WADA External Quality Assessment Scheme (EQAS) and its new statistical framework

Eurachem’s 10th Workshop on Proficiency Testing in Analytical Chemistry, Microbiology and Laboratory Medicine
WADA regularly distributes urine and blood test samples to Laboratories to continuously monitor their proficiency.

The **International Standard for Laboratories (ISL)** requires satisfactory EQAS performance in order to obtain and maintain WADA accreditation.
WADA EQAS: Main Objectives

- To evaluate laboratory proficiency
- To improve test result uniformity between laboratories
- To provide educational opportunities
Regular WADA External Quality Assessment Schemes

**Blind EQAS**
- Labs are aware that the samples are EQAS samples
- Samples delivered by WADA EQAS sample provider
- 3 rounds of 5 samples per year

**Double-Blind EQAS**
- Samples are indistinguishable from routine athlete samples
- Samples delivered by Anti-Doping Organizations
- Total of 5 samples per year

**Educational EQAS**
- Samples are provided in a variety of forms
- For educational purposes or data gathering
- 2-3 samples per year

Samples involving threshold substances are typically obtained from excretion studies. These are value-assigned, tested for batch homogeneity and storage/transportation stability.
Other WADA External Quality Assessment Schemes

**EQAS for Athlete Biological Passport (ABP) blood samples**
Conducted monthly in collaboration with the Quality Control Center Switzerland

**EQAS for Laboratory accreditation decisions**
Pre-probationary Test • Final Accreditation Test
Lifting of suspensions or analytical testing restrictions

**EQAS for Major Events**
Olympic Games • Paralympic Games

**EQAS for Laboratory on-site assessments**

**EQAS for Laboratory Investigations**
Statistical evaluation of the quantitative results from **WADA EQAS** is going to change
Currently, the calculations rely on empirical ‘robust’ statistical methods (ISO 13528:2015) instead of explicit statistical measurement models.

Why revise the current statistical evaluation approach?

\[
\begin{align*}
    s^* &= 1,134 \sqrt{\sum_{i=1}^{p} \left( x_i^* - x^* \right)^2 / (p - 1)} \\
    s^* &= \frac{1}{0.798 \times p} \sum_{i=1}^{p} |x_i - \text{med}(x)| \\
    r_p &= \begin{cases} \\
        \frac{1}{p} \left[ 1,6019 + \frac{1}{p} \left( -2,128 - \frac{5,172}{p} \right) \right] & p \text{ odd} \\
        \frac{1}{p} \left[ 3,6756 + \frac{1}{p} \left( 1,965 + \frac{1}{p} \left( 6,987 - \frac{77}{p} \right) \right) \right] & p \text{ even}
    \end{cases}
\end{align*}
\]
Why revise the current statistical evaluation approach?

- Current evaluations do not always recognize the finer structure of the reported results.

Carbon isotope ratio measurements (GC/C/IRMS) are reported with the associated measurement uncertainties, which are ignored.

Steroid Profile and Threshold Substance measurements have proportional errors (most standard models assume constant errors).

The rounding of the specific gravity results that is imposed on the laboratories is not taken into account.
Why revise the current statistical evaluation approach?

3 The decision making relies on the use of maximum allowed measurement uncertainty, not the reproducibility uncertainty.

The EQAS 2023-1 Round provided a total of 1350 quantitative results with zero cases of $|z| \geq 3.0$, indicating the conservative nature of current data evaluation methods.
Mixed Effects Measurement Model

We employ linear mixed effects measurement model which provides a coherent statistical framework for all results of a given analyte – across all Laboratories and all EQAS Samples.
Mixed Effects Measurement Model Example

Specific Gravity of Urine

Reported result by each laboratory (\(lab\)) for each sample (\(s\))

\[ X_{lab,s} = \mu_s + L_{lab} + E_{lab,s} + R_{lab,s} \]

Sample-specific consensus value

Laboratory bias
Measurement error *
Rounding error

\* Estimated by combining the results from multiple samples

Laplace distribution
Gaussian distribution
Uniform distribution
Bayesian Framework for Interlaboratory Comparisons

1. provides flexible, model-based approach to data reduction
2. allows to incorporate the expected measurement uncertainties \( u_c < u_{c_{\text{Max}}} \)
3. provides uncertainty distributions for all model parameters
4. naturally recognizes correlations between model parameters, for example, when evaluating the Laboratory bias
Example Analysis: Steroids in Urine

RESULTS FROM FIVE SAMPLES (median centered)

LABORATORY BIASES (4 Labs show significant bias)

MEASUREMENT ERRORS

Only 2 of these Labs are flagged by the conventional Rank Sum analysis

Conventional analysis does not provide MU evaluation

Results of 8 out of 30 Labs are shown here
Custom Software for EQAS Data Reduction

EQAS Calculator (v.1)

1. z-scores are calculated using model-based predictive standard deviations of the results
2. PDF and XLSX reports are generated programatically
Outlook

The use of modern statistical methods and tools provides more information from the same data, more advanced statistical modelling, and more realistic uncertainty evaluations.
play true