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# EP12-A2

## User Protocol for Evaluation of Qualitative Test Performance; Approved Guideline—Second Edition

This document provides a consistent approach for protocol design and data analysis when evaluating qualitative diagnostic tests. Guidance is provided for both precision and method-comparison studies.

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

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## User Protocol for Evaluation of Qualitative Test Performance; Approved Guideline—Second Edition

Volume 28 Number 3

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### Abstract

Clinical and Laboratory Standards Institute document EP12-A2—*User Protocol for Evaluation of Qualitative Test Performance; Approved Guideline—Second Edition* provides the user with a consistent approach for protocol design and data analysis when evaluating qualitative diagnostic tests. Guidance is provided for both precision and method-comparison studies.

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## Foreword

Qualitative diagnostic tests have been used since the early days of laboratory medicine for the screening, diagnosis, and management of a variety of diseases. These tests are found in many specialties of the clinical laboratory. Method evaluation procedures for such tests are diverse, with each laboratory specialty often emphasizing different issues in both the experimental design and in the data analysis and interpretation of such studies.

There have been four key published efforts to standardize both the experimental details as well as the data analysis of qualitative information. The International Federation of Clinical Chemistry published a guideline in 1989 on protocol design and data analysis, featuring examples for urinary glucose and albumin by visually read reagent strips.<sup>1</sup> The European Committee for Clinical Laboratory Standards published a guideline in 1990 that focused on the evaluation of qualitative tests.<sup>2</sup> A very prominent work on the assessment of both quantitative and qualitative laboratory tests, *Beyond Normality: The Predictive Value and Efficiency of Medical Diagnosis*, was written by Gambino and Galen in 1975.<sup>3</sup> In addition, CLSI/NCCLS document GP10<sup>4</sup> describes the assessment of the diagnostic accuracy of a test compared to the clinical status of the patient.

The latter two publications both focus on the relation of the test result to the clinical status of the patient, for either qualitative or quantitative tests. In many laboratories, the clinical information is not readily available, so it is important that protocols for evaluations are established that enable comparison of a new test (candidate method) to other laboratory procedures, in much the same way that most method evaluation studies are performed for quantitative tests. Ideally, the comparison should be made to “diagnostic accuracy criteria” or to a so-called “gold standard.” However, comparison with a method in current use is also of interest. This guideline describes two different situations for these studies: the first is when the laboratory knows the clinical diagnosis of each specimen in the study, and the second is when the laboratory does not know the clinical diagnosis of each patient specimen. These are treated separately, to enable appropriate data analysis. Parameters such as specificity and sensitivity, and predictive value for the candidate method are estimated in the former situation, and agreement measures are estimated in the latter situation.

This guideline is intended to promote uniformity in performance assessment of qualitative tests among:

- laboratories of all types that perform qualitative tests;
- manufacturers of qualitative diagnostic tests, for describing test performance and helping customers design test performance verification studies; and
- regulatory agencies and laboratory surveyors.

During the review and revision of EP12-A, the working group added to the evaluation protocol information on the confidence limits achieved by different numbers of observations made and different results observed, allowing the user to appreciate directly the difference in confidence limits when fewer or more observations are made. In addition, some new terms were included and defined. The term “C<sub>5</sub>-C<sub>95</sub> interval” is used to describe the range of analyte concentrations around the cutoff such that observed results at concentrations *outside* this interval are consistently negative (concentrations <C<sub>5</sub>) or consistently positive (concentrations >C<sub>95</sub>). Observed results at concentrations inside this interval are not consistent due to imprecision. These concepts are explained in greater detail in Section 8.

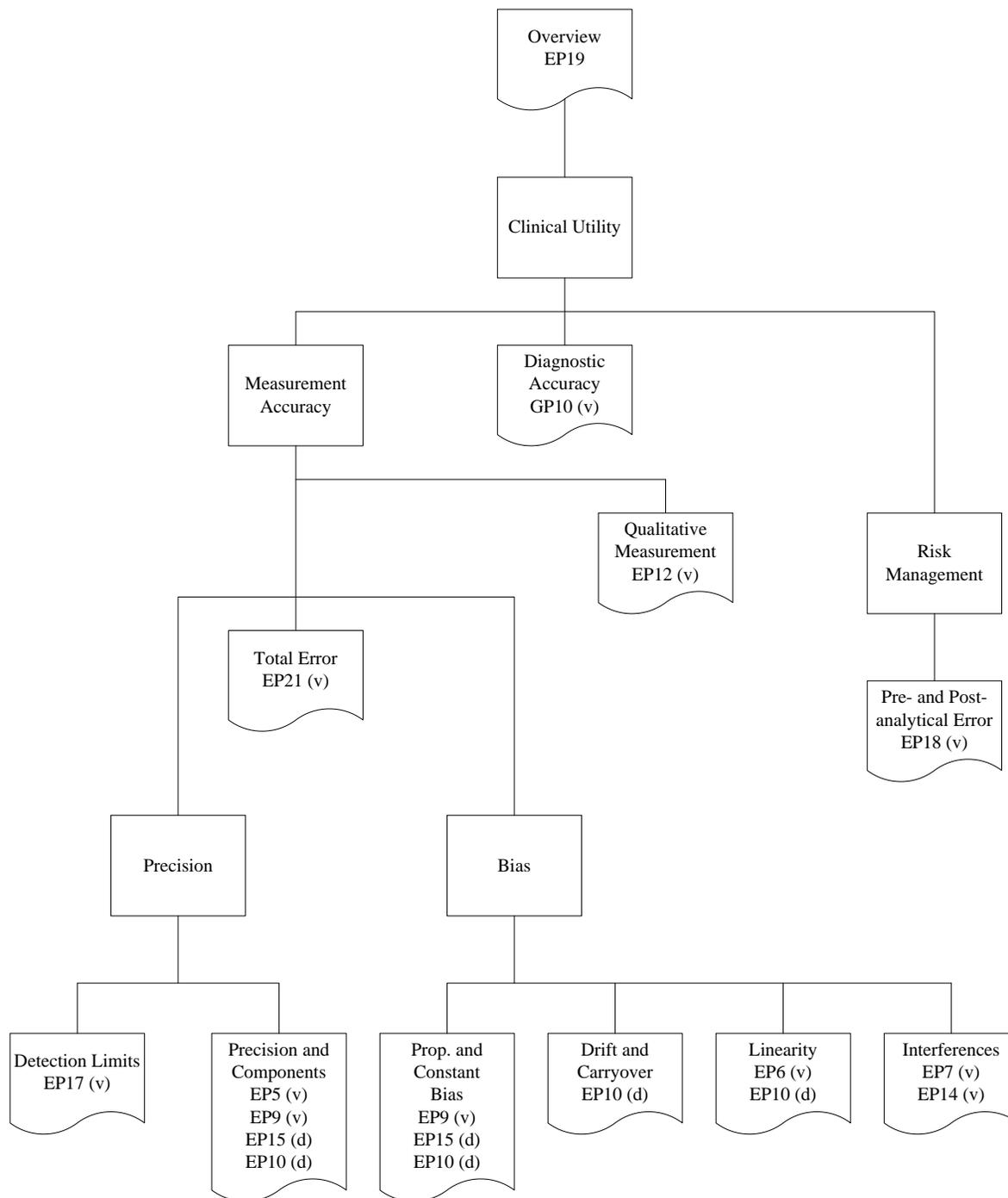
A figure was also added to illustrate which error sources the EP12 protocol can detect with respect to all error sources and other Evaluation Protocols (EP) documents (see page ix). In addition, the working group added an appendix that describes and discusses the confidence intervals used in the protocol. The

concepts are complex, and the working group encourages comments, questions, and suggestions for improvements in future revisions of the document.

**Key Words**

Analytical goals, evaluation protocol, qualitative test

**Laboratory Error Sources and CLSI Evaluation Protocols Documents**



**Laboratory Error Sources and CLSI Evaluation Protocols Documents.**<sup>a</sup> This figure illustrates the relationship among parameters estimated by EP documents. Items higher up in the figure are more comprehensive whereas lower level items are more specific. Overall, the figure is much like a cause-and-effect diagram. Documents marked (d) provide guidance for demonstrating that a source of measurement inaccuracy is within acceptable limits. Documents marked (v) provide guidance for more rigorous evaluation of inaccuracy components.

<sup>a</sup> For a description of each of the documents listed, please see page 45.



## **User Protocol for Evaluation of Qualitative Test Performance; Approved Guideline—Second Edition**

### **1 Scope**

This guideline provides protocols for the evaluation of qualitative test performance characteristics. In this document, a qualitative test is restricted to those tests that have only two possible outcomes (eg, positive/negative, present/absent, reactive/nonreactive). EP12 is written primarily for individuals and laboratories that use and evaluate such tests. These protocols are intended to help users determine test performance in their own testing environment. This guideline for qualitative test performance evaluation should help the device developer and the user to meet documentation and regulatory goals. While this document is not intended for manufacturers to establish test performance characteristics, the data analysis principles described here can be used by manufacturers.

Test methods with values that are reported as, for instance, negative, +1, +2, or +3, or as endpoint dilutions (commonly in multiples of 8, reflecting the microtiter plate format, or in multiples of 10) are often called semiquantitative. These methods are not further discussed in EP12, although if one of the values results is considered the cutoff for a positive test, the evaluation protocol recommended here could be applied to that cutoff. For instance, if a test for antibodies to the Lyme disease pathogen was reported as positive if the endpoint titer was  $\geq 1:160$ , the precision and method comparison experiments discussed below could be applied to that cutoff.

### **2 Introduction**

Qualitative tests return one of two possible responses. Method evaluation procedures for such tests are diverse, with each laboratory specialty often emphasizing different issues in the experimental design, data analysis, and interpretation of such studies. EP12 offers a defined approach to method evaluation for many qualitative tests.

Clinical laboratories develop and implement qualitative tests for a number of reasons. Laboratories should document that the test performs as intended in their facilities, by operators who are expected to use the device. Often, such demonstration is required by laboratory regulatory or accreditation bodies.

Qualitative candidate methods are diverse, employing technologies from lateral flow with visual reading, to automated nucleic acid sequencing and base calling, to microarrays. While universal evaluation guidelines may not be feasible, common features exist. For example, precision studies and comparison of methods studies with patient specimens can be used to demonstrate each type of test's performance capabilities.

In addition to technical diversity, qualitative tests may differ just by having a different cutoff or medical decision point. For example, a qualitative candidate method for screening blood donations for an infectious disease, such as human immunodeficiency virus (HIV) or hepatitis B virus (HBV), would have a cutoff chosen to ensure a high sensitivity and high negative predictive value (NPV), so there is a correspondingly high probability that an infected unit would be excluded from the blood supply. The same method could be used to make a qualitative test for diagnosis, with a cutoff that is chosen to minimize the number of false-positive and false-negative results.

When a qualitative test is used as an aid in the diagnosis of an infectious disease, such as HIV, Streptococcus, or Trichomonas, the "cutoff" is the "limit of blank." (See the Definitions section and CLSI/NCCLS document EP17.<sup>5</sup>) The objective is to recognize the presence of the characteristic, such as immunologic response in the host or the presence of an antigen of the pathogen, which is indicative of