A practical approach to long-term monitoring of iodine laboratories

Gary Ma IGN Deputy Regional Coordinator for South-East Asia & Pacific

To ensure sustainability of IDD control programs, it is essential to collect accurate data on urinary iodine levels and salt iodine content. These require rigorous and sustained laboratory testing systems.

Erroneous laboratory data can lead to sub-optimal and potentially harmful public health interventions. Therefore, laboratory assay quality control systems, whether they are internal or external in nature, are important to monitor the performance of a laboratory.

About EQUIP

Ensuring the Quality of Urinary Iodine Procedures (EQUIP) (1) is an external quality assurance program for urinary iodine assays, established over 15 years ago under the National Center for Environmental Health, Division of Laboratory Sciences (DLS) of the Centers for Diseases Control and Prevention (CDC) in Atlanta, USA. It has approximately 205 active members worldwide, and it continues to grow. EQUIP is free to any laboratory that enrols directly with DLS. Each registered laboratory receives quality control materials three times a year. Each time, they include four sample sets (a total of 12 ampoules of human urine of approximately 1 mL each) to be tested under three separate assay conditions *(Table 1)*.

TABLE 1 **Standard EQUIP assay procedure specifies that, during each of the three rounds of testing per cycle, four urine samples (A-D) must be tested under three separate assay conditions.**

QC Materials	Assay 1	Assay 2	Assay 3
A1, A2 & A3	A1	A2	A3
B1, B2 & B3	B1	B2	B3
C1, C2 & C3	C1	C2	C3
D1, D2 & D3	D1	D2	D3

Assessment of laboratory performance

At the end of each annual cycle, the laboratory's performance is graded using the EQUIP Annual Score System. The score is calculated from all 12 samples in a cycle, each sample weighing 8.33% of the total score. A sample result is incorrect if it falls outside the CDC Target Range. Laboratories scoring 80% or more receive a certificate of Successful Participation (SP), and those scoring below 80% receive a certificate of Participation (P).

A modified procedure improves performance testing in South-East Asia

In the South-East Asia & Pacific Region, this approach has been modified, and the score is calculated after each testing round based on the 4 samples, with each sample weighing 25% of a total score of 100%. Thus, 3 out of 4 correct results would result in a score of 3 x 25% = 75%. Table 2 demonstrates how the Performance Score (PS) was calculated in selected laboratories in the South-East Asia region performing urinary iodine analysis. Figure 1 tracks one laboratory's performance over time, from round 35 in 2013 to round 44 in 2016.

Any laboratory with a PS of 50% or less for two consecutive rounds will be contacted to identify the potential source of error in the assay system. Much effort has gone into trying to understand the problems leading to poor laboratory performance, and resources and technical assistance have been offered to resolve them. While this may be time-consuming, the outcomes have been rewarding.

TABLE 2 **Sample of performance scores calculated in selected iodine laboratories across South-East Asia region in 2013–2014 (anonymized data). R35 indicates round 35.**

Lab	R35	PS%	R36	PS%	R37	PS%	R38	PS%
1	3/4	75%	1/4	25%	1/4	25%	2/4	50%
2	4/4	100%	4/4	100%	4/4	100%	4/4	100%
3	1/4	25%	4/4	100%	3/4	75%	3/4	75%
4	4/4	100%	3/4	75%	4/4	100%	4/4	100%
5	4/4	100%	2/4	50%	4/4	100%	4/4	100%
6	4/4	100%	3/4	75%	4/4	100%	1/4	25%
7	4/4	100%	3/4	75%	4/4	100%	3/4	75%
8	4/4	100%	4/4	100%	4/4	100%	4/4	100%

Establishing internal and external quality control systems

In clinical laboratories, internal quality control (QC) procedures which monitor the analytical techniques for assay accuracy, precision and reliability are absolutely essential to ensure that acceptable standards are met during patient testing. There is a plethora of information available, and each laboratory should implement procedures that meet their needs (2-4).

To establish an internal QC system, a laboratory should prepare or purchase control materials based in the same type of matrix as the clinical samples, at three concentration levels (low, medium, and high). The staff should assay these materials multiple times over several weeks to develop a Levey-Jennings plot for each concentration level *(Figure 2)*. In the plot, the central line represents the mean value derived from the sum of all the measurements. It is plotted against the frequency (e.g., days) on the x-axis. An Upper Control Limit (UCL) and a Lower Control Limited (LCL) are derived from +/- 2 standard deviations (SD) of the mean and plotted horizontally on either side of the mean. The UCL and LCL lines represent the expected imprecision of the method. The plot shows each QC result sequentially over time and allows an immediate visual assessment of the method's performance, including trend detection.

The frequency of performing internal quality control is defined by each laboratory and may vary. QC samples must be measured in the same manner as clinical samples, so that their results can be used to determine that the procedure meets performance requirements appropriate for patient care. Before any patient results are released, all QC results must be within the UCL–LCL range.

EQUIP is an external quality control program that provides identical QC materials to all its member laboratories that perform urinary iodine analysis, but its performance score is merely a tracking tool for assay performance. An internal QC system is, therefore, necessary to monitor assay precision, accuracy, and sensitivity.

An important thing to bear in mind is that the Levey-Jennings plot will not predict future assay performance. However, it is a good tool to flag any abnormality in previous assay runs. Action must be taken immediately to review and resolve errors in the assay system, and failure to act promptly may result in poor performance in future assays.

FIGURE 1 **Tracking the performance score of 'Laboratory 1' in the South-East Asia region 2013 to 2016 (testing rounds 35 to 44).**

In this example, performance deteriorated after the laboratory manager retired. No replacement was recruited. Maintenance of equipment was neglected because the demand for urinary iodine measurements was low. Internal quality control system was not maintained or reviewed. Laboratory priority and resources had been shifted to other, more demanding laboratory facilities. After numerous contacts and discussions with the laboratory manager, an extensive overhaul of the whole iodine laboratory took place in late 2013. Laboratory 1 has now returned to an acceptable performance level.

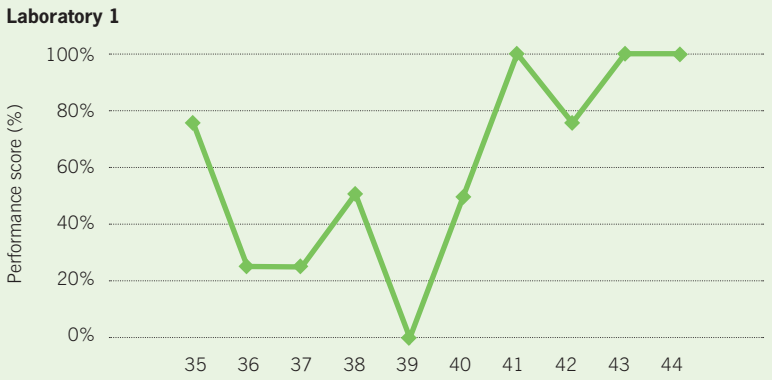
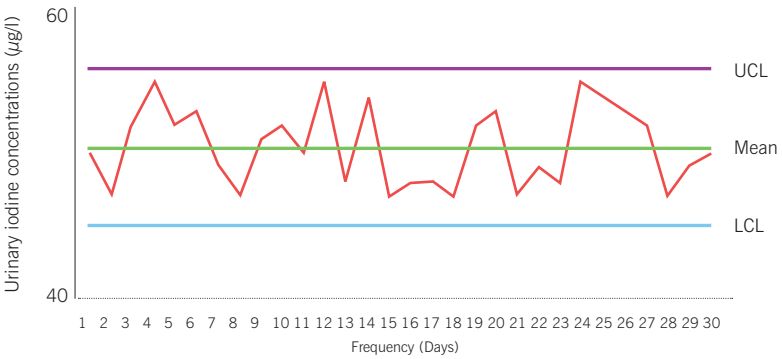


FIGURE 2 **Levey-Jennings plot of a typical assay with Upper and Lower Control Limits (UCL and LCL) on either side of the mean.**



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