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GUIDE

Fulfillment of Metrological Traceability Requirements

Introduction

Purpose

This document from the Diagnostic Accreditation Program (DAP) provides guidance for organizations on fulfilling the Laboratory Medicine Accreditation Standards.

The ability to produce equivalent measurement results for the same measurand from a variety of measurement procedures primarily dependent on traceability to a reference that expresses results to a measurement unit of the International System of Units (SI). Ensuring traceability allows laboratories to confirm the comparability of results, which enables the establishment of common reference intervals and clinical decision values.

For consistently interpretable clinical information, results from test kits used in the laboratories must be traceable to references of higher order. A reference of higher order is a reference standard produced by a reference material producer (RMP) which may be accredited. The acceptability of more than one procedure through comparisons between laboratory results and higher order standards allows the formation of a traceability chain without disrupting measuring systems already in place.

If you have questions about items in the standards, please email them to dap@cpsbc.ca.

Objectives

The objectives of this document are to

- familiarize assessors with the concept of metrological traceability,
- identify where metrological traceability is relevant in laboratories, and
- describe the assessment of metrological traceability.

Metrological traceability

What is metrological traceability?

"Metrological Traceability is the property of the result of a measurement or the value of a standard that is related to national or international standards through an unbroken chain of

comparisons all having stated uncertainties."[1] In other words, metrological traceability is the property that connects an examination result to a reference standard used in calibration to an acceptable measurement unit. Associating an examination result to a reference standard means that result can be compared to another result linked to the same reference standard even "in a different place at a different time." This can extend throughout the laboratory system where results can be compared because all results are derived from comparison to the same reference standard in the system. Equipment and reference standards must be calibrated by a National Metrology Institute (NMI) or an accredited calibration laboratory whose service is covered by the CIPM Mutual Recognition Arrangement (CIPM MRA).

Although metrological traceability plays a critical role in achieving harmonized laboratory results, it is not sufficient in producing reliable results. There are other factors such as quality assurance and quality control measures that need to be in place to ensure the measurement process is stable and in control. Qualified staff, proper maintenance of equipment and reagents, use of document-controlled measurement procedures, and monitoring quality control results all play an important role in creating a stable measurement process.

According to the Joint Committee of Traceability in Laboratory Medicine (JCTLM), traceability can only be claimed by referring to ISO-17511:2020 (17) and ISO-21151:2020 (18). Traceability is not "traceability" to:

1. the producers of the reference material used for calibrating measuring systems
2. the internal or external quality control samples used in the measurement
3. the manufacturers of the reagents and measuring systems used

Source: https://www.jctlm.org/media/1189/2022-03-23-traceability-in-laboratory-medicine-in-brief.pdf

Relationship of metrological traceability and uncertainty of measurement

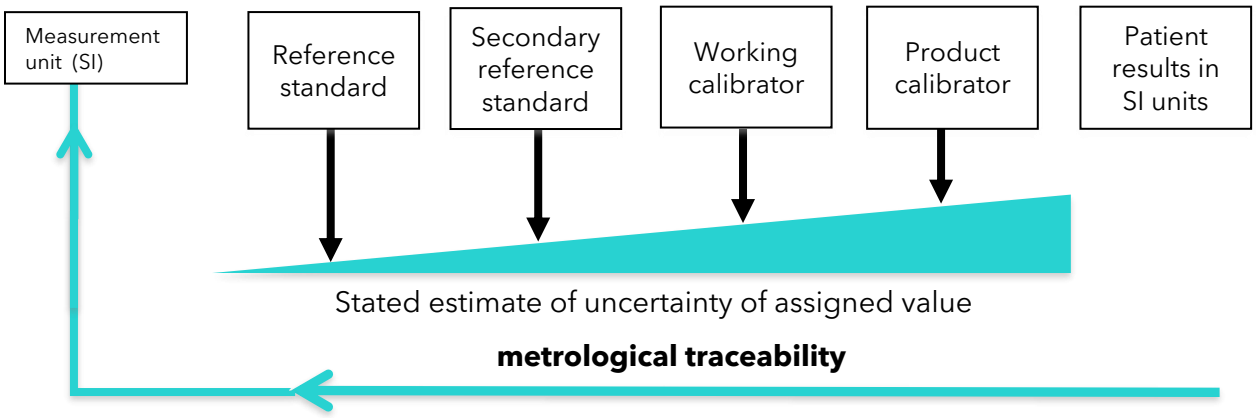
Uncertainty of measurement is defined as a parameter associated with the result of a measurement that characterises the dispersion of the values that could reasonably be attributed to the measurand. The term "parameter" may be considered a standard deviation, range or interval with a certain level of confidence. An estimate of the uncertainty of measurement provides an interval or range of values within which the true value is believed to lie with an approximate confidence level of 95%. The uncertainty can be attributed to random variation from one measurement to the next over the measurement timescale and sources of bias from repeated measurements. Therefore, uncertainty of measurement includes the allowance of both random and, to some degree, systematic errors, and the "true value" of the measured result must fall within the range of values.

Uncertainty of measurement is an essential component of metrological traceability. All routine measurement results for a given measurand must have a measurable relationship to an internationally recognized or certified reference standard. This relationship is established through a hierarchy of calibrators, typically from a higher order international reference standard via secondary reference standards to laboratory routine method calibrators. At each stage, the value and estimated uncertainty of measurement of the calibrators must be known.

[1] ISO, International Vocabulary of Basic and General Terms in Metrology. Geneva: International Organization for Standardization, 1993

The example below illustrates the relationship between metrological traceability and uncertainty of measurement.

Relationship of metrological traceability and uncertainty of measurement



What must a laboratory do to ensure metrological traceability?

Use higher order reference standards available for calibrators. All reference standards must be produced by an NMI or an accredited calibration laboratory and covered by the CIPM MRA that includes the range and uncertainty. Refer to the Bureau International des Poids et Measures key comparison database (BIPM KCDB) Appendix C: Calibration and Measurement Capabilities (CMCs): https://kcdb.bipm.org/appendixC/.

Assessment of metrological traceability

To evaluate ERS3.1.6, assessors will examine the procedures and information for reference materials and calibrator preparation to ensure laboratories have used the correct material. This includes reviewing the manufacturer's information or documentation that the reference standards are approved by an NMI.

ERS3.1.6	**M**	Calibration procedures record the metrological traceability of the calibration standard and the traceable calibration of the item of equipment.
Evidence:		Demonstrate metrological traceability to an acceptable measurement unit and provide evidence of the calibrators' traceability to reference standards recognized by an NMI.
Where:		Regional: Chemistry and hematology protocols
Interpretation:		The laboratory must use higher order reference standards available for calibrators. Laboratories must review manufacturer's information to ensure that those reference materials are appropriate for the measurand and the instruments used.

ERS3.1.14	**M**	Metrological traceability is to a reference material or reference procedure of the higher metrological order available. *Guidance: Documentation of calibration traceability to a higher order reference material or reference procedure may be provided by an examination system manufacturer. Such documentation is acceptable as long as the manufacturer's examination system and calibration procedures are used without modification.*
Evidence:		Reference material or documentation that demonstrates metrological traceability includes reference to a reference material or reference procedure to provide evidence of the calibrators' traceability recognized by an NMI.
Where:		Regional: Chemistry and hematology protocols
Interpretation:		The laboratory must use higher order reference standards available for calibrators. Laboratories must review manufacturer's information to ensure that those reference materials or reference procedures are appropriate for the measurand and the instruments used.

ERS3.1.15	**M**	If metrological traceability to a reference material or reference procedure of the higher metrological order, is not possible or relevant, other means for providing confidence in the results are applied, including but not limited to the following: • use of certified reference materials • examination or calibration by another procedure • mutual consent standards or methods which are clearly established, specified, characterized and mutually agreed upon by all parties concerned
Evidence:		Demonstrate appropriate alternative means to provide confidence in the results outside of the use of metrologically traceable material. Documentation of alternative approaches to provide confidence in results through description in available policies and maintenance of appropriate certificate or analysis, validation records or documented consent by all parties where appropriate.
Where:		Regional: Chemistry and hematology protocols
Interpretation:		The laboratory must use higher order reference standards available for calibrators. Where higher order standards are not available or relevant the laboratory must establish alternate means to instill confidence in result reliability. instruments used.

Terms and definitions

accuracy	The closeness of agreement between a measured quantity value and the true quantity value of the measurand.	VIM[2]
analytical measurement range (AMR)	The range of analyte values that a method can directly measure of the specimen without any dilution, concentration, or other pretreatment not part of the usual assay process.	CLSI
comparability	Agreement between patient results obtained for a measurand using different measurement procedures within a healthcare system. **Note**: Results are considered to be comparable if the differences do not exceed a critical value established based on defined acceptance criteria.	CLSI
detection limit – lower limit of detection (LLOD)	Lowest amount of measurand in a sample that can be detected with (stated) probability, although perhaps not quantified as an exact value.	CLSI
detection limit – lower limit of quantitation (LLOQ)	Lowest amount of measurand in a sample that can be quantifiably determined with stated acceptable precision and trueness under stated experimental conditions.	CLSI
examination	A set of operations having the object of determining the value or characteristics of a property. Synonyms: analysis, assessment, investigation, measurement, study, test	ISO
imprecision	An expressed variation, either standard deviation or coefficient of variation, calculated from the results in a set of replicate measurements.	CLSI
linearity	Assuming no bias, the ability (within a given range) to provide results that are directly proportional to the concentration of the measurand in the test sample.	CLSI
measurand	Quantity intended to be measured. Synonym: analyte	CLSI
measurement uncertainty	A non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand based on the method used.	CLSI

References

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4. Clinical and Laboratory Standards Institute. Expression of measurements uncertainty in laboratory medicine. Wayne, PA: Clinical and Laboratory Standards Institute; 2012. CLSI document EP29-A
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