'How far the light shines?: Its Definition and Use within the CCQM

Background

The concept of 'How far the light shines' was introduced at the start of CIPM MRA activities within the CCQM. The report of the 6th meeting of the CCQM (2000) records that: 'The CCQM decided to organize a second symposium on primary methods, with much more emphasis on the question "How far does the light shine?" This phrase describes the challenge that the CCQM faced in identifying, designing and conducting a limited number of key comparisons to enable the assessment of measurement comparability among national metrology institutes across the very broad field of chemistry then, and now biology as well.

In 2003, the CCQM 'confirmed that a clear statement about how far the light shines (HFTLS) was to be included as part the Final Report for each of its Key Comparisons.

This has developed into a working practice and provides guidance to NMIs, RMOs, CCQM WGs and the CCQM on what range of CMC claims can be supported by the results of any key comparison carried out under the auspices of the CCQM.

In the examples given below for comparisons organized by the Organic (a,b,c,d) and Gas (e,f,g) Analysis Working groups, it can also be seen that the content of HFTLS statements have followed the developments in the CCQM Strategy and models for core comparisons and capabilities, which were designed to increase the effectiveness of key comparisons in underpinning CMCs.

Examples of HFTLS statements

a) CCQM-K6: Key Comparison on the Determination of Cholesterol in Serum (in 2001), HFTLS Statement:

This Key Comparison study demonstrated that the participating NMIs could successfully measure serum cholesterol for normal and elevated levels, using ID/MS-based methods, with interlaboratory expanded uncertainties of less than 1%.

Ideally, an internationally recognized reference system should be established for all important health status markers, but that is not possible in any reasonable time frame. Every serum analyte of interest as a health status marker provides a unique set of challenges. To provide a more comprehensive measure of the capabilities of NMIs for measuring well-defined serum analytes, the CCQM also has conducted pilot studies for the determinations of serum glucose and creatinine. These two analytes were chosen because they present very different challenges than does cholesterol, thus providing a more complete picture of the capabilities of participating NMIs. Glucose is highly water-soluble and also associates strongly with proteins. Creatinine is very polar, present at much lower levels than cholesterol, and its determination requires considerable care to assure separation from creatine, without interconversion between creatinine and creatine. The CV among the results from the participating laboratories was less than 1 % for glucose and less than 1.5 % for the creatinine both at clinically significant levels. Key Comparisons for both of these additional measurands are underway. The combination of these three Key Comparisons may provide a basis for the evaluation of measurement capabilities of participating NMIs for other well-defined organic analytes present in serum at µg/g levels or higher, without having to actually conduct a Key

Comparison for all such analytes. (see also CCQM-K11 (Glucose in Serum, in 2001) and CCQM-K12 (Creatinine in Serum, in 2001))

b) CCQM-K40, Determination of PCB Congeners in Solution in 2004, HFTLS Statement:

This Key Comparison study demonstrated a high level of equivalence in capabilities of the participating NMIs to successfully identify and measure five PCB congeners (congener numbers 28, 101, 105, 153, and 170) in a solution using GC/MS-based methods.

The PCB congeners measured in CCQM-K40 were selected to be representative of PCB congeners typically used as calibrants in the determination of the approximately 150 congeners found in environmental samples and to provide the typical analytical measurement challenges encountered in the value -assignment of these PCB calibration solutions, such as volatility losses and resolution from potential interferences and other PCB congeners present as components in the solution during chromatographic separation.

The abilities demonstrated by the laboratories that provided comparable measurements for all five congeners (including the non-detection of PCB 170) in this Key Comparison should be indicative of their ability to provide reference measurements for a suite of PCB congeners in solutions when present at levels greater than 90 ng/g provided the laboratory demonstrates an acceptable degree of separation of the PCB congeners in the specific solution being analyzed.

c) CCQM-K55.c (Valine Purity) in 2012, HFTLS statement:

The comparison was intended to demonstrate a laboratory's performance in determining the mass fraction of the main component in a high purity organic material. Successful participation should be indicative of the performance of a laboratory's measurement capability for the mass fraction purity assignment of organic compounds of low structural complexity (molar mass range 100-300) and high polarity ($pK_{OW} > -2$) and for which related structure impurities can be quantified by high performance liquid chromatography either directly or after preliminary derivatisation with fluorescence detection.

d) CCQM-K132 (Low-Polarity Analytes in a Biological Matrix: Vitamin D Metabolites in Human Serum, in 2015). HFTLS statement:

Successful participation in CCQM-K132 demonstrates capabilities in analysis of low molecular mass (100 g/mol to 500 g/mol) and low-polarity (nonpolar, pKow < -2) analytes at the 1 ng/g to 500 ng/g mass fraction range in complex biological matrixes with core competencies for sample preparation and analysis using ID LC-MS/MS. This study extends the mass fraction capability range to 10^5 to 10^6 times lower than that previously demonstrated in previous CCQM Key Comparisons for cholesterol in serum, another nonpolar clinical analyte.

e) CCQM-K52 (Carbon dioxide in Air, in 2006), HFTLS Statement:

This key comparison aims to support CMC-claims for carbon dioxide in both nitrogen or air (synthetic and purified) from 100 µmol/mol to 20 cmol/mol.

f) CCQM-K82 (Methane in Air, in 2012), HFTLS Statement:

The results of this key comparison can be used to support:

1) Claimed capabilities CH_4 in synthetic air, scrubbed air, or in nitrogen in the range

1700 nmol/mol to 2500 nmol/mol;
2) Claimed capabilities for CH_4 in nitrogen or in air in the range 2.5 µmol/mol to 25 mmol/mol, where an NMI's smallest claimed relative standard uncertainty is equal or greater to the relative standard uncertainty it reported in CCQM-K82 for results that agree with the KCRV;
3) Claims of purity measurements in nitrogen, oxygen and argon matrix gases for the quantification of methane amount of substance fractions above 1 nmol/mol where the standard uncertainty is equal or greater to u(KCRV).

g) CCQM-K111 (Propane in Nitrogen, in 2014), HFTLS Statement:

The results of this key comparison can be used to support CMC claims in two different ways:
1) For core capabilities, under the flexible scheme, using the pooling mechanism for the stated uncertainties;
2) For propane in nitrogen, air and automotive gas mixtures, under the default scheme.

3) For the purity analysis of propane.

The way in which this key comparison supports CMC claims is described in more detail in the "GAWG strategy for comparisons and CMC claims" [9].

[9] Brewer P.J., Van der Veen A.M.H., "GAWG strategy for comparisons and CMC claims", CCQM Gas Analysis Working Group, April 2016