CLINICAL AND LABORATORY STANDARDS INSTITUTE®

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GP43-A4

Procedures for the Collection of Arterial Blood Specimens; Approved Standard—Fourth Edition

This document provides principles for collecting, handling, and transporting arterial blood specimens to assist with reducing collection hazards and ensuring the integrity of the arterial specimen.

A standard for global application developed through the Clinical and Laboratory Standards Institute consensus process.

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Procedures for the Collection of Arterial Blood Specimens; Approved Standard—Fourth Edition

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Abstract

Collection of a blood specimen, as well as its handling and transport, are key factors in the clinical laboratory analysis and ultimately in delivering quality patient care. CLSI document GP43—*Procedures for the Collection of Arterial Blood Specimens* serves a dual purpose: to reduce the potential hazard to the patient and to maintain the integrity of the arterial blood specimen. Collecting arterial blood is not only technically difficult but also imposes a degree of risk for the patient. Arterial blood is also one of the specimens most sensitive to preanalytic effects. This standard will be particularly valuable to those involved in blood specimen collection, such as clinical laboratory directors, respiratory therapists, physicians, physicians in training, nurses, medical technologists, exercise physiologists, phlebotomists, and perfusionists.

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Foreword

This standard has been written for use by clinical laboratory directors, respiratory therapists, medical technologists, physicians, physicians in training, nurses, exercise physiologists, phlebotomists, perfusionists, and any others who may collect or be involved with the collection of arterial blood specimens for clinical laboratory analysis. The preanalytical phase of the laboratory path of workflow includes the collection of blood specimens for clinical laboratory analysis. This is one of the initial critical steps in providing clinical laboratory services for quality patient care. Without the proper and efficient collection of specimens, laboratory results would have little value.

The collection of arterial blood is not only technically difficult, but can be painful and hazardous for the patient. Therefore, it is essential that individuals performing arterial puncture be familiar with the proper techniques, with the hazards/complications of the procedure, and with the necessary precautions.

Arterial blood is one of the specimens most sensitive to preanalytic effects. Improper patient assessment, test requisition, collection or transport of a specimen of arterial blood intended for pH, and blood gas analysis can alter the gas tensions, or pH, or both. In addition to pH/gases analysis, instruments are now available for the specific measurement of pH/gases and other critical care analytes (e.g., sodium, potassium, chloride, ionized calcium, glucose, hematocrit, hemoglobin) on the same arterial whole-blood specimens. Therefore, scrupulous attention to the principles outlined in this standard is mandatory to eliminate a major potential source of erroneous laboratory results.

This publication has been written for the primary purpose of reducing the potential hazards to the patient and increasing the integrity of the arterial blood specimen. The primary focus of this standard is arterial puncture with a discussion of arterial cannulation. While providing some specific guidelines, it is not intended to provide an exhaustive discussion of related subjects, such as pH/blood gas analysis and the technical implications of improper sampling.

NCCLS is dedicated to quality clinical laboratory services, and this standard covers one of the many areas in which standards are being developed to help achieve this end.

The revisions in this version of the GP43 standard are intended principally to delineate between quality system essentials (QSEs) related to and the path of work flow for arterial blood collection. The previous edition (H11-A3) was published for wide and thorough review in the NCCLS consensus-review process. The objective of this review was to obtain specific input on the utility and applicability of the recommendations provided for arterial blood collection techniques. However, a “Summary of Consensus Comments” has not been included in this approved, fourth-edition document as all comments received as a result of the consensus review process were editorial in nature.

The Area Committee on Clinical Chemistry and Toxicology urges users to submit comments related to experience in using GP43-A4 to assure future editions reflect the “state of the art.”

Key Words

Arterial blood, arterial cannula/catheter, arterial puncture, blood collection, blood gas, blood gas analysis, oxygen tension, pH

Procedures for the Collection of Arterial Blood Specimens; Approved Standard—Fourth Edition

1 Scope

This standard has been written for the primary purpose of reducing the potential hazards to the patient and medical personnel and to increase the clinical usefulness of the arterial blood specimen. It has been written for use by clinical laboratory directors, respiratory therapists, physicians, physicians in training, nurses, exercise physiologists, perfusionists, and any others who may collect, or be involved with the collection of, arterial blood specimens.

It addresses collection of whole blood specimens from arterial sites with emphasis on reducing the potential hazards to the patient and to medical personnel. The specimen collection procedures are intended to provide appropriate whole blood samples for blood gas, electrolyte, and metabolite determinations.

2 Introduction

Arterial blood is the substance presented to all organs for their metabolic needs; its composition is uniform throughout the body. The composition of venous blood is conditioned by the metabolic activity of the tissue which it drains and therefore varies among different parts of the body and at different times (e.g., depending on muscular activity). The largest difference between arterial and venous blood is its oxygen content, but pH, carbon dioxide content, packed cell volume, and the concentrations of lactic acid, plasma chloride, glucose, ammonium and other metabolites also vary. All differences between arterial and venous blood are exaggerated when the general or local circulation is impaired. Arterial blood therefore is the preferred specimen for all these determinations and it is essential for evaluating respiratory and metabolic functions.

All individuals performing arterial puncture should be familiar with the hazards/complications of the procedure and with precautions designed to prevent hazards to the patient or to the laboratorian, or alteration of the results of the laboratory test. For example, anxiety or excitement of the patient alters the breathing pattern which will change the gas tensions within less than a minute. There must be attention to detail in the precollection and postcollection phases of arterial sampling to maintain the integrity of test results.

3 Standard Precautions

Because it is often impossible to know what might be infectious, all patient and laboratory specimens are treated as infectious and handled according to "standard precautions." Standard precautions are guidelines that combine the major features of "universal precautions and body substance isolation" practices. Standard precautions cover the transmission of all infectious agents and thus are more comprehensive than universal precautions which are intended to apply only to transmission of blood-borne pathogens. Standard and universal precaution guidelines are available from the U.S. Centers for Disease Control and Prevention (*Guideline for Isolation Precautions in Hospitals.* Infection Control and Hospital Epidemiology. CDC. 1996;17(1):53-80 and *MMWR* 1988;37:377-388). For specific precautions for preventing the laboratory transmission of all infectious agents from laboratory instruments and materials and for recommendations for the management of exposure to all infectious disease, refer to the most current edition of NCCLS document M29—*Protection of Laboratory Workers from Occupationally Acquired Infections*.

4 Definitions

Oxygen content of blood, c_tO_2 – The sum of the substance concentrations of the oxygen bound to hemoglobin as O_2Hb plus the amount dissolved in blood (intra- and extracellular).

Partial pressure – *Of a component in a solution,* the pressure that would exist in a hypothetical ideal gas phase, in equilibrium with the solution.

pH – The symbol for the negative (decadic) logarithm of the {relative molal} hydrogen ion activity (αH^+); **NOTE:** Historically, pH arose as a symbol for the "power of hydrogen."

Sample (patient) – In this document, a sample taken from the patient specimen and used to obtain information by means of a specific laboratory test; **NOTE:** ISO 15189 defines sample as "one or more parts taken from a system, and intended to provide information on the system, often to serve as a basis for decision on the system or its production;" EXAMPLE: A volume of serum taken from a larger volume of serum.[1]

Specimen – Biological material which is obtained in order to detect or to measure one or more quantities. (EN 375)[2]

Total carbon dioxide//Total CO_2 – The combination of all of the various forms of carbon dioxide in the plasma in equilibrium with whole blood.

5 Quality System Essentials

5.1 Personnel

Job qualifications, job descriptions, and processes for selection, orientation, training, and assessing the competence and overall performance of personnel should be clearly defined.

There should be a process for training instructors, as well as new and existing employees. Training should be provided for new employees when new procedures are being implemented or changed, and when training needs are identified. (Please refer to NCCLS document GP21—*Training and Competence Assessment* for additional information.)

5.2 Process Control/Process Improvement

Table 1 provides examples of substances that may interfere with the measurement of blood gases, electrolytes, and/or other metabolites.[3]

NOTE: It is critical that the operator check with the manufacturer not only for known or interfering substances, but for assistance in recognizing the effects of a previous unknown material.

The Quality System Approach

NCCLS subscribes to a quality system approach in the development of standards and guidelines, which facilitates project management; defines a document structure via a template; and provides a process to identify needed documents through a gap analysis. The approach is based on the model presented in the most current edition of NCCLS document HS1—*A Quality System Model for Health Care.* The quality system approach applies a core set of "quality system essentials" (QSEs), basic to any organization, to all operations in any healthcare service's path of workflow. The QSEs provide the framework for delivery of any type of product or service, serving as a manager's guide. The QSEs are:

Documents & Records	Equipment	Information Management	Process Improvement
Organization	Purchasing & Inventory	Occurrence Management	Service & Satisfaction
Personnel	Process Control	Assessment	Facilities & Safety

GP43-A4 addresses the following quality system essentials (QSEs):

Documents & Records	Organization	Personnel	Equipment	Purchasing & Inventory	Process Control	Information Management	Occurrence Management	Assessment	Process Improvement	Service & Satisfaction	Facilities & Safety
X HS4	HS4	X GP21 HS4	X HS4	HS4	X HS4	HS4	HS4	HS4	X HS4	HS4	X HS4 M29 X3

Adapted from NCCLS document HS1—*A Quality System Model for Health Care*.

Path of Workflow

A path of workflow is the description of the necessary steps to deliver the particular product or service that the organization or entity provides. For example, GP26 defines a clinical laboratory path of workflow which consists of three sequential processes: preanalytic, analytic, and postanalytic. All clinical laboratories follow these processes to deliver the laboratory's services, namely quality laboratory information.

GP43-A4 addresses the following steps within the clinical laboratory path of workflow:

Preanalytic					Analytic		Postanalytic	
Patient Assessment	Test Request	Specimen Collection	Specimen Transport	Specimen Receipt	Testing Review	Laboratory Interpretation	Results Report	Post-test Specimen Management
X	X	X H3 H4 LA4	X	X	C46	C46		

Adapted from NCCLS document HS1—*A Quality System Model for Health Care*.

Related NCCLS Publications*

C46-A **Blood Gas and pH Analysis and Related Measurements; Approved Guideline (2001).** This document provides clear definitions of the quantities in current use, and provides a single source of information on appropriate specimen collection, preanalytical variables, calibration, and quality control for blood pH and gas analysis and related measurements.

GP21-A2 **Training and Competence Assessment; Approved Guideline—Second Edition (2004).** This document provides background and recommended processes for the development of training and competence assessment programs that meet quality/regulatory objectives.

GP26-A2 **Application of a Quality System Model for Laboratory Services; Approved Guideline—Second Edition (2003).** This guideline describes the clinical laboratory's path of workflow and provides information for laboratory operations that will assist the laboratory in improving its processes and meeting government and accreditation requirements.

H3-A5 **Procedures for the Collection of Diagnostic Blood Specimens by Venipuncture; Approved Standard—Fifth Edition (2003).** This document provides procedures for the collection of diagnostic specimens by venipuncture, including line draws, blood culture collection, and venipuncture in children.

H4-A5 **Procedures and Devices for the Collection of Diagnostic Capillary Blood Specimens; Approved Standard—Fifth Edition (2004).** This document provides a technique for the collection of diagnostic capillary blood specimens, including recommendations for collection sites and specimen handling and identification. Specifications for disposable devices used to collect, process, and transfer diagnostic capillary blood specimens are also included.

HS1-A **A Quality System Model for Health Care; Approved Guideline (2002).** This document provides a model for healthcare service providers that will assist with implementation and maintenance of effective quality systems.

HS4-A **Application of a Quality System Model for Respiratory Services; Approved Guideline (2002).** This document provides a model for providers of respiratory services that will assist with implementation and maintenance of an effective quality system.

LA4-A4 **Blood Collection on Filter Paper for Neonatal Screening Programs; Approved Standard—Fourth Edition (2003).** This document addresses the issues associated with specimen collection, the filter paper collection device, and the transfer of blood onto filter paper, and provides uniform techniques for collecting the best possible specimen for use in newborn screening programs.

M29-A2 **Protection of Laboratory Workers from Occupationally Acquired Infections; Approved Guideline—Second Edition (2001).** This document provides guidance on the risk of transmission of hepatitis viruses and human immunodeficiency viruses in any laboratory setting; specific precautions for preventing the laboratory transmission of blood-borne infection from laboratory instruments and materials; and recommendations for the management of blood-borne exposure.

X3-R **Implementing a Needlestick and Sharps Injury Prevention Program in the Clinical Laboratory; A Report (2002).** This document provides guidance for implementing safer medical devices that reduce or eliminate sharps injuries to laboratory personnel.

* Proposed- and tentative-level documents are being advanced through the NCCLS consensus process; therefore, readers should refer to the most recent editions.

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