CLINICAL AND LABORATORY STANDARDS INSTITUTE®

4th Edition

C24

Statistical Quality Control for Quantitative Measurement Procedures: Principles and Definitions

This guideline provides definitions, principles, and approaches to laboratory quality control design, implementation, and assessment.

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

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Statistical Quality Control for Quantitative Measurement Procedures: Principles and Definitions

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Abstract

Clinical and Laboratory Standards Institute guideline C24—*Statistical Quality Control for Quantitative Measurement Procedures: Principles and Definitions* discusses the principles of statistical QC, with particular attention to the planning of a QC strategy and the application of statistical QC in a medical laboratory. Although these principles are of interest to manufacturers, this guideline is intended for use by medical laboratory personnel in order to provide a QC strategy that uses control materials that are external to a reagent kit, instrument, or measuring system and that are intended to simulate the measurement of a patient specimen.

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Foreword

The medical laboratory community has used C24, now in its fourth edition, for more than 20 years. Today, statistical QC is still critically important to ensure the quality of the results of any laboratory measurement procedure. The almost universal applicability of statistical QC to quantitative measurement procedures provides laboratories with an essential quality management tool that can be used to monitor the effects of many instrument, reagent, environment, and operator variables on the outcome of a measurement process.

The laboratory director is generally responsible for the laboratory QC program. The definition of quality requirements for the tests being performed is particularly important because laboratory managers, supervisors, scientists, and quality specialists often use those quality requirements to select and validate appropriate measurement and control procedures. C24's approach provides medical laboratory scientists with practical guidance on how to satisfy recommendations by authorities and/or accreditation organizations.[1]

The concepts, approaches, and practices discussed in this guideline are interdependent and all should be carefully studied and considered when developing the specific QC strategy for any measurement procedure, system, or laboratory. C24 highlights the technical issues that need a careful scientific approach to designing, implementing, and assessing QC strategies in order for laboratories to achieve the quality requirements needed by the physicians and patients they serve.

Overview of Changes

This guideline replaces the previous edition of the approved guideline, C24-A3, published in 2006. The fourth edition maintains the focus on principles and approaches to laboratory QC design, implementation, and assessment that reflect the realities of the modern medical laboratory and its role within the health care enterprise. Several changes were made in this edition, including:

- The alignment of principles and definitions to be consistent with and to supplement the general patient risk model described in CLSI document EP23.[2]
- The introduction of additional performance measures useful for evaluating the performance characteristics of a QC strategy (see Chapter 5)
- Expanded guidance on setting target values and SDs for QC materials (see Subchapter 5.3)
- A greater focus on QC frequency and QC schedules as a critical part of a QC strategy (see Subchapter 5.5)
- A substantive chapter on recovering from an out-of-control condition (see Chapter 6), including sections on:
  - Responding to an out-of-control QC event
  - Responding to an out-of-control condition
  - Identifying and correcting reported erroneous patient results

NOTE: The content of this guideline is supported by the CLSI consensus process, and does not necessarily reflect the views of any single individual or organization.

Key Words

Patient risk, quality control, quality control plan, quality control rules, quality control strategy, quality requirements, Sigma metric

Statistical Quality Control for Quantitative Measurement Procedures: Principles and Definitions

Chapter 1: Introduction

This chapter includes:

- Guideline's scope and applicable exclusions
- Background information pertinent to the guideline's content
- Standard precautions information
- "Note on Terminology" that highlights particular use and/or variation in use of terms and/or definitions
- Terms and definitions used in the guideline
- Abbreviations and acronyms used in the guideline

1.1 Scope

This guideline explains the purpose of statistical QC for quantitative measurement procedures, describes an approach for planning a QC strategy for a particular measurement procedure, describes the use of QC material and QC data, and provides examples that demonstrate a practical QC planning process for medical laboratories.

The recommendations for establishing and maintaining a statistical QC strategy are applicable to quantitative laboratory measurement procedures in all fields of laboratory medicine for which stable control materials can be measured in the same manner as patient specimens. The intended users of this guideline include those responsible for designing, implementing, and using QC, ie, medical laboratory scientists.

This guideline does **not:**

- Describe built-in control mechanisms that might be part of a measuring system, or qualitative or semiquantitative measurement procedures.
- Define specific QC strategies that are appropriate for an individual device or technology.
- Describe alternatives to statistical process control, eg, real-time patient-based QC.
- Consider specific legal requirements that may impose different philosophies or procedures on QC practices (eg, a specific approach for defining quality requirements, specific values for quality requirements, a specific procedure for determining target values for control materials, or a frequency and number of QC measurements) defined by government regulation in a specific country or region.

Additionally, there are types of random errors that may affect measurements performed on individual specimens, rather than a whole group of specimens, and those errors are not detected by a statistical QC strategy. Such errors may be due to the specific design of a measuring system (eg, effect of specimen

viscosity, carryover from a previous specimen, or specimen-specific interferences) or possible operator errors that affect individual specimens, as well as preexamination errors of specimen preparation, storage, and transportation. Special QC strategies may be needed to monitor known special vulnerabilities that relate to a particular device or system design.

1.2 Background

Statistical QC strategies are implemented to monitor a measurement procedure's performance to detect any change relative to stable baseline analytical performance. When the actual performance deviates from the expected model, the QC strategy is designed to alert the laboratorian to a change that may affect medical decision making and potentially lead to incorrect treatment, delays in treatment, or patient harm. Designing an effective QC strategy entails determining the magnitude of the change in performance that compromises the usefulness of the measurement procedure results.

There is abundant literature explaining the theoretical and practical bases for initiating and maintaining QC strategies in clinical chemistry[3-9]; however, the routine practice of statistical QC depends on understanding how to:

- Plan QC strategies based on the performance of the measurement procedure and the performance needed to support the intended medical use of the results, including selecting appropriate control materials, establishing the expected values for those control materials, determining when to evaluate controls, and identifying the control rules to determine acceptable performance.

- Implement QC strategies to identify situations when a measurement procedure may not be providing results that are suitable for use in medical decisions.

- Respond to out-of-control situations.

The prevalence of a broad range of automated medical laboratory instruments using widely different measuring principles has complicated the terminology and the steps necessary for establishing QC strategies. There are some highly automated systems that can perform specific, built-in checks that help detect potential problems and alert the operator to instrument malfunction. However, the benefit of statistical QC using samples intended to simulate measurement of patient specimens is that it monitors the outcome of many of the variables and steps that occur in the entire measurement procedure.

1.3 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 bloodborne pathogens. Published guidelines are available that discuss the daily operations of diagnostic medicine in humans and animals while encouraging a culture of safety in the laboratory.[10] 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 diseases, refer to CLSI document M29.[11]

