

ANNUAL REPORT 2022

Scheme Organiser	Scientific Advisor	Website for reporting results	Administration office
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1. Purpose

The purpose of the ERNDIM External Quality Assurance Scheme for Pterins in Urine is the monitoring of the analytical quality of the assay of pterins in laboratories involved in the screening and diagnosis of patients with inherited metabolic disorders. The scheme consists of a quantitative assay of pterins in urine and will be discussed in this report. For details: www.erndim.org / www.ERNDIMQA.nl

2. Participants

A total of 35 datasets have been submitted, for 1 of them an annual report could not be generated due to insufficient data submission. One laboratory did not submit any results at all.

3. Design

The Scheme has been designed, planned and coordinated by Dr. Alessio Cremonesi as scientific advisor and Dr. Eline van der Hagen as scheme organizer (on behalf of the MCA Laboratory), both appointed by and according and in line with the procedures of the ERNDIM Board. The design includes samples and reports to provide information with a balance between short-term and long-term reports and between detailed and aggregated information. As a subcontractor of ERNDIM, the MCA Laboratory prepares and dispatches EQA samples to the scheme participants and provide a website for on-line submission of results and access to scheme reports.

Samples

The scheme consisted of 8 lyophilized samples, all prepared from the same basic urine, but with various amounts of added analytes. The analytes included are biopterin, neopterin, and primapterin (7-biopterin) and results are expressed in both $\mu\text{mol/L}$ and mmol/mol creatinine. The samples were identical two by two: the pairs, the biochemical and (mimicked) clinical characteristics are in the table below. Samples have been tested for stability and homogeneity according to ISO 13528.

¹ If this Annual Report is not Version 1 for this scheme year, go to APPENDIX 1 for details of the changes made since the last version of this document

Table 1. Samples

Sample Pair	Biochemical Characteristics	Clinical Characteristics
1 and 8	High primapterin	A pterin-4a-carbinolamine dehydratase (PCD) deficiency or a healthy person (sample 1) A pterin-4a-carbinolamine dehydratase (PCD) deficiency or a phenylalanine hydroxylase (PAH) deficiency (sample 8)
2 and 7	Low biopterin & low neopterin	A GTP cyclohydrolase (GTPCH) deficiency
3 and 5	High primapterin	A pterin-4a-carbinolamine dehydratase (PCD) deficiency
4 and 6	Low biopterin & high neopterin	A 6-pyruvoyl-tetrahydropterin synthase (PTPS) deficiency

Reports

All data-transfer, the submission of data as well as request and viewing of reports proceeded via the interactive website www.erndimqa.nl which can also be reached through the ERNDIM website (www.erndim.org). The results of your laboratory are confidential and only accessible to you (with your name and password). The anonymised mean results of all labs are accessible to all participants. Statistics of the respective reports are explained in the general information section of the website.

An important characteristic of the website is that it supplies short-term and long-term reports. Short-term reports are associated with the eight individual specimens, for each of which there has been a specific deadline in the year 2022. Two weeks after the respective deadline participants could request their reports and as such had eight times up-to-date information on their analytical performance. Although technically not required (the website can work without any delay time), a delay time of 14 days has been chosen to enable the scientific advisor to inspect the results and add his comment to the report. Contrary to the early short-term report is the annual long-term report. The annual report is based on the design-anchored connection between samples, which enables to report a range of analytical parameters (accuracy, precision, linearity, recovery and interlab dispersion) once an annual cycle has been completed. The annual report is discussed below.

A second important characteristic of the website is the wide range in aggregation of results, which permits labs to make an individual choice for detailed and/or aggregated reports. The most detailed report, which can be requested from the website, is the "Analyte in Detail", which shows results of a specific analyte in a specific sample (56 such Analyte-in-Detail-reports can be requested in the year 2022 cycle). A more condensed report is the "Current Report" (Called "Cycle Review" on the website), which summarizes the performance of all analytes in a specific sample (8 such Current Reports can be requested in 2022). The highest degree of aggregation has the Annual Report, which summarizes the performance of all analytes of all 8 samples (1 such Annual-Report can be requested in 2022). Depending on their position in the laboratory, one can choose to have a glance at only the annual report (managers) or at all 56 detailed reports (technicians).

4. Discussion of Results in the Annual Report 2022

In this part, the results as seen in the annual report 2022 will be discussed. Subsequently we will focus on accuracy, recovery, precision, linearity, interlab CV and cross-sectional relations. Please keep at hand your annual report from the Interactive Website when you read the "guided tour" below and keep in mind that we only discuss the results of "all labs": it is up to you to inspect and interpret the specific results of your laboratory.

4.1 Accuracy

A first approach to describe the accuracy is comparison of your mean outcome in the eight samples with the mean of all labs. This is shown in the columns "your lab" and "all labs" under the heading "Accuracy", respectively. E.g. for neopterin the mean of all labs is 37.0 $\mu\text{mol/L}$ with which you can compare the mean of your lab.

4.2 Recovery

A second approach to describe accuracy is the percentage recovery of added analyte. In this approach, it is assumed that the recovery of the weighed quantities is the target value. The correlation between weighed quantities as added to the samples (on the x-axis) and your measured quantities (on the y-axis) have been calculated. The slope of the correlation multiplied by 100 is your recovery (%) of the added amounts. Outcome for your lab in comparison to median outcome of all labs is shown in the column "Recovery" in the annual report. For all labs the recovery ranges from 95% for neopterin ($\mu\text{mol/L}$) to 107% for biopterin (mmol/mol creatinine). The overall recovery is 99%.

4.3 Precision

Reproducibility is an important parameter for quality in the laboratory and is encountered in the schemes' design. Samples come in pairs, which can be regarded as duplicates from which CV's can be calculated (Intra Laboratory CV as indicator for reproducibility). Outcome for your lab in comparison to the median of all labs is shown in the column "Precision" of the Annual Report. Precision ranges from 7.6% for neopterin ($\mu\text{mol/L}$) to 16.9% for primapterin (mmol/mol creatinine). The overall intralab CV is 10.7%.

4.4 Linearity

Linearity over the whole relevant analytical range is another important parameter for analytical quality. Again, this is encountered in the schemes' design. With weighed quantities on the x-axis and your measured quantities on the y-axis the coefficient of regression (-r-) has been calculated. Outcome for your lab in comparison to the median of all labs is in the column "Linearity" of the annual report. The coefficient of regression ranges from 0.975 for biopterin (mmol/mol creatinine) to 0.998 for primapterin ($\mu\text{mol/L}$).

4.5 Interlab CV

For comparison of outcome for one patient in different hospitals and for use of shared reference values it is relevant to have a high degree of harmonization between results of various laboratories. Part of the schemes' design is to monitor this by calculating the Interlaboratory CV. This, along with the number of laboratories who submitted results, is shown in the column "Data All labs" in the Annual Report. Most laboratories submitted results for neopterin (mmol/mol creatinine) (33) whereas only 24 labs assayed primapterin. The Interlab CV ranges from 23.5% for biopterin ($\mu\text{mol/L}$) to 32.3% for primapterin ($\mu\text{mol/L}$). The mean Interlab CV for all analytes is 26.5%.

4.6 Cross Sectional Relations

The various parameters as described above often have an interrelation: often more than one parameter directs towards good or bad analytical control. This pattern, clearly seen in the other ERNDIM schemes is less prominent in the pterins scheme.

4.7 Your laboratory performance: Flags

Since January 2009 a flagging system to judge performance of the individual laboratories has been implemented. In the annual report for an individual laboratory flags indicate poor performance for accuracy, precision, linearity and recovery. Analytes with satisfactory performance for at least three of the four parameters (thus no or only one flag or no result) receive a green flag. Thus, a green flag indicates satisfactory performance for analysis of that particular analyte while a flag indicates that your laboratory has failed to attain satisfactory performance. Criteria for red flags can

be found in the general information on the website (general information; interactive website, explanation annual report).

4.8 **Poor Performance Policy**

A wide dispersion in the overall performance of individual laboratories is evident. Table 2 shows the percentage of flags observed. 53% of the laboratories have no flag at all and thus have attained excellent overall performance. In contrast, at the other extreme there are also 6% of laboratories with $\geq 25\%$ flags. Following intensive discussion within the ERNDIM board and Scientific Advisory Board (SAB) and feedback from participants we could agree on a harmonised scoring system for the various branches of the Diagnostic Proficiency schemes and qualitative schemes. We have also tested a scoring system for the quantitative schemes as described in our Newsletter of Spring 2009. In parallel to this the SAB has agreed levels of adequate performance for all the schemes and these will be re-evaluated annually. The scoring systems have been carefully evaluated by members of the SAB and have been applied to assess performance in our schemes from 2007 onwards. The ERNDIM Board has decided that the Scientific Advisor will judge the performance of the individual laboratories based on these levels of satisfactory performance and issue a letter of advice of failure to achieve satisfactory performance to those laboratories, which do not achieve satisfactory performance. The letter is intended to instigate dialogue between the EQA scheme organiser and the participating laboratory to solve any analytical problems to improve quality of performance of labs in the pursuit of our overall aim to improve quality of diagnostic services in this field.

Table 2. Percentage Flags

% Red Flags seen in Annual Report	Percentage Labs in this Category	Cumulative Percentage of Labs
>25%	6%	6%
25%	6%	12%
>20 – <25%	6%	18%
>15 – $\leq 20\%$	3%	21%
>10 – $\leq 15\%$	14%	35%
>5 – $\leq 10\%$	12%	47%
>0 – $\leq 5\%$	0%	47%
0%	53%	100%

4.9 **Interpretation**

In this scheme, we also requested the interpretation with respect to metabolic conditions. Table 3 shows the interpretation frequency for the respective sample pairs. The correct interpretation is marked in green. For sample #1 7 laboratories and 20 laboratories reported the correct interpretations “a healthy person” or “a PCD deficiency”; 2 labs reported “a PTPS deficiency” and 0 laboratories “a GTPCH deficiency” or “a PAH deficiency”. Since in samples #1 and #8 interferences were present in the chromatograms, two diagnoses for each sample were accepted.

Table 3. Interpretation.

Description	Pair 1-8	Pair 2-7	Pair 3-5	Pair 4-6
a healthy person	7 – 1	1 – 0	2 – 1	0 – 0
Pterin-4a-carbinolamine dehydratase (PCD) deficiency	20 – 28	0 – 0	25 – 29	1 – 0
6-pyruvoyl-tetrahydropterin synthase (PTPS) deficiency	2 – 3	0 – 0	1 – 1	29 – 32
a GTP cyclohydrolase (GTPCH) deficiency	0 – 0	29 – 30	0 – 1	0 – 0
a phenylalanine hydroxylase (PAH) deficiency	0 – 1	2 – 1	2 – 0	0 – 0

4.10 **Additional Specific Remarks of the Scientific Advisor**

It is important to bear in mind that for a correct interpretation not only the analytical results but also the provided phenylalanine concentrations must be used.

5. **Certificates**

Starting from 2017 the pterins are included on the certificates.

As for other schemes the performance as it is indicated by the red/green flags in the individual laboratories annual report is summarised in the annual participation certificate. The certificate lists the total number of pterins in the scheme, the number for which results have been submitted and the number for which satisfactory performance has been achieved. It is important to bear in mind that the certificate has to be backed up by the individual annual report in the case of internal or external auditing.

6. **Preview Scheme 2023**

Laboratories will be expected to participate in 6 out of 8 distributions with a score of at least 10 points out of 16 (2 points for correct interpretation, 0 points for incorrect interpretation) with no critical errors in order to attain satisfactory performance.

7. **Questions, Remarks, Suggestions**

If you have any questions, remarks or suggestions please address to the Scientific Advisor Dr. Alessio Cremonesi (alessio.cremonesi@kispi.uzh.ch) or the scheme organizer Dr. Eline van der Hagen (mca.office@skbwinterswijk.nl).

Zürich, 01 April 2023



Dr. Alessio Cremonesi
Scientific Advisor

Please note:

This annual report is intended for participants of the ERNDIM Pterins in urine scheme. The contents should not be used for any publication without permission of the scheme advisor.

The fact that your laboratory participates in ERNDIM schemes is not confidential. However, the raw data and performance scores are confidential and will be shared within ERNDIM for the purpose of evaluating your laboratory performance, unless ERNDIM is required to disclose performance data by a relevant government agency. For details, please see the terms and conditions in the ERNDIM Privacy Policy on www.erndim.org.

APPENDIX 1. Change log (changes since the last version)

Version Number	Published	Amendments
1	18 April 2023	<ul style="list-style-type: none">2022 annual report published

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