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GP44-A4

Procedures for the Handling and Processing
of Blood Specimens for Common Laboratory
Tests; Approved Guideline—Fourth Edition

SAMPLE

This document includes criteria for preparing an optimal serum or plasma sample and for the devices used to process blood specimens.

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

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Procedures for the Handling and Processing of Blood Specimens for Common Laboratory Tests; Approved Guideline—Fourth Edition

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Abstract

Clinical and Laboratory Standards Institute document GP44-A4—*Procedures for the Handling and Processing of Blood Specimens for Common Laboratory Tests; Approved Guideline—Fourth Edition* considers multiple variables that are involved in handling and processing blood specimens. Its application should enable the user to recognize and control accuracy and precision factors that occur between the time of blood collection and the time of test performance.

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Foreword

Several issues in the handling and processing of blood specimens are documented in the scientific literature.¹⁻¹² Specific concerns relate to prolonged contact of serum or plasma with cells or with tube stoppers; hemolysis; measurand concentration changes due to evaporation; incorrect storage temperature; the use of anticoagulants and serum/plasma separator devices; incorrect transport; and turnaround time for patient results. Recognition and control of these variables should reduce error and contribute to the medical usefulness of patient test results.

Several changes were made in this edition; chief among them are an expanded discussion of measurand stability and centrifugation times; the introduction of the appendix, which lists acceptability of specimen testing for representative measurands after centrifugation within 24 and 48 hours of the time of collection; the introduction of Table 1, which provides information on the effect of hemolysis on laboratory tests; incorporation of information on hormone stability; precentrifugation phase handling and processing information for ribonucleic acid (RNA)-based molecular testing; postcentrifugation phase considerations for biobanking; and a new illustration of the relative centrifugal force nomograph. References were incorporated and updated throughout as appropriate.

Key Words

Centrifugation, handling, plasma, postcentrifugation, precentrifugation, processing, serum, specimen

SAMPLE

Procedures for the Handling and Processing of Blood Specimens for Common Laboratory Tests; Approved Guideline—Fourth Edition

1 Scope

This guideline addresses handling and processing of blood specimens for examination procedures using serum, plasma, or whole blood in the clinical laboratory. The variables associated with precentrifugation, centrifugation, and postcentrifugation phases of specimen handling and processing are emphasized. Factors that can introduce test result inaccuracy or systematic bias after the specimen is collected but before the test is performed are discussed and performance criteria for *in vitro* diagnostic blood collection devices used to separate serum or plasma from cellular components are also addressed.

This guideline specifies criteria to assist the laboratory and other health care providers in recognizing and reducing or eliminating preexamination errors resulting from improper handling of blood specimens. When applicable, the recommendations should be considered by the following laboratory areas: chemistry, coagulation, hematology, immunology, ligand assay, serology, toxicology/therapeutic drug monitoring, virology, blood bank, and molecular or deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) analysis. Information provided in this document on handling and processing of blood specimens for coagulation, hematology, and virology is limited. Users are referred to the current version of applicable CLSI documents for more detailed discussion as appropriate.

2 Standard Precautions

Because it is often impossible to know what isolates or specimens 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 known 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 US Centers for Disease Control and Prevention.¹³ For specific precautions for preventing the laboratory transmission of all known infectious agents from laboratory instruments and materials and for recommendations for the management of exposure to all known infectious disease, refer to CLSI document M29¹⁴ or other country-specific safety regulations.

3 Terminology

3.1 A Note on Terminology

CLSI, as a global leader in standardization, is firmly committed to achieving global harmonization wherever possible. Harmonization is a process of recognizing, understanding, and explaining differences while taking steps to achieve worldwide uniformity. CLSI recognizes that medical conventions in the global metrological community have evolved differently in the United States, Europe, and elsewhere; that these differences are reflected in CLSI, ISO (International Organization for Standardization), and European Committee for Standardization (CEN) documents; and that legally required use of terms, regional usage, and different consensus timelines are all important considerations in the harmonization process. In light of this, CLSI’s consensus process for development and revision of standards and guidelines focuses on harmonization of terms to facilitate the global application of standards and guidelines.

In GP44, the term *analyte* was changed to *measurand* to be consistent with accepted international usage.

3.2 Definitions

accuracy (measurement) – closeness of agreement between a measured quantity value and a true quantity value of a measurand (ISO/IEC Guide 99).¹⁵

biobanking – collection of biological material (blood, tissue, or other) from one or several human beings obtained and stored indefinitely or for a specified time, and whose origin is traceable to the humans from whom it originates.

centrifugation phase – the time period when the specimen is inside the centrifuge.

examination – set of operations having the object of determining the value or characteristics of a property (ISO 15189).¹⁶

measurand – quantity intended to be measured (ISO/IEC Guide 99)¹⁵; **NOTE 1:** The specification of a measurand requires knowledge of the kind of quantity, description of the state of the phenomenon, body, or substance carrying the quantity, including any relevant component, and the chemical entities involved (ISO/IEC Guide 99)¹⁵; **NOTE 2:** In the second edition of the VIM and in IEC 60050-300:2001, the measurand is defined as the ‘quantity subject to measurement’ (ISO/IEC Guide 99)¹⁵; **NOTE 3:** The measurement, including the measuring system and the conditions under which the measurement is carried out, might change the phenomenon, body, or substance such that the quantity being measured may differ from the measurand as defined. In this case, adequate correction is necessary (ISO/IEC Guide 99).¹⁵

postcentrifugation phase – the time period after the centrifuging of the specimen and before removal of an aliquot of serum or plasma for testing.

precentrifugation phase – time period after specimen collection and before specimen centrifugation.

preexamination procedures – steps starting, in chronological order, from the clinician’s request and including the examination requisition, preparation of the patient, collection of the primary sample, and transportation to and within the laboratory, and ending when the analytical examination procedure begins (ISO 15189).¹⁶

sample – 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 (ISO 15189)¹⁶; **NOTE:** In the context of GP44, a sample may be serum or plasma, available (for testing) after centrifugation of the specimen, or whole blood.

secondary tube – a tube used to contain the resultant plasma/serum yielded by the centrifugation of a primary additive/serum tube containing the patient specimen.

separated serum/plasma – serum or plasma that has been completely separated from any contact with cells or a clot; **NOTE 1:** The serum or plasma has either been removed, by pipette, from the cells or contact has been interrupted by a chemical/physical barrier through the use of a serum/plasma separator device (see Section 6); **NOTE 2:** The separated serum/plasma should be visually free of erythrocytes; however, 0.1% to 1% intact cells do not contribute to a hemolysis effect.⁷

specimen (patient) – the discrete portion of a body fluid or tissue taken for examination, study, or analysis of one or more quantities or characteristics to determine the character of the whole.

uncentrifuged specimen – a blood specimen that was not centrifuged.

The Quality Management System Approach

Clinical and Laboratory Standards Institute subscribes to a quality management 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. The approach is based on the model presented in CLSI document HS01—*A Quality Management System Model for Health Care*. The quality management system approach applies a core set of “quality system essentials” (QSEs), basic to any organization, to all operations in any health care service’s path of workflow (operational aspects that define how a particular product or service is provided). The QSEs provide the framework for delivery of any type of product or service, serving as a manager’s guide. The QSEs are as follows:

Documents and Records	Equipment	Information Management	Process Improvement
Organization	Purchasing and Inventory	Occurrence Management	Customer Service
Personnel	Process Control	Assessments—External and Internal	Facilities and Safety

GP44-A4 addresses the QSEs indicated by an “X.” For a description of the other documents listed in the grid, please refer to the Related CLSI Reference Materials section on the following page.

Documents and Records	Organization	Personnel	Equipment	Purchasing and Inventory	Process Control	Information Management	Occurrence Management	Assessments—External and Internal	Process Improvement	Customer Service	Facilities and Safety
H11		H11	H11	H03	X C37 GP33 H03 H04 H11 H20 H21 MM13			C44	H11		H03 H11 M29

Adapted from CLSI document HS01—*A Quality Management 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, CLSI document GP26—*Application of a Quality Management System Model for Laboratory Services* defines a clinical laboratory path of workflow, which consists of three sequential processes: preexamination, examination, and postexamination. All clinical laboratories follow these processes to deliver the laboratory's services, namely quality laboratory information.

GP44-A4 addresses the clinical laboratory path of workflow steps indicated by an “X.” For a description of the other documents listed in the grid, please refer to the Related CLSI Reference Materials section on the following page.

Preexamination			Examination			Postexamination	
Examination Ordering	Sample Collection	Sample Transport	Sample Receipt/processing	Examination	Results review and Follow-up	Interpretation	Results Reporting and Archiving
H03	X GP33 H03 H04	X H03	X GP33 H03	GP33 H03	H03		GP33
H11	H11	H11	H11 H20	H20	H20		
	H21 MM13	H21 MM13	MM13				MM13

Adapted from CLSI document HS01—*A Quality Management System Model for Health Care*.

Related CLSI Reference Materials*

- C37-A** **Preparation and Validation of Commutable Frozen Human Serum Pools as Secondary Reference Materials for Cholesterol Measurement Procedures; Approved Guideline (1999).** This guideline details procedures for the manufacture and evaluation of human serum pools for cholesterol measurement.
- C44-A** **Harmonization of Glycohemoglobin Measurements; Approved Guideline (2002).** This document describes an established program to harmonize glycohemoglobin (GHB) testing results among laboratories to a common, outcomes-based reference system and includes recommendations for the clinical application of harmonized GHB testing results.
- GP33-A** **Accuracy in Patient and Sample Identification; Approved Guideline (2010).** This guideline describes the essential elements of systems and processes required to ensure accurate patient identification. The principles in this document may be applied to manual or electronic systems. Design considerations covered include criteria for accuracy, differences in inpatient vs outpatient settings that impact patient identification, language and cultural considerations, and standardization of processes across the health care enterprise.
- H03-A6** **Procedures for the Collection of Diagnostic Blood Specimens by Venipuncture; Approved Standard—Sixth Edition (2007).** This document provides procedures for the collection of diagnostic specimens by venipuncture, including line draws, blood culture collection, and venipuncture in children.
- H04-A6** **Procedures and Devices for the Collection of Diagnostic Capillary Blood Specimens; Approved Standard—Sixth Edition (2008).** 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.
- H11-A4** **Procedures for the Collection of Arterial Blood Specimens; Approved Standard—Fourth Edition (2004).** 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.
- H20-A2** **Reference Leukocyte (WBC) Differential Count (Proportional) and Evaluation of Instrumental Methods; Approved Standard—Second Edition (2007).** This document is a reference method for the evaluation of automated differential counters, based on the visual differential count.
- H21-A5** **Collection, Transport, and Processing of Blood Specimens for Testing Plasma-Based Coagulation Assays and Molecular Hemostasis Assays; Approved Guideline—Fifth Edition (2008).** This document provides procedures for collecting, transporting, and storing blood; processing blood specimens; storing plasma for coagulation testing; and general recommendations for performing the tests.
- M29-A3** **Protection of Laboratory Workers From Occupationally Acquired Infections; Approved Guideline—Third Edition (2005).** Based on US regulations, this document provides guidance on the risk of transmission of infectious agents by aerosols, droplets, blood, and body substances in a laboratory setting; specific precautions for preventing the laboratory transmission of microbial infection from laboratory instruments and materials; and recommendations for the management of exposure to infectious agents.
- MM13-A** **Collection, Transport, Preparation, and Storage of Specimens for Molecular Methods; Approved Guideline (2005).** This document provides guidance related to proper and safe biological specimen collection and nucleic acid isolation and purification. These topics include methods of collection, recommended storage and transport conditions, and available nucleic acid purification technologies for each specimen/nucleic acid type.

*CLSI documents are continually reviewed and revised through the CLSI consensus process; therefore, readers should refer to the most current editions.



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