

ANNUAL REPORT 2023

Scheme Organiser	Scientific Advisor	Website for reporting results	Administration office
Dr. C.W. Weykamp Streekziekenhuis Koningin Beatrix MCA Laboratory Beatrixpark 1 7101 BN Winterswijk The Netherlands e-mail: mca.office@skbwinterswijk.nl	Dr. Rafael Artuch Hospital Sant Joan de Deu Clinical Biochemistry Dept/ CIBERER Passeig Sant Joan de Deu 2 Esplugues de Llobregat 08950 Barcelona Spain e-mail: Rartuch@sjdhospitalbarcelona.org	Mrs. Irene de Graaf Streekziekenhuis Koningin Beatrix MCA Laboratory Beatrixpark 1 7101 BN Winterswijk The Netherlands e-mail : i.degraaf@skbwinterswijk.nl	ERNDIM Administration Office c/o EMQN CIC, Unit 4, Enterprise House, Manchester Science Park Pencroft Way Manchester M15 6SE United Kingdom. e-mail: admin@erndim.org

Published: Barcelona-Winterswijk, 03rd January 2024¹

1. **Purpose**

The purpose of the ERNDIM External Quality Assurance Scheme for Special Assays in Serum is the monitoring of the analytical quality of the quantitative assay of a range of analytes in serum in laboratories involved in the diagnosis of patients with inherited metabolic disorders. For details see www.erndim.org / www.ERNDIMQA.nl

2. **Participants**

A total of 298 datasets (238 labs) have been submitted, for 4 of them an annual report could not be generated due to insufficient data submission. 5 laboratories did not submit results at all.

3. **Design**

The Scheme has been designed, planned and co-ordinated by the scientific advisor (Dr. Rafael Artuch) and Dr. C.W. Weykamp as scheme organizer (on behalf of MCA Laboratory), both appointed by and according to the procedure 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 serum but with various amounts of added analytes, except for biotinidase activity, NEFA and total cholesterol concentrations, that they were that present as endogenous

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

activity/concentration in the lyophilized samples and they were not added (results are the mean values reported by the different laboratories). The samples were identical two by two: the pairs analytes and their source as well as the added amounts are in the table below. Samples have been tested for stability and homogeneity according to ISO 13528.

Table 1.

Analyte	Source:	Units	Added Amounts			
			Sample Pair 2023. 01 - 05	Sample Pair 2023. 02 - 08	Sample Pair 2023. 03 - 06	Sample Pair 2023. 04 - 07
3-OH-Butyric Acid	Aldrich 29.836-0	mmol/L	0,0	2,44	0,94	3,94
7-Dehydrocholesterol	Sigma 30800	µmol/L	0,00	74,0	169	9,01
7-Ketocholesterol	Sigma C2394	µmol/L	0,10	0,50	1,50	1,00
Biotinidase	Endogenous	nmol/min/ml serum	5,84	5,38	5,47	5,76
C22:0 Behenic acid	Aldrich 21.694-1	µmol/L	0,0	56,0	16,0	36,0
C24:0 Lignoceric acid	Sigma L6641	µmol/L	1,01	46,1	31,0	11,0
C26:0 Cerotic acid	Sigma H0388	µmol/L	0,00	1,01	9,04	4,13
C26:0 LPC	Sigma 855810P	µmol/L	0,14	1,46	0,78	0,30
Carnitine Free	Sigma C0283	µmol/L	0,00	62,0	12,0	102
Cholestane-3b. 5a. 6b-triol	Merck 700054P	µmol/L	0,05	0,80	0,50	0,30
Cholesterol	Sigma D6128	µmol/L	0,00	13,0	93,0	68,1
Cholesterol	Endogenous	mmol/L	3,64	3,62	3,66	3,65
Coenzyme Q10	Sigma C9538	µmol/L	0,00	4,01	2,01	1,00
Creatine	Sigma C3630	µmol/L	0,00	43,1	23,0	63,0
Galactose	Sigma G0750	µmol/L	50,1	1200	1900	500
Glucosylsphingosine	Sigma 43659	nmol/L	0,0	600	400	1000
Guanidinoacetate	Aldrich G11608	µmol/L	1,06	12,9	6,34	19,0
Homocysteine	Sigma H6010	µmol/L	0,00	200	40,3	15,1
Lactic Acid	Sigma L7022	mmol/L	0,00	2,19	6,49	4,19
LysoGb3	Sigma G9534	nmol/L	0,00	100,0	50,0	9,80
Lysosphingomyelin	Cayman Chem. 100079475	nmol/L	0,00	50,0	8,00	4,00
Methylmalonic acid	Aldrich M5.405-8	µmol/L	0,00	400	50,3	2,10
NEFA	Endogenous	µmol/L	518	518	520	523
Phytanic acid	Sigma P4060	µmol/L	0,00	7,03	22,0	15,0
Pipecolic Acid	Sigma P2519	µmol/L	0,00	20,3	8,38	38,1
Pristanic acid	Sigma P6617	µmol/L	0,00	7,15	4,97	1,97
Pyruvic Acid	Sigma B8574	mmol/L	0,05	0,20	0,15	0,10
Succinylacetone	Sigma D1415	µmol/L	0,00	3,91	1,56	0,78

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 four individual specimens, for each of which there has been a specific deadline in the year 2023. Two weeks after the

respective deadlines participants could request their reports and as such had four 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 fast 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 inter-laboratory 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 (224 such Analyte-in-Detail-reports can be requested in the 2023 cycle). A more condensed report is the "Cycle Review" which summarizes the performance of all analytes in a specific sample (8 such Cycle-Review-Reports can be requested in 2023). 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 2023).

4. Discussion of Results in the Annual Report 2023

In this part the results as seen in the annual report 2023 will be discussed. Subsequently we will regard accuracy, recovery, precision, linearity, inter-laboratory 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.

Biotinidase, cholesterol and NEFA are not included in the annual report because these analytes have not been spiked which makes it impossible to calculate recovery and linearity.

4.1 Accuracy

A first approach to describe the accuracy is to compare mean outcome in your lab of the eight samples with the mean outcome of all labs. This is done in the first columns of the annual report. It can be seen that the mean outcome for all labs for free Carnitine free is 75.6 $\mu\text{mol/L}$.

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) has 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 41% for Coenzyme Q10 to 99% for creatine. Except for CoQ, good recoveries were observed.

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 column "Precision" of the Annual Report. Precision ranges from 3.3% for lactic acid to 40.5% for Coenzyme Q10. The overall precision of 9.7% is quite satisfying.

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. It can be seen that the coefficient of regression is best for Homocysteine and Methylmalonic acid (1.000) and lowest for Coenzyme Q10 (0.858).

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. It can be seen that most laboratories submitted results for 3-hydroxybutyric acid (n=119) whereas only 9 labs submitted results for C26:0 LPC. The Inter-laboratory CV ranges from 5.87% for Lactic Acid to 114% for Coenzyme Q10.

4.6 Cross Sectional Relations

The various parameters as described above often have an interrelation: more than one parameter directs towards good or bad analytical control.

A typical example of good analytical control is lactic acid: many (82) laboratories submitted results, the reproducibility within the labs is good (precision of 3.3%), the interlab CV is good (5.87%), linearity is good (0.998) as is the recovery (98%).

4.7 Your performance: Flags

In order to easily judge performance of individual laboratories the annual report of an individual laboratory may include flags with different colours in case of 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) receive a green flag. Thus a green flag indicates satisfactory performance for analysis of that particular analyte. Criteria for flags can be found in the general information on the website (on this website under 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. 56% of the laboratories have no flag at all and thus have attained excellent overall performance. In contrast, at the other extreme there are also 3% of laboratories with more than 25% red flags. Following intensive discussion within the ERNDIM board and Scientific Advisory Board (SAB) and taking into account feedback from participants we have been able to 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 in order to solve any particular analytical problems in order to improve quality of performance of labs in the pursuit of our overall aim to improve quality of diagnostic services in this field.

If your laboratory is assigned poor performance and you wish to appeal against this classification please email the ERNDIM Administration Office (admin@erndim.org), with full details of the reason for your appeal, within one month receiving your Performance Support Letter. Details of how to appeal poor performance are included in the Performance Support Letter sent to poor performing laboratories.

Table 2. Percentage Flags

% Red Flags seen in Annual Report	Percentage Labs In this Category	Cumulative Percentage Of Labs
>25%	3%	3%
25%	6%	9%
20 – 25%	3%	12%
15 – 20%	4%	16%
10 – 15%	8%	24%
5 – 10%	12%	36%
0 – 5%	8%	44%
0%	56%	100%

4.9 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 special assays 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.

4.10 Additional Specific Remarks of the Scientific Advisor

The Annual Report dealing with analytical performance in terms of accuracy, precision, linearity, recovery and inter-laboratory CV, shows in general a good overall performance. 14 metabolites displayed a CV < 15%, 4 between 15-20% and 6 >20%. The less satisfying results assessed as precision (CV% of duplicates and inter-laboratory CV) affects CoQ10 and C26:0 LPC (the latter recently added to the scheme) following by succinylacetone. The three metabolites showed inter-laboratory CV% higher than 35%. While CoQ10 and C26:0 LPC also present poor results for precision (CV% of the duplicates), results of succinylacetone analysis are better than that of the last year. The number of participant laboratories in the analysis of these 3 metabolites is low and this can explain such variations. Stability and technical issues can further explain such variations.

Linearity is in general good for all metabolites, being the lowest that of CoQ10 analysis.

5. Summary

The Annual Report dealing with analytical performance in terms of accuracy, precision, linearity, recovery and, inter-laboratory CV shows a performance with similarities to previous years. For some analytes the performance is good, while for others there is still something to do to achieve sufficient intra- and inter-laboratory quality.

The poor performance observed for CoQ10 will lead us to take a final decision during SAB meeting in 2024. If performance or the number of participants do not improve, we will remove this metabolite from the SAS scheme. Alternatively, as will occur with C26:0 LPC, we can plan to move CoQ10 to the new lipid scheme. Results of succinylacetone have moderately improve in 2023 when compared with 2022

6. Preview Scheme 2024

The design of the 2024 scheme is essentially the same as in 2023. As a new, during 2024 some lipids present in the SAS scheme will also be included in the new lipid pilot scheme (see information of this new scheme in the ERNDIM website).

7. Questions. Comments and Suggestions

If you have any questions. comments or suggestions please address to the scientific advisor of the scheme Dr. Rafael Artuch (Rartuch@sjdhospitalbarcelona.org) and/or to the scheme organiser Dr. C.W. Weykamp (mca.office@skbwinterswijk.nl)

Barcelona, 3rd January 2024



Mr. Rafael Artuch
Scientific Advisor

Please note:

This annual report is intended for participants of the ERNDIM Special Assays in Serum 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	3 rd January 2024	<ul style="list-style-type: none">2023 annual report published

END