Evaluation of the measurement uncertainty based on in-house validation data

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Outline

Different approaches for MU evaluation
Uncertainty components
Available guidance
Need for additional guidance
Snapshots of the guide
Final remarks
Different approaches for MU evaluation

- Bottom-up approach
  - Based on in-house validation data
- Top-down approach
  - Based on interlaboratory data
Uncertainty components

- Precision
- Trueness
- Others

Using in-house validation data for MU evaluation

- VAM project, 2000 [1]
- Eurachem/CITAC, QUAM, 2012 (Example A4) [2]

Need for additional guidance

• How to handle the variation of the MU with the concentration
• How to quantify precision improvement from replicate analysis under different conditions
• How to handle systematic effects estimated from the analysis of various reference materials:
  ◦ Correct/ Not correct
  ◦ Systematic effects variation with sample matrix

Guide presented as a tutorial where options are explained!
Snapshots of the guide (1)

How to handle the variation of the MU with the concentration, \( c \)

Above about 2LOQ, the relative intermediate precision, \( s' \) ([\( s' = s/c \)], is approximately constant.

Below about 2LOQ, the absolute intermediate precision, \( s_1 \), is approximately constant.

LOQ – limit of quantification
How to handle the variation of the MU with the concentration, $c$

Below about $2\text{LOQ}$, the absolute intermediate precision, $s_1$, is approximately constant.

Above about $2\text{LOQ}$, the relative intermediate precision, $s'_1 (s'_1 = s_1 / c)$, is approximately constant.

LOQ – limit of quantification
Snapshots of the guide (2)

How precision improves from replicate analysis

Sample result can be estimated as the mean of replicate results obtained under:

- repeatability conditions
- intermediate precision conditions
Snapshots of the guide (2)

How precision improves from replicate analysis

Sample result can be estimated as **mean of replicate results** obtained under:

- repeatability conditions
- intermediate precision conditions

Validation data:
- Intermediate precision standard deviation: $s_l$
- Repeatability standard deviation: $s_r$

If replicates are in agreement with quantified imprecision…

Example: duplicates under repeatability conditions, $x_1$ and $x_2$

$$|x_1 - x_2| \leq 2.8s_r$$

(...)
Snapshots of the guide (2)

How precision improves from replicate analysis
If replicates are in agreement with quantified imprecision…
Example: duplicates under repeatability conditions, \(x_1\) and \(x_2\):
\[|x_1 - x_2| \leq 2.8s_r\]

Precision standard uncertainty, \(u_p\)

<table>
<thead>
<tr>
<th>Single Analysis</th>
<th>Mean of (n) replicates obtained on different days (dd)</th>
<th>Mean of (n) replicates obtained on the same day (sd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(u_p = s_I)</td>
<td>(u_p(n; \text{dd}) = \frac{s_I}{\sqrt{n}})</td>
<td>(u_p(n; \text{sd}) = \sqrt{s_I^2 + \frac{s^2_r(1 - n)}{n}})</td>
</tr>
</tbody>
</table>

Precision reduction from replicate analysis if \(s'_I / s'_r = 3\):

![Graph showing precision reduction with number of replicates](image)
### Snapshots of the guide (2)

<table>
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<tr>
<th>Single Analysis, $u_p$</th>
<th>Mean of $n$ replicates obtained on different days (dd), $u_p(n; dd)$</th>
<th>Mean of $n$ replicates obtained on the same day (sd), $u_p(n; sd)$</th>
</tr>
</thead>
</table>

Precision reduction from replicate analysis if $s'/s_r = 3$:

![Graph showing precision reduction from replicate analysis](image)

- $u_p(n)/u_p$
- $n = 2$
- Different day
- Same day

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Snapshots of the guide (2)

Trueness uncertainty assessed from $N$ reference materials
Evaluated through the determination of analyte recovery:

\[
\frac{c}{c_{\text{Ref}}} \quad \text{measured concentration}
\]
\[
\frac{c_{\text{Ref}}}{\text{reference concentration}}
\]

Recovery value is fit for results correction if systematic effects are proportional to the concentration.

\[
\sigma = \sqrt{\sum_{i=1}^{N} \left( \frac{c_{i}}{c_{\text{Ref}(i)}} \right)^2 \left( \frac{R_i^2}{R_i^2 \cdot n_i} + \frac{u^2(c_{\text{Ref}(i)})}{c_{\text{Ref}(i)}^2} \right)}
\]
Snapshots of the guide (2)

Trueness uncertainty assessed from \( N \) reference materials

After recovery corrections has been made:

\[
\text{square of the relative standard uncertainty of the } i\text{th reference value}
\]

\[
u_R = \sqrt{\sum_{i=1}^{N} \left( \frac{1}{R_i} \left[ \frac{S_i^2}{R_i^2} \cdot n_i + \frac{u^2(C\text{Ref}(i))}{c_{\text{Ref}(i)}} \right] \right)}
\]

\( n_i \) = number of \( i \)th recovery tests

\( N \) = recovery variance (interm. pres.)

\( \text{recovery variance} \)
FINAL REMARKS

Additional guidance on using in-house validation data for MU evaluation is needed

The simplification of MU evaluation involves facing some challenges properly

Online Eurachem/CITAC Workshop on:
Measurement uncertainty evaluation based on in-house validation data

Dates: 25-26 October 2022