture must be repeated elsewhere, preferably on the other arm. An incident or accident report shall be completed [22].

Loss of limb mobility, decreased grip strength, and persistent pain are possible complications of nerve damage [164] [165] [166] [167]. Patients with suspected nerve damage shall be referred to an authorized healthcare professional [22].

12.10 Accidental arterial puncture

When an artery is accidentally punctured, bright red blood spurts into the tube with a lot of pressure and a hematoma can quickly form [43]. If you think you have punctured an artery, immediately loosen the tourniquet, remove the needle, and firmly compress the puncture site with a gauze pad for at least five minutes and until the bleeding stops [22].

A doctor or emergency services shall be notified immediately of the situation, which shall be documented on the requisition or in the patient's chart. An incident or accident report shall be completed [22].

13.0 Particular patient consideration

13.1 Pediatric venipuncture

- The venipuncture material used should help minimize the risk of vein collapse [22]. Use material for appropriate pediatric use (when available) or any other necessary supplies, for example [22] :
  - Winged blood collection set (butterfly) attached to a tube holder for pediatric use, fitted with a 22 or 23 gauge needle (see point 10.1);
  - syringe system integrated into a collection tube and provided with a 22 or 23 gauge needle (butterfly type or not);
  - tubes for pediatric use.
- Pay particular attention to the volume of blood collected (see point 13.1.1).
- Ask for help to immobilize the child's arm, to avoid sudden movements that can cause injury [22].
- Follow the other steps of the venipuncture described in point 11.0.

13.1.1 Precautions related to blood volume collected

When multiple samples are taken from the same patient, especially if it is a child under 14 years of age or a patient in critical condition, the volume of blood collected can have harmful consequences such as anemia [168] [169] [170].

That is the reason why it is desirable that the various healthcare professionals consult each other to minimize the number of punctures and the blood volume collected [3] [22].

If possible, smaller tubes for pediatric use are recommended to reduce the blood volume collected [22] [171].

According to a review of the literature [172], the amount of blood collected from children should be between 1 and 5% of the total blood volume per 24-hour period and not exceed 10% of the total blood volume per 8-week period [3] [22]. Blood mass is around 75 ml to 80 ml / kg in children and is even higher in newborns (up to 85 ml / kg) [173]. In sick people it is advisable to collect a volume of blood below the prescribed limits [3] [22]. The maximum blood volume to be drawn from children based on punctures and periods (24 hours and 8 weeks), are presented in a table in Annex 7 (for information purposes only). Each institution shall determine the maximum volumes to be collected in agreement with the concerned specialists.

It is recommended to document the date of collection and the blood volume collected on a record sheet left at the patient's bedside [3] [22]. This document should then be added to the patient's file.

13.2 Venipuncture of semi-conscious, unconscious or sleeping patient

Any sleeping patient (except if under anesthesia) must be woken up before the puncture [22].

In view of a performing a venipuncture from a semi-conscious or unconscious patient, it is necessary :

- to ask for help to immobilize the arm [43];
- to expect sudden movements during the intervention;
- to be ready to quickly withdraw the needle and tourniquet;
- if the needle accidentally enters deep into the arm, ask a doctor to verify for injuries.

13.3 Venipuncture of a patient in isolation

The patient is placed in isolation to prevent the transmission of infections to other people (staff, visitors, etc.) or as a preventive measure, when the patient himself risks being infected by an external source (immunosuppressed patient, transplant patient, neutropenic, severely burned, etc.).

The guide published by Health Canada under the title *Routine practices and additional precautions for preventing the transmission of infection in healthcare* [12] describes the guidelines for infection prevention, in order to promote the development of policies, procedures and evaluation mechanisms that ensure optimal quality of care.

Basic practices (hand hygiene, glove wearing, mask, gown, etc.) aimed at preventing infection shall be respected each time healthcare is provided to a patient. In situations that require it (defined by the institution's infection prevention team), additional precautions are taken to minimize the risk of transmitting a particular infection [12].

The **ASSTSAS** has created a poster detailing the steps to be taken to put on and remove PPE. This poster can be viewed at the following address:

http://asstsas.qc.ca/sites/default/files/publications/documents/Affiches/a70a-epi-ppe.pdf

The infection prevention and control specialist teams working in healthcare centers, establish additional precautions and isolation measures that must be followed. The health professional shall always refer to the isolation practices guide in his institution.

13.4 Blood collection for forensic analysis

Requests for blood collection for forensic analysis can come from a court's jurisdiction. In all other cases, a prescription from an authorized prescriber is required to proceed. Keep a copy of the prescription or certificate in the patient's file or in the laboratory if the person does not have a file in the institution.

Always follow the procedure described by the requestor, otherwise follow the one of the laboratory which will carry out the analysis. Ensure the chain of custody procedures by signing and dating all forms and seals provided, and affixing these in the designated places [114].

As indicated in point 11.13.2, an alcohol-containing solution shall not be used to sanitize the puncture site if the blood collected is intended for measure blood alcohol level [114].

14.0 Factors influencing test results at the preanalytical stage

The sample conformity criteria are established in each laboratory in close collaboration with specialists. These criteria can lead to rejection of the sample, if one or more preanalytical conditions have not been met [6].

In addition to mastering all stages of the puncture, the healthcare professional must know the main factors that may affect the validity of the test results [32].

14.1 Factors related to identification

Non-biological errors are mainly related to the incorrect identification of the patient, sample or request form. The quality criteria for these elements were discussed earlier in this document (see points 11.3 and 11.18).

Managing these errors is also part of the administrative and organizational procedures; for more information on this topic, consult the OPTMQ document entitled *Quality Management Guide in Biomedical Laboratories* [(9)].

14.2 Factors related to sample integrity

The following are the main factors that could affect the integrity of the sample.

14.2.1 Hemolysis

In vitro hemolysis results in the release of hemoglobin and intracellular elements of erythrocytes such as potassium, lactate dehydrogenase (LDH), aspartate aminotransferase (AST) and alanine aminotransferase (ALT), etc. [(174) (175)]. The hemolysis can also be a cause of spectral interference and distort the hemoglobin dosage. Lysis of thrombocytes and granulocytes can also affect chemical reactions during analysis of the sample [(176)].

The hemolysis can be estimated by certain analyzers [(177)] or, in the absence of such instruments, using an interpretation tool of the degree of hemolysis (see Annex 8). However, the evaluation made using this tool must not be recorded on the analysis report when it is possible to issue the estimation of hemolysis provided from an analyzer (except in the presence of certain drugs which may distort the estimate of the analyzer l [(177)]).

The following measures help avoid hemolysis of the blood [(19) (22) (174)] :

- verify that the alcohol is well evaporated by examining the puncture site before performing the puncture;
- avoid using a needle of a caliber that is too small (e.g., certain 25 G needles);
- avoid drawing blood from a hematoma;
- avoid drawing blood from a peripheral venous catheter;
- if using a syringe, avoid pulling the plunger forcibly to draw the blood and pushing forcefully on the plunger to inject the blood into the tubes;
- make sure the needle is securely attached to the syringe to prevent foaming;
- make sure that the blood flows freely in the tube;
- do not leave the tourniquet in place for more than one minute;
- avoid shaking the tubes vigorously;

- make sure to completely fill the tubes in order to respect the blood: anticoagulant ratio;
- avoid large volume evacuated tubes if collecting the sample from a child [19];
- make sure to place the tube upright after collection and protect it from shaking during transport.

The hemolysis of samples shall be declared and documented in the patient's report. For some tests, hemolysis is a criteria for rejecting the sample [174].

14.2.2 Hemoconcentration

Hemoconcentration refers to the increase in the concentration of macromolecules in the blood, following a decrease in plasma volume: the largest elements of the blood are found in less fluid. When the tourniquet is applied around the patient's arm and tightened, it limits the flow of blood in the distal part of the arm (downstream, under the tourniquet). Blood cannot return as easily to the heart and leads to fluid accumulate in this part of the arm. To counter this accumulation, the fluid diffuses into the tissues, taking with it the smallest elements of the blood. The circulating blood that remains in this part of the arm therefore contains less fluid, but larger elements [178].

Tests affected by hemoconcentration mainly relate to the largest elements present in greater quantity in the vein and, consequently, in the blood sample. These include, among others, erythrocytes, clotting factors, albumin, cholesterol, glucose, enzyme, and protein levels [100] [101] [179].

A prolonged application of the tourniquet and the repetitive movement of opening and closing the hand can cause hemoconcentration of the sample and give erroneous results for these tests. Although it occurs *in vivo*, hemoconcentration is therefore directly linked to a step of venipuncture [178].

14.2.3 Insufficient filling of tubes

The quality and stability of the sample are directly linked to compliance with the blood: anticoagulant ratio prescribed in the collection tube. It is therefore necessary to aim for an optimal ratio [155]. The optimal level is often indicated on the tube and depends on the filling capacity of the tube.

If the optimal volume of blood is not added to a tube containing a liquid anticoagulant, the results will be erroneous because the blood is more diluted in the anticoagulant [180]. In the case of lyophilized anticoagulants (e.g., K_2EDTA), excess anticoagulant can also affect the results [181].

However, in anticipation of a difficult puncture, it may be better to opt for smaller tubes to ensure the accuracy of the analysis. Failure to respect the minimum acceptable volume is one of the criteria for rejecting samples [155].

14.2.4 Presence of clots

To avoid the formation of clots in a tube containing an anticoagulant, the contents of the tube must be mixed immediately after collection, gently, inverting the tube as many times as required by the manufacturer [22]. A puncture that is not straightforward can also lead to the formation of micro clots in the tube.

The presence of a clot (in a tube containing an anticoagulant) leads to the rejection of the sample, because the test results will be erroneous; obtaining false results can have significant clinical consequences for the patient [151] [152].

Caution: The clot should **never** be removed before shipping the tube to the laboratory, as the tests on the remaining blood will be erroneous [152].

14.2.5 Transport and storage of samples

The integrity of the sample is also dependent on the time between its collection and analysis and the temperature at which it is stored [3]. For more information on the factors that influence the integrity of samples during transport and storage, consult the OPTMQ document entitled *Transport et conservation des échantillons dans le domaine de la biologie médicale* [162].

14.3 Patient-related in vivo factors

Certain factors that can influence the test results are related to the patient and occur *in vivo*. These factors can be non-modifiable (age, gender, pregnancy, genetic factors, etc.) or modifiable (collection schedule, diet, physical activity, medication intake, position of the body during venipuncture, etc.) [176] [179].

Here are some of these factors [176] [179] :

- circadian rhythm: preferably always take samples at the same time (e.g. in the morning between 7 and 9 am);
- medication intake: for dosing purposes, verify and record the time of the last dose of medication taken before the puncture (e.g. carbamazepine, which may increase the level of gammaglutamyl transferase [GGT], erythromycin, oral contraceptives (except micro pill), phenytoin);
- strenuous physical activity (e.g., creatinine kinase);

- patient's position during blood collection: when a patient who is lying down, gets up or sits, the increase of his filtration pressure promotes the passage of liquids and low molecular weight molecules through the capillary wall to the extravascular compartment. The blood then contains more analytes of higher molecular weight. This situation can cause, among other things, an artificial increase in the concentration of several analytes, including erythrocytes and cholesterol.

  The increased concentration of macromolecules, cells and protein-bound analytes in the intravascular compartment is similar to the hemoconcentration that occurs when the tourniquet is left in place for too long.

  Therefore laboratory's instructions must be followed in regards to the waiting time between the change of position and the collection.

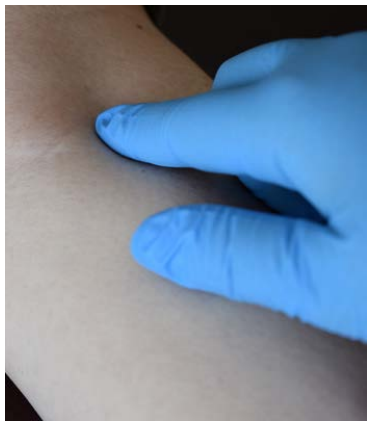
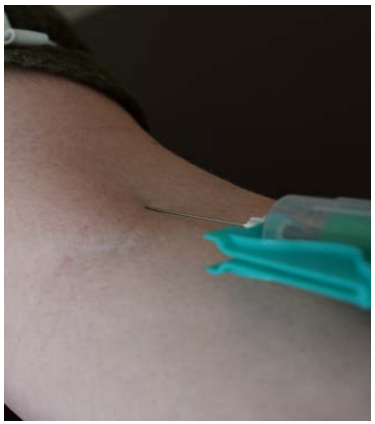
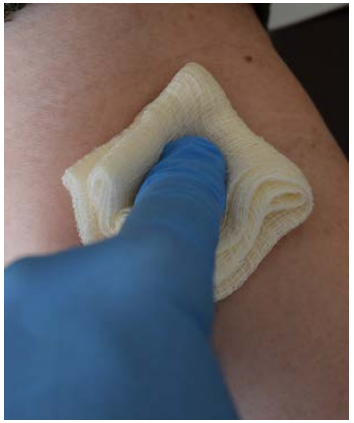
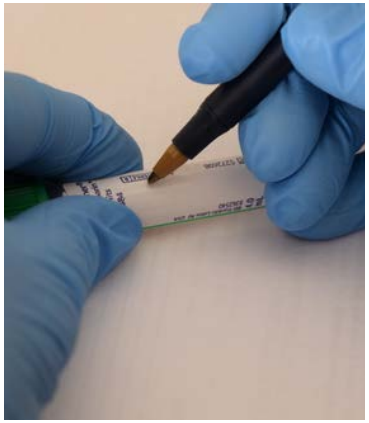
Annex 1
Venipuncture steps

Step	Don't forget
1. Verify the prescription and complete the forms	Make sure to understand what tests are requested and verify that the prescription is well completed.
2. Greet or approach the patient and identify yourself	Identify yourself and your professional title
3. Verify the patient's identity	Ask the patient to state his first name, last name and date of birth. Compare the information provided with the information on the prescription, ID card, bracelet and / or labels.
4. Obtain informed consent from patient	Implicit if the patient comes to the collection center. May be withdrawn at any time.
5. Verify the patient's preparation	Verify for patient-related factors that may affect the results (e.g., fasting, exercise, medication intake, dehydration).
6. Verify the consistency between the prescription, the forms, the labels and the collection material	Ensure that the patient's identity matches the information provided on these documents. Gather the material and tubes necessary for the prescribed analysis.
7. Wash or disinfect hands and put on the necessary PPE	The use of a liquid alcohol disinfectant is acceptable under certain circumstances. Wearing gloves protects in case of exposure to body fluids.
8. Position the patient	Place the arm outstretched downward and ask the patient to close his fist. The patient should keep the fist closed (without opening and closing it).
9. Select the puncture site	Prioritize the region of the antecubital fossa. Avoid areas at risk of complications.
10 Apply the tourniquet	If possible, apply over clothing. Do not leave the tourniquet in place for more than one minute to avoid hemoconcentration. If necessary, loosen for at least two minutes and replace.
11. Select the vein for puncture	The median vein should be prioritized, then the cephalic vein and, finally, the basilic vein.

Annex 1 (continued)
Venipuncture steps

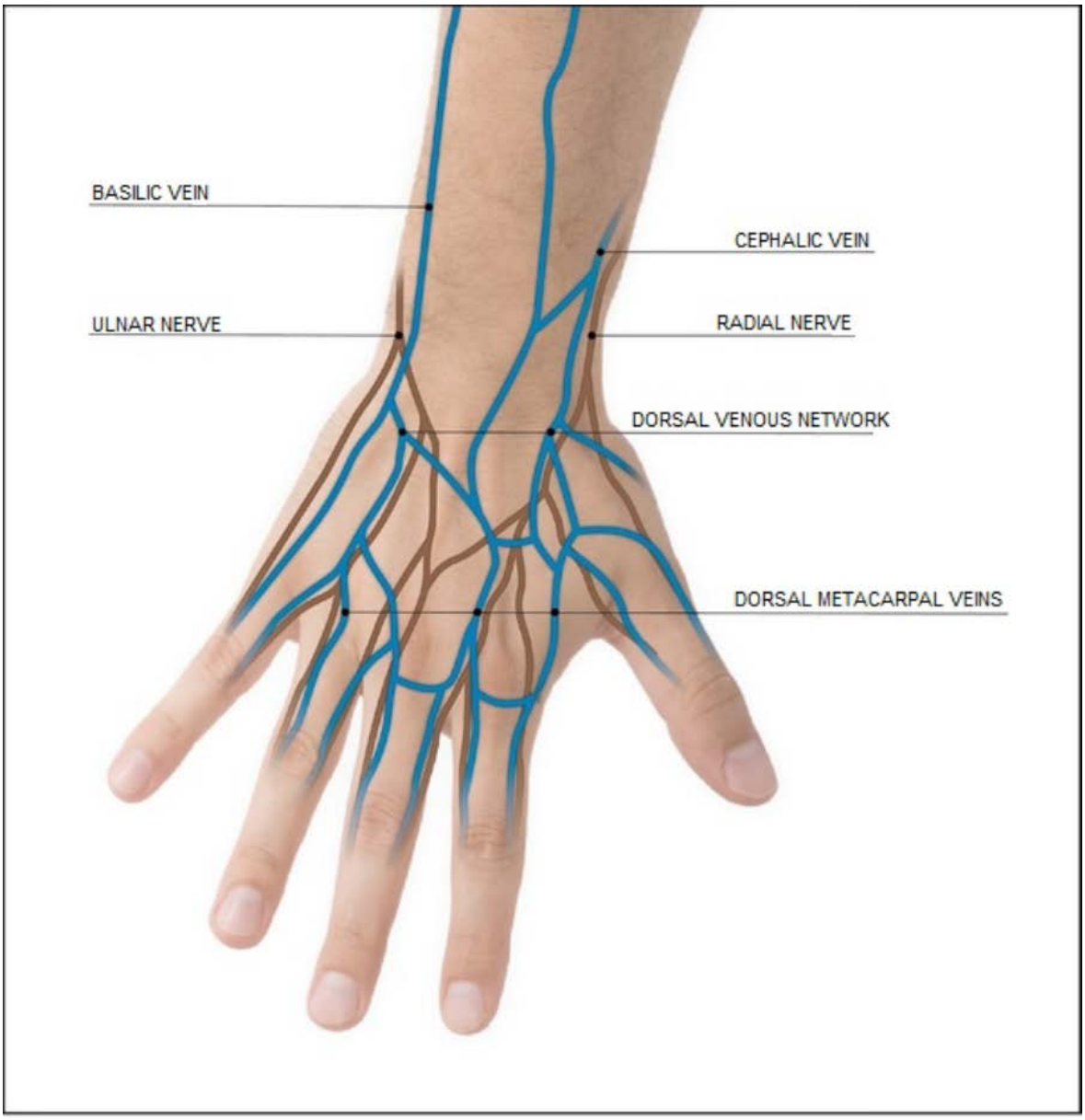
Step	Don't forget
12. Choose and assemble the necessary collection material	The size and fragility of the vein should guide the choice of material. Attach the needle to the tube holder in front of the patient.
13. Sanitize the puncture site	Wait until the alcohol is dry before performing the puncture. Do not palpate the sanitized area to avoid contaminating it.
14. Insert the needle, draw the blood and remove the tourniquet	Insert the needle at a maximum angle of 30 degrees. Remove the tourniquet as soon as blood flows into the first tube.
15. Fill the tubes and mix their contents	Fill the tubes in the prescribed order and at optimal capacity to respect the blood: anticoagulant ratio. Immediately invert the tubes for the number of times prescribed to avoid the formation of clots.
16. Remove the needle, apply pressure and discard the needle	Do not bend the patient's arm. Apply pressure for at least two to three minutes. Dispose securely of the needle.
17. Observe the patient, verify the puncture site and apply a bandage or an adhesive tape	Verify that the puncture site is no longer bleeding. Apply a bandage or adhesive tape suitable for the patient's restrictions. Advise the patient not to remove the bandage or tape for at least 15 minutes.
18. Identify the sample	Identify all the tubes in the patient's presence by indicating at least his first name, last name and identification number (e.g., RAMQ). Document the date and time of the collection and the identity of the person who collected it.
19. Lift dietary restrictions and thank the patient	Ensure that the patient does not need to be fasting for other tests.
20. Discard all used materials	Dispose of soiled material in the appropriate containers.
21. Remove PPE and wash or disinfect hands	Dispose of PPE in the appropriate containers. Wash or disinfect hands according to standard practices.
22. Stabilize, store and transport the sample to the laboratory	Follow the stabilization, storage and transport instructions provided by the testing laboratory.

Annex 2
Illustration of venipuncture steps

				
Attach the tourniquet and ask the patient to close his hand.	Select a vein.	Disinfect the puncture site.	Keeping the bevel of the needle facing up, puncture the vein at an angle of 30º or less.	Immobilize the tube holder collar and stabilize the needle. Push the tube to the bottom of the tube holder and verify that blood flows into the tube.
				
As soon as the blood flows steadily, remove or loosen the tourniquet and ask the patient to open the hand.	After removing the last tube, cover the puncture site with a gauze pad and withdraw the needle slowly without changing the insertion angle.	Apply firm pressure on the vein.	Dispose of the needle in an approved container marked "Biomedical waste".	Identify each sample immediately after collection and in the presence of the patient. Each sample must bear the last name, first name and a patient-specific identification number.

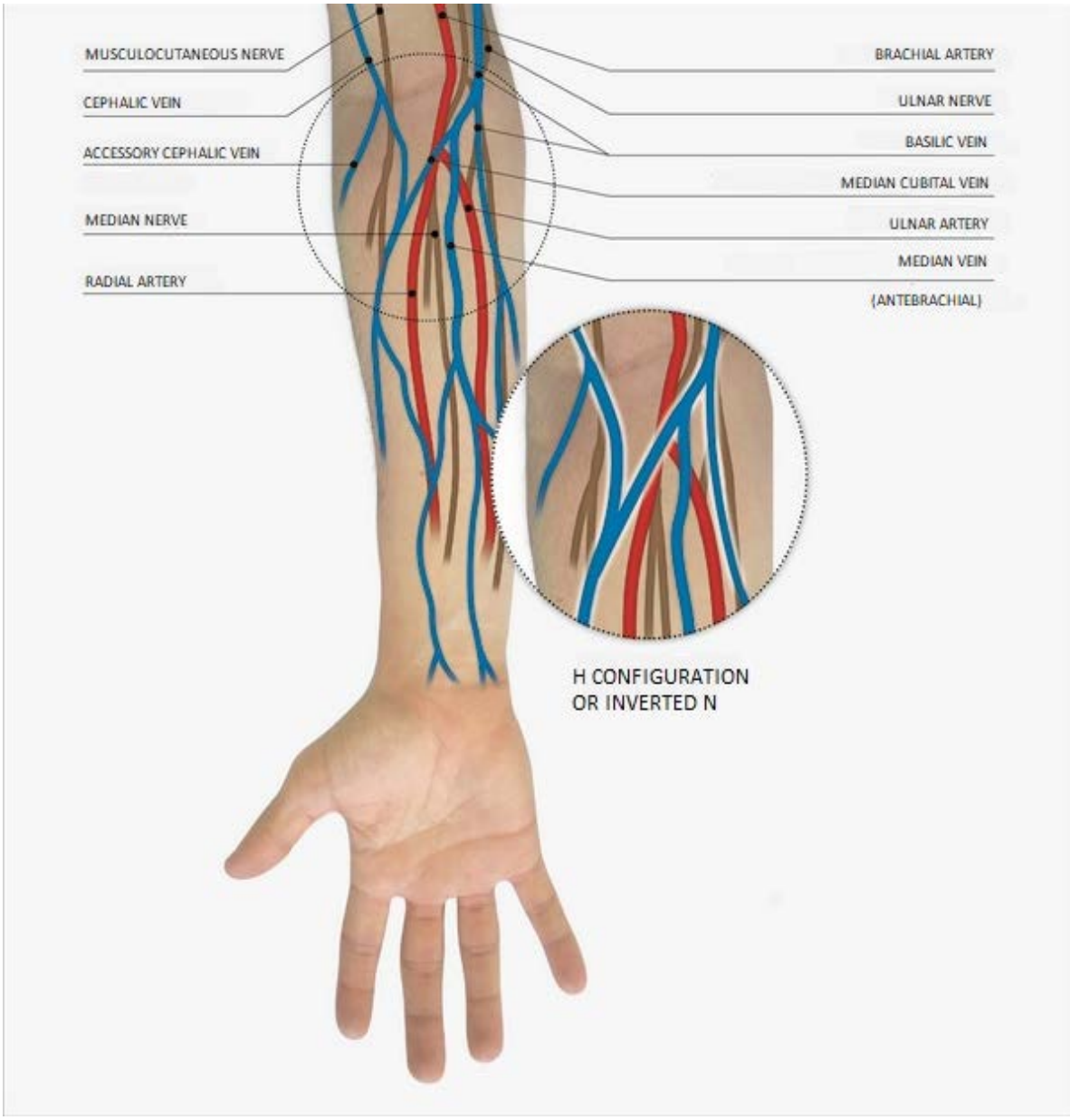
Annex 3

Veins on the back of the hand

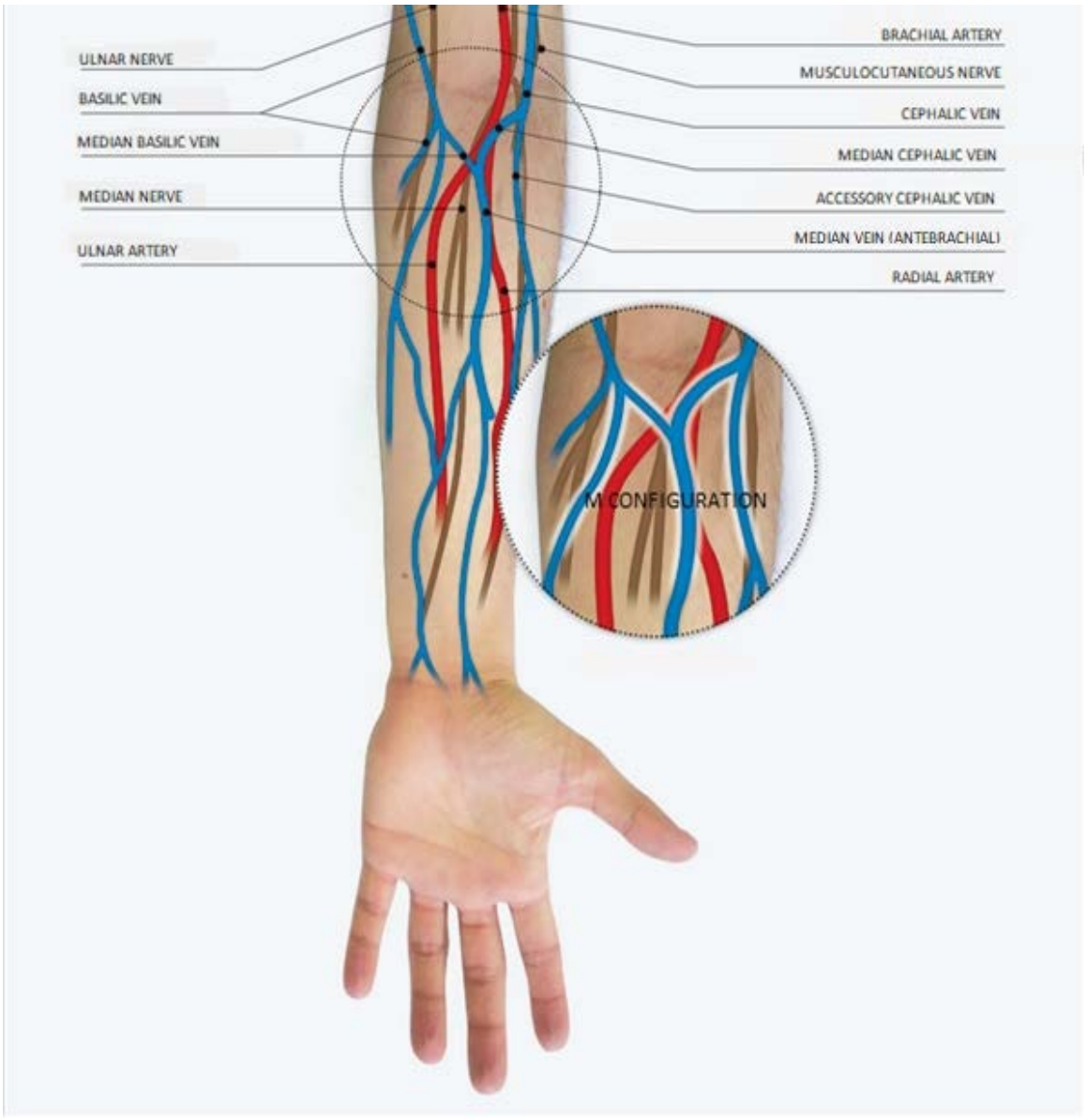


Annex 4

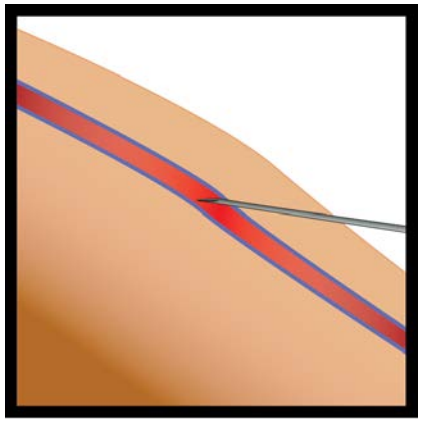
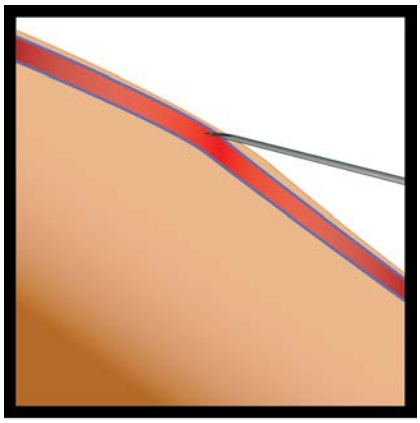
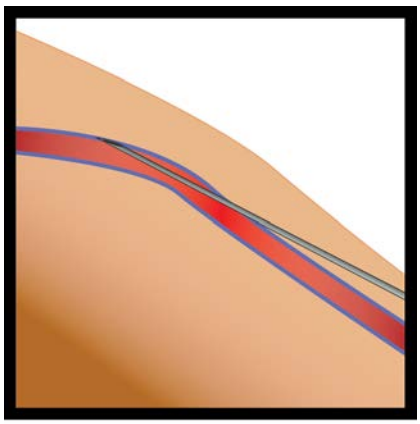
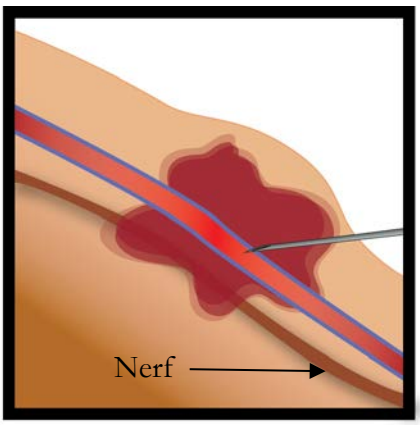
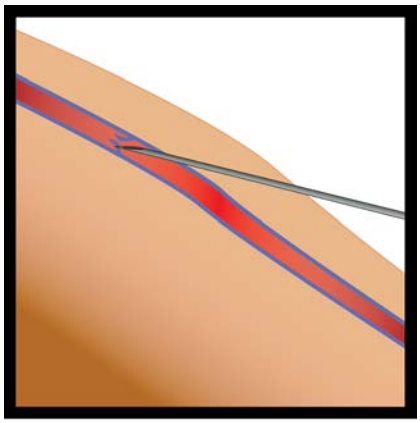
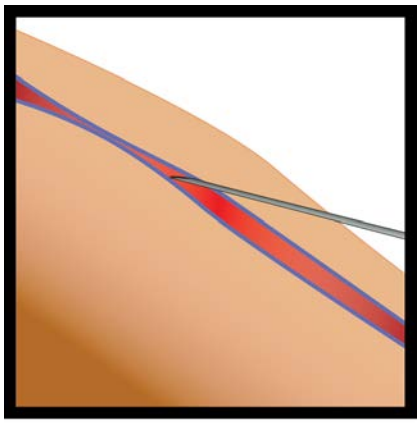
Configuration of veins in H or inverted N shape



Annex 5
Configuration of veins in M shape



Annex 6
Positioning of the needle

Correct insertion of the needle 	Bevel slightly outside the skin; the vacuum will be lost 
Bevel pressed against the upper wall of the vein preventing the flow of blood 	Needle partially inserted into the vein causing blood to infiltrate tissue and compressing the nerve 
Bevel that enters a valve preventing blood flow 	Collapse of the vein, stopping the flow of blood 

Annex 7
Maximum blood volume to be drawn from children

Weight of patient		Maximum volume per draw[a]	Maximum volume per 24 hours[b]	Maximum volume per 8 weeks[c]
lb	**kg**	**ml**	**ml**	**ml**
6 to 8	2,7 to 3,6	2,5	10	20
8 to 10	3,6 to 4,5	3,5	14	27
10 to 15	4,5 to 6,8	5	17	34
16 to 20	7,3 to 9,1	10	27	55
21 to 25	9,5 to 11,4	10	35	70
26 to 30	11,8 to 13,6	10	44	88
31 to 35	14,1 to 15,9	10	52	104
36 to 40	16,4 to 18,2	10	62	124
41 to 45	18,6 to 20,5	20	70	140
46 to 50	20,9 to 22,7	20	78	156
51 to 55	23,2 to 25,0	20	87	174
56 to 60	25,5 to 27,3	20	96	192
61 to 65	27,7 to 29,5	25	104	208
66 to 70	30,0 to 31,8	30	112	224
71 to 75	32,3 to 34,1	30	121	242
76 to 80	34,5 to 36,4	30	129	258
81 to 85	36,8 to 38,6	30	138	276
86 to 90	39,1 to 40,9	30	147	294
91 to 95	41,4 to 43,2	30	155	310
96 to 100	43,6 to 45,5	30	164	328

It is recommended to reduce these volumes in sick patients. Each institution must determine the maximum volumes to be collected in concert with the specialists concerned.

Annex 7 (continued)

Maximum blood volume to be drawn from children

a) Data source, maximum volume per draw: GARZA, Diana and BECAN- MCBRIDE, Kathleen. *Phlebotomy Handbook*, 9e Edition, Pearson Education, Inc, New Jersey, 2015, 629 p. [71]

b) Maximum volume per 24 hours based on a limit of 5% of the total blood volume over 24 hours for the lowest weight of the interval indicated [3] [172]. Calculation based on a blood volume estimated at 75 ml / kg in children [173]. In newborns, the volume can reach 85 ml/kg.

c) Maximum volume per 8 weeks based on a limit of 10% of total blood volume over 8 weeks for the lowest weight in the indicated range [3] [172]. Calculation based on a blood volume estimated at 75 ml / kg in children [173]. In newborns, the volume can reach 85 ml/kg.

Annex 8
Hemolysis Scale

The hemolysis can be estimated by some analyzers or, in the absence of such instruments, using an interpretation tool of the degree of hemolysis like this one. However, the evaluation made using this tool must not be recorded on the analysis report when it is possible to issue the estimation of hemolysis provided from an analyzer (except in the presence of certain drugs that may distort the estimate of the analyzer).

					
Degree of hemolysis	**No hemolysis**	**1+**	**2+**	**3+**	**4+**
Approximate hemoglobin concentration	**0 g/L**	**1 g/L**	**2 g/L**	**3 g/L**	**> 4 g/L**

Images taken by Carolle Robert, T.M. au CHU de Sherbrooke. Reproduced with permission.

Note : The hemoglobin concentration is provided for information purposes only; it does not need to be noted in the report.

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Comments

Considering the evolution of technology, this guide will be subject to periodic revision. We invite you to send us any suggestions that could improve the content.

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