Challenges and solutions for implementing IQC measures in *ad-hoc* or non-routine analysis in universities

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Laboratory was accredited to ISO/IEC 17025:2005 from Sep 2001 to Jan 2007

Overview

1. **Background**

2. **Challenges for universities**
   - How reliable are research data?
   - What’s the problem for research labs?
   - ISO 17025 standard & best practices and university laboratories

3. **Some suggested solutions**
   - Lessons learned: ISO 17025 accreditation and courses
   - Practical examples & suggestions
   - UK Code of Practice for Research
The Background

History of quality issues:
- Scientific fraud
- Incompetence
- Simple errors

➢ Funding bodies, industry, the public need valid data

Midkiff 1984, *J. AOAC Internat.* 67, 851-860
Key et al 1996, *J. AOAC Internat.* 80, 895-899
Mueller-Harvey 2003, *J. Food Agric. Env.* 1, 9-11

How reliable are research data?
- Acceptable range 0.23 - 0.41 mg/kg
- Only 4 laboratories within acceptable range

Mueller-Harvey 2003, *J. Food Agric. Env.* 1, 9-11
What’s the problem for research labs in universities?

Many published methods don’t work in other labs

- Problem could stem from:  
  - Scientific fraud
- Or may be due to:  
  - Sampling, sample preparation
  - Inappropriate method
  - Interferences
  - Equipment malfunction
  - Incorrect calibration of equipment
  - Calculation/transcription errors
  - Human error

→ Teach ethics

→ Apply ISO 17025 principles

The Challenges
Challenge 1: the environment

But...
Peer review ensures quality for:
- Teaching
- Research grant applications
- Scientific papers

Myths & beliefs:
- ‘Analysis is routine, easy, not worth investing in’
  - Analysis is never ‘routine’
  - I prefer: ‘systematic analysis’
- ‘Accreditation hinders research’
- ‘Scientific research cannot be subject to quality management’

What about QC in analysis?
- Papers tend not to report QC results
  - QC receives little attention


Challenge 2: Certified Reference Materials

Various IRMM standards
http://irmm.jrc.ec.europa.eu

NIST standard: Vaccinium berries
http://www.nist.gov/srm/

Gingko leaves

Urine samples
http://www.nist.gov/srm/

Research funds are difficult to obtain.
Up to $550 per CRM bottle:
- too expensive
- not suitable for regular use in universities

http://esciencenews.com
Challenge 3:  
ISO language is difficult to understand

Text is
- ‘legalese’ and abstract
- bland
- pretty meaningless

Standard appears
- not appropriate for university labs

Many academics are not familiar with ISO 17025 standard
- Cannot teach it
- Students don’t learn it

Challenge 4:  
Students have difficulty implementing course material

Our 3-day course:
“ISO 17025 – How to Accredit your Laboratory: Practical Aspects of Gaining Accreditation”

- Occasionally my PhD students attend
- What have they learned?
Challenge 4 (cont.):

• “I thought the balance check was only done on this particular balance”
  
  Note: during the course the balance check was only demonstrated on one balance

- Is there really no need to check other balances?
- What about the logbook next to each balance?

➢ Why do students find it difficult to translate theory/demonstrations into their lab practice?

Some Solutions

See also:

Teaching of Ethics

A Code of Ethics needs to be part of the lab culture
• Awareness building is crucial
• People need to be educated to take their own responsibility
• Ethics needs to be taught within students’ own disciplines
• Trained students could recognise ethical issues that consultants had overlooked.

➢ Training in Ethics Awareness = Training in Health & Safety Awareness

Helping students to understand ISO language and best practices (1)

• translate the legalese ISO language
• bring life into the abstract standard
• make it meaningful

➢ demonstrate how QC can be applied in the real world and in their own research
Helping students to understand ISO language and best practices (2)

Students need:
- to learn how to question own and other’s assumptions
- not to trust numbers from instruments or computers
- to see good practice in everyday activities
- to experience quality measures embedded in the laboratory culture

→ then students will “learn by doing”

Traceability: a key component of QC

Applies to:
- Documents
- QC-samples & research samples
- Instruments
- Results

Teaching of Traceability
- The lab needs to demonstrate each point with examples
- Students need to apply procedures to their own work

Teaching of traceability with QC sample

QC chart demonstrates that analysis is “in control”

QC chart for milk fat (g/100 ml)

ISO 17025 accreditation

Upper action

Upper warning

Lower warning

Lower action

Mean

calibration problem

calibration 02/02/01

calibration 23/03/01

calibration 01/05/01

Limits:

Mueller-Harvey & Baker, VAM Bulletin 13, 26, 2002
QC Chart for Milk Fat (g/100 ml)

Fat content

Upper action limit
Upper warning limit
Mean
Lower warning limit
Lower action limit

QC Chart for ADF Fibre using Maize Silage (L16-3)

ADF %

Upper action limit
Upper warning limit
Mean
Lower warning limit
Upper action limit
Simple measures for universities

- **Lab books:** Need to be understandable by others; Ensure traceability of samples, results Methods, if under development, which version?
- **Lab register:** Unique numbers for plant samples
- **Extracts/processed samples:** Each researcher has unique ID numbers in fridges/freezers

Simple measures (cont.)

- **Freezers, fridges, incubators, ovens, muffle ovens:**
  - Annual checks using a flexible wire.
  - Keep thermometer in fridge.
- **Deionised water system:**
  - Logbook records when cartridge exchanged.
- **Instruments:**
  - Internal or external service (how often?). Calibration (how often?).
  - Performance tests: leak tests for gases, liquids; pressure readings; test clock.
  - Have annual service stickers on instruments
  - Have logbooks next to each instrument
  - Makes it easy to complete QC paperwork
Simple measures (cont.)

- **Glass pipettes**: All checked when donated to lab.
- **Auto Pipettes**: Checked before use; occasional service.
- **Balances**: Annual service; check before each use with IRM check weights; record each check in log books.
- **Thermometers**: Calibrate one – then check all others against this master. Keep all thermometers in 1 drawer & compare.

CRMs *versus* In-house Reference Materials

→ find your own!

- [http://www.fleaglass.com](http://www.fleaglass.com)
Table used for check weights

Our balance logbooks contain acceptable ranges

- Makes it easy to decide whether:
  - re-calibration necessary
  - balance is ok

<table>
<thead>
<tr>
<th>Nominal weight</th>
<th>Weight found after calibration</th>
<th>Acceptance range</th>
</tr>
</thead>
<tbody>
<tr>
<td>50.0000</td>
<td>49.9984</td>
<td>49.9979 – 49.9989</td>
</tr>
<tr>
<td>20.0000</td>
<td>20.0006</td>
<td>20.0001 – 20.0011</td>
</tr>
<tr>
<td>10.0000</td>
<td>10.0003</td>
<td>10.0001 – 10.0005</td>
</tr>
<tr>
<td>5.0000</td>
<td>4.9984</td>
<td>4.9982 – 4.9986</td>
</tr>
<tr>
<td>2.0000</td>
<td>1.9998</td>
<td>1.9996 – 2.0000</td>
</tr>
<tr>
<td>1.0000</td>
<td>0.9999</td>
<td>0.9997 – 1.0001</td>
</tr>
</tbody>
</table>

Reading of check weights following Eastleigh Instrument service & calibration on 16/07/2007
Balance BAL 2: Sartorius AC 210 S, S.N. 2040279
Calibrated range 0 – 200 g
Acceptable limits for weights of 50 mg
(checked on 3/08/07)

What else do we do?

- Lab network: Contains SOPs, current/agreed methods, QC charts, information on acceptable SD-values.
- Use duplicates/triplicates: Depends on method.
- Technician versus young researchers: Compare results on real samples.
- Use QC sample: For training to demonstrate proficiency.
- Choose appropriate QC sample: Make our own IRM.
In-house Reference Materials (IRM)

We make all our own IRM!

- Costs time
- But generates enough material


Ad hoc QC chart for condensed tannins (HCl-butanol method)
Code of Practice for Research

• for research grants funded
  • by
  • UK research councils
  • and
  • government ministries
  • (e.g. Agriculture, Environment, Food Standards Agency)

http://www.bbsrc.ac.uk

Code of Practice for Research

1. Responsibilities:
   ISO Ref 4.1, 5.2
   1. Organisation structure showing line management

2. Project planning:
   ISO Ref 4.2, 4.3, 4.4, 5.4, 5.6, 5.8
   2a. Up-to-date study plans with milestones
   2b. Statistical validation of experimental plan & procedures for data analysis
   2c. Approved procedures for sampling
   2d. Ethical approval documentation and licences

3. Staff competence:
   ISO Ref 4.1.5
   3a. CV’s
   3b. Training records

4. Health & Safety:
   4a. Safety policy
   4b. Documentation (e.g. pathogenic organisms, toxic chemicals)

5. Facilities & equipment:
   ISO Ref 5.4, 5.6
   5. Maintenance and calibration records of equipment used in research project
### Code of Practice for Research

ISO Ref 4.2, 4.3, 4.4, 5.4 |
|------------------------------------------|------------------------------------------------------------------|
| 7. Research or work records: | 7a. Signed laboratory notebooks or indexed computer data files  
7b. Archiving schedules & retrieval processes  
ISO Ref 4.12 |
| 8. Handling of samples & materials: | 8a. Procedures for receiving, labelling and tracking samples  
8b. Storage log-books, sample register or LIMS system  
ISO Ref 5.8 |
| 9. Quality Control: | 9a. Internal project reviews and auditing procedures for the research  
9b. Approved publication policy with authorisation procedures  
ISO Ref 4.13, 4.14, 5.4, 5.6, 5.9, 5.10 |

### Summary

**Code of Practice for Research**

- ‘Has no teeth’
- Is limited in scope and rigour
- Irregular and infrequent inspections
- Standards tend to lapse after initial efforts...

**Outside inspections:**

- Do have teeth’, e.g.
  - UK teaching assessments
  - UK research assessments
  - Health & Safety legislation
  - ISO 17025 accreditation

**What can we do now?**

- Embed ethics & IQC into the lab culture
- Implement simple measures/processes
Conclusions

IQC including the ‘Code of Practice for Research’ need to be

- Taught in university laboratories
- Formalised, implemented and embedded
- Subjected to regular inspections

Thank you

- Mr Richard Baker
- Mrs Carol Bowerman
- Mr Ron Brown
- Mr Richard Pilgrim
- Ms Sarah Lavender

Hefce Improve Project