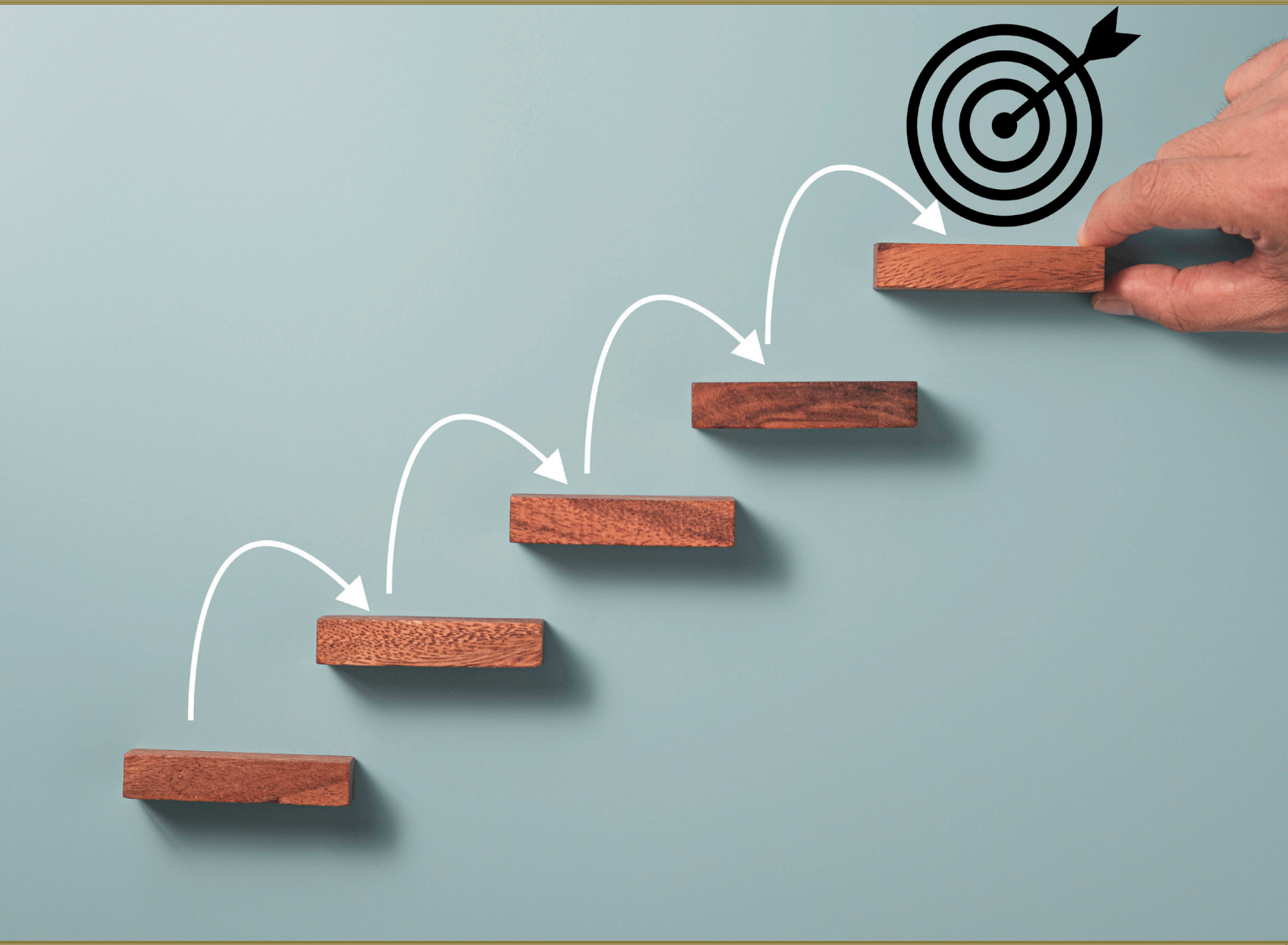
TROUBLESHOOTING GUIDE

Guideline for root cause analysis and investigation of laboratory results in ESfEQA External Quality Assessment surveys

Version 1.0



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About ESfEQA Trouble Shooting Guide

This guide is intended to support participants of the ESfEQA External Quality Assessment surveys to identify the root cause of deviations for laboratory results that do not match expected values. Suggestions are provided for further investigation and corrective actions.

We hope this guide will help laboratories to continuously improve analytical quality for the sake of reliable patient results and confidence in laboratory services.

This Trouble Shooting Guide summarizes the most common errors we observe that require further investigation.

How to use the guide

- For quantitaive analysis:
  - » Check your ESfEQA survey report and identify analytes with error flags.
  - » The error flag denotes failed anlaytes: Z-score above +3,0 or below -3,0.
  - » You will find seven tables (1.1-1.6 and 2.0) on the following pages that describe common deviations in quantitative results.
  - » Each table lists reasons for poor performance, beginning with the most likely.
- For qualitative analysis:
  - » Table 2.1 addresses deviations in qualitative EQAs.

On the last page of this guide, we have added a “Handout for overview of root cause analysis” to record errors and provide suggestions for corrective and preventive actions. It can be used for any number of ESfEQA EQAs and dispatches.

ESfEQA’s brochure “Report Interpretation” is also a helpful guide to the statistics in our reports. It can be found on our website under EQA Programs/Instructions for Participants (https://www.esfeqa.eu/en/).

References: Biochemia Medica 2017; 27(1):49-62

Content

1.0 Quantitative EQA

2.0 Qualitative EQA

1.0 Quantitative EQA

1.1 High deviation of the z-score for (almost) all analytes (z-scores all negative in one sample but all positive in the other sample)

Possible Causes	Investigation
Sample mismatch	•Check if the samples were mixed up. Check ID of samples 1a, 1b, etc.
Incorrect reconstitution/preparation of EQA samples	• Check if ESfEQA IFU was followed correctly (volume, appropriate diluent) • Check if the correct IFU was used
Submission error: results submitted for the wrong sample	•Check if the results were sent for the correct survey, e.g. results sent for sample 5a with data of sample 6a
Inappropriate handling or storage of the samples	•Check if the samples were handled according to the ESfEQA IFU •Check if the samples were stored according to the ESfEQA IFU •Check performance of other samples that were delivered in the same shipment
Improper operation of instrument	• Check maintenance issues • Check instrument is correctly calibrated • Check instrument settings • Check for any instrument error messages • Check performance of the internal quality control
Configuration error in TEQA	•Check configuration settings in TEQA (instrument, method, reagent, units)

Example 1.1

Report Summary

sample: **TMH4_2024_02_a**

Parameter	Evaluation	Target value		SD		U	Number of Labs	Number of results	Lab result	Z-Score	BIAS [%]
AFP ng/mL	GENERAL	124.3	(A)	9.94	(S)	1.09	131	131	5.8	-11.9	-95.33
	INSTRUMENT GROUP	113.3	(A)	9.06	(S)	3.03	14	14		-11.9	-94.88
CA 125 U/mL	GENERAL	102.8	(A)	8.22	(S)	2.36	127	127	47.8	-6.7	-53.5
	INSTRUMENT GROUP	123.3	(A)	9.87	(S)	5.14	16	16		-7.7	-61.23
CA 19-9 U/mL	GENERAL	135.9	(A)	10.87	(S)	8.62	118	118	175.57	3.7	29.21
	INSTRUMENT GROUP	627	(A)	50.16	(S)	28.08	15	15		-9	-71.99
CEA ng/mL	GENERAL	9.099	(A)	0.76	(S)	0.18	137	137	3.84	-6.9	-57.8
	INSTRUMENT GROUP	11.1	(A)	0.92	(S)	0.16	18	18		-7.9	-65.41
PSA Total ng/mL	GENERAL	12.95	(A)	1.08	(S)	0.15	215	215	2.05	-10.1	-84.17
	INSTRUMENT GROUP	11.6	(A)	0.97	(S)	0.19	30	30		-9.9	-82.33

* (A) AlgoA, (G) Expert Group, (R) Reference value, (C) Certified Value, (S) Set by coordinator, (E) Experiment, (I) Interqartile, (N) Non robust sd

sample: **TMH4_2024_02_b**

Parameter	Evaluation	Target value		SD		U	Number of Labs	Number of results	Lab result	Z-Score	BIAS [%]
AFP ng/mL	GENERAL	6.41	(A)	0.96	(S)	0.11	127	127	116.16	113.9	1712.79
	INSTRUMENT GROUP	6.098	(A)	0.96	(S)	0.33	13	13		114.2	1805.54
CA 125 U/mL	GENERAL	33.57	(A)	2.8	(S)	0.69	128	128	153.5	42.8	357.25
	INSTRUMENT GROUP	42.54	(A)	3.4	(S)	1.12	15	15		32.6	260.84
CA 19-9 U/mL	GENERAL	32.9	(A)	3.2	(S)	1.72	119	119	715.69	213.4	2075.38
	INSTRUMENT GROUP	144.9	(A)	11.59	(S)	7.72	14	14		49.2	393.93
CEA ng/mL	GENERAL	2.929	(A)	0.25	(S)	0.06	137	137	11.89	35.8	305.94
	INSTRUMENT GROUP	3.539	(A)	0.29	(S)	0.15	18	18		28.3	235.97
PSA Total ng/mL	GENERAL	2.737	(A)	0.25	(S)	0.03	214	214	9.57	27.3	249.65
	INSTRUMENT GROUP	2.496	(A)	0.25	(S)	0.06	29	29		28.3	283.41

* (A) AlgoA, (G) Expert Group, (R) Reference value, (C) Certified Value, (S) Set by coordinator, (E) Experiment, (I) Interqartile, (N) Non robust sd

1.2 High deviation of z-score for individual analytes in all evaluated groups (some positive, some negative in the same sample)

Possible Causes	Investigation
Typing error during submission of result for the affected analyte	• Check if the results were entered correctly (e.g., no typos) • Check the correct results were entered (e.g., check EQA results were entered, not patient results)
Inappropriate handling or storage of the samples	•Check if the samples were handled according the ESfEQA IFU •Check if the samples were stored according to the ESfEQA IFU •Check performance of other samples that were delivered in the same shipment
Incorrect storage and/or preparation of reagents and calibrators for the device	•Check if the reagents/standards were stored according to the IFU
Configuration error in TEQA	•Check configuration settings in TEQA (instrument, method, reagent, units)
Improper operation of instrument	• Check maintenance issues • Check instrument is correctly calibrated • Check instrument settings • Check for any instrument error messages • Check performance of the internal quality control
No instrument / method /reagent -specific peer group available	•Contact ESfEQA (surveys@esfeqa.eu)

Example 1.2

Report Summary

sample: CC4_2024_02_a

Parameter	Evaluation	Target value		SD		U	Number of Labs	Number of results	Lab result	Z-Score	BIAS [%]
ALT (GPT) U/L	GENERAL	46.98	(A)	3.92	(S)	0.24	569	569	38.5	-2.2	-18.05
	INSTRUMENT	37.61	(A)	3.33	(S)	7.7	9	9		0.3	2.37
(!) Cholesterol mg/dL	GENERAL	141.7	(A)	8.37	(S)	0.45	546	546	191	5.9	34.79
	INSTRUMENT	142.6	(A)	8.37	(S)	3.95	7	7		5.8	33.94
Creatinine mg/dL	GENERAL	1.302	(A)	0.08	(S)	0	591	591	1.5	2.4	15.21
	INSTRUMENT - METHOD	1.339	(A)	0.08	(S)	0.04	8	8		1.9	12.02
	METHOD	1.304	(A)	0.08	(S)	0.01	51	51		2.4	15.03
(!) HDL Cholesterol mg/dL	GENERAL	42.82	(A)	2.86	(S)	0.16	479	479	27	-5.5	-36.95
	INSTRUMENT	32.97	(A)	2.2	(S)	0.97	8	8		-2.7	-18.11
(!) LDL Cholesterol mg/dL	GENERAL	78.22	(A)	5.21	(S)	0.39	274	274	150	13.8	91.77
	INSTRUMENT	88.26	(A)	5.88	(S)	3	6	6		10.5	69.95
	METHOD	79.27	(A)	5.29	(S)	0.97	46	46		13.4	89.23
(!) Triglycerides mg/dL	GENERAL	136.7	(A)	7.6	(S)	0.41	539	539	72	-8.5	-47.33
	INSTRUMENT	124.6	(A)	7.6	(S)	3.59	7	7		-6.9	-42.22
	METHOD	134.2	(A)	7.6	(S)	1.32	52	52		-8.2	-46.35
Urea mg/dL	GENERAL	42.74	(A)	2.85	(S)	0.15	571	571	44	0.4	2.95
	INSTRUMENT	43.39	(A)	2.89	(S)	1.28	8	8		0.2	1.41
(!) Uric Acid mg/dL	GENERAL	5.509	(A)	0.24	(S)	0.01	508	508	6.8	5.4	23.43

1.3 High deviation of the z-score in general group only

Possible Causes	Investigation
No instrument / method / reagent-specific peer group available	•Contact ESfEQA (surveys@esfeqa.eu)
Inaccuracy of the target value, e.g. caused by scattering of participant results	•Check the calculated uncertainty and comments in the EQA report
Instrument- (or method-, reagent-) specific target values for a specific analyte.	•Check the configuration and comments in the EQA report

Example 1.3

sample: **CC4_2024_02_b**

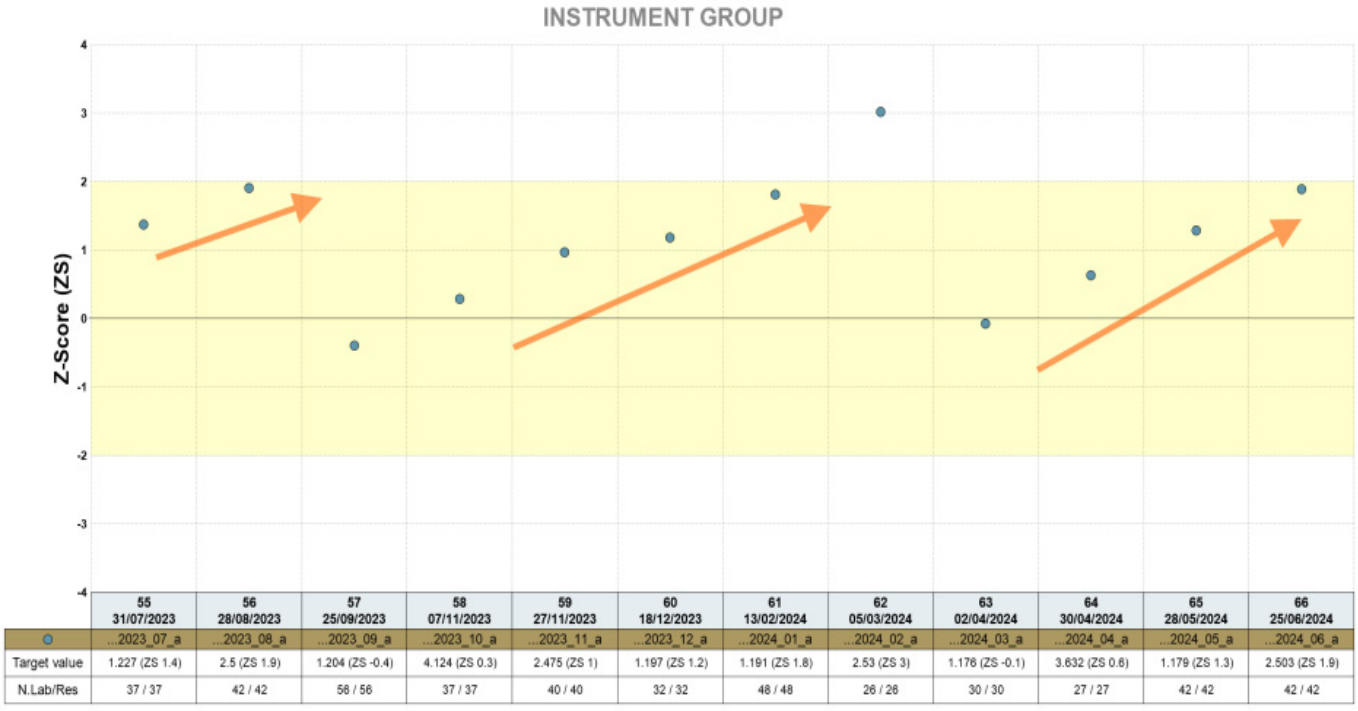
Parameter	Evaluation	Target value		SD		U	Number of Labs	Number of results	Lab result	Z-Score	BIAS [%]
Calcium (ionized) mmol/L	GENERAL	1.496	(A)	0.04	(S)	0.02	55	55	1.44	-1.2	-3.74
(!) Chloride (Cl) mmol/L	GENERAL	127.4	(A)	3.4	(S)	0.33	370	370	140	3.7	9.89
Creatinine mg/dL	GENERAL	4.729	(A)	0.3	(S)	0.02	564	564	4.8	0.2	1.5
	METHOD	4.641	(A)	0.29	(S)	0.02	343	343		0.5	3.43
(!) Glucose mg/dL	GENERAL	289.5	(A)	14.47	(S)	0.79	525	525	245	-3.1	-15.37
Potassium (K) mmol/L	GENERAL	6.565	(A)	0.18	(S)	0.02	388	388	6.6	0.2	0.53
Sodium (Na) mmol/L	GENERAL	167.5	(A)	2.79	(S)	0.37	384	384	170	0.9	1.49
(!) Urea mg/dL urea N	GENERAL	62.15	(A)	4.14	(S)	0.22	552	552	88	6.2	41.61

* (A) AlgoA, (G) Expert Group, (R) Reference value, (C) Certified Value, (S) Set by coordinator, (E) Experiment, (I) Interqartile, (N) Non robust sd

1.4 Positive or negative trend of the z-score over several EQAs cycles (Shewhart chart)

Possible Causes	Investigation
Ageing of reagent	•Check the expiration date and storage conditions of the reagent
Use of outdated calibration	•Check the validity of the calibration curve (expiry date of calibrator, calibration frequency)
Instrument maintenance	•Review the instrument manual for a solution or contact the manufacturer • Check if maintenance is required

Example 1.4

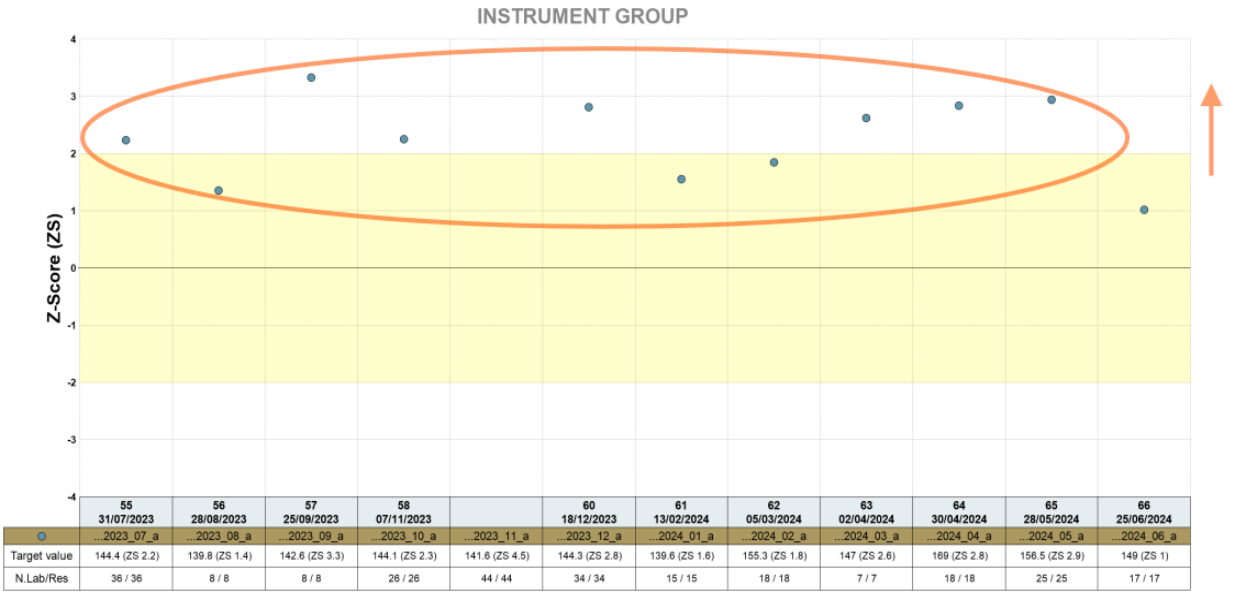


	55 31/07/2023	56 28/08/2023	57 25/09/2023	58 07/11/2023	59 27/11/2023	60 18/12/2023	61 13/02/2024	62 05/03/2024	63 02/04/2024	64 30/04/2024	65 28/05/2024	66 25/06/2024
	...2023_07_a	...2023_08_a	...2023_09_a	...2023_10_a	...2023_11_a	...2023_12_a	...2024_01_a	...2024_02_a	...2024_03_a	...2024_04_a	...2024_05_a	...2024_06_a
Target value	1.227 (ZS 1.4)	2.5 (ZS 1.9)	1.204 (ZS -0.4)	4.124 (ZS 0.3)	2.475 (ZS 1)	1.197 (ZS 1.2)	1.191 (ZS 1.8)	2.53 (ZS 3)	1.176 (ZS -0.1)	3.632 (ZS 0.8)	1.179 (ZS 1.3)	2.503 (ZS 1.9)
N.Lab/Res	37 / 37	42 / 42	56 / 56	37 / 37	40 / 40	32 / 32	48 / 48	26 / 26	30 / 30	27 / 27	42 / 42	42 / 42

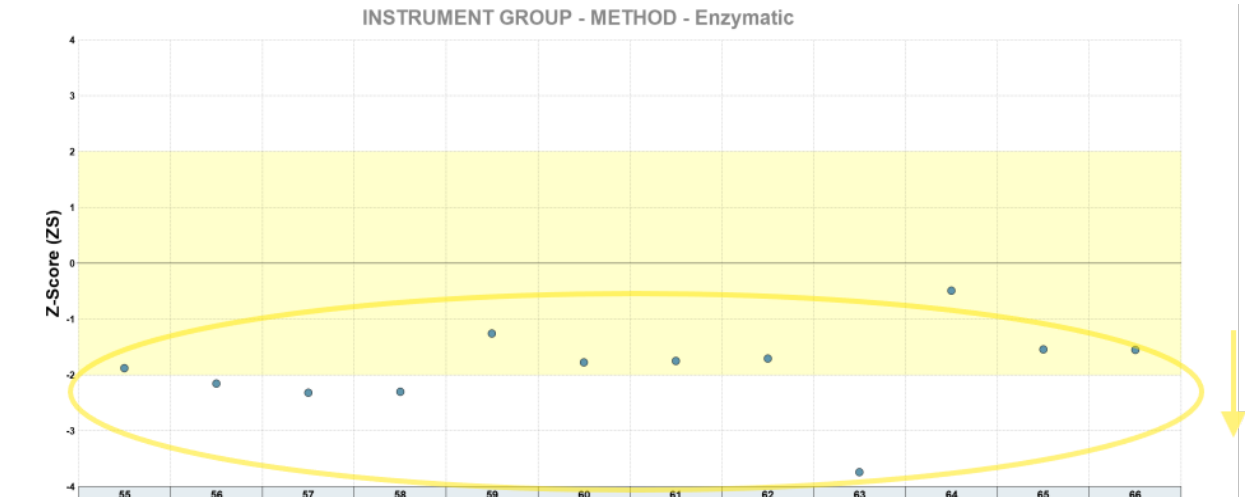
1.5 Consistent positive or negative z-score across EQAS cycles (Shewhart chart)

Possible Causes	Investigation
Use of outdated calibration	•Check the validity of the calibration curve (expiry date of calibrator, calibration frequency)
Instrument maintenance	•Review the instrument manual for a solution or contact the manufacturer • Check if maintenance is required
Improper operation of instrument	• Check instrument settings • Check for any instrument error messages • Check performance of the internal quality control

Example 1.5



	55 31/07/2023	56 28/08/2023	57 25/09/2023	58 07/11/2023		60 18/12/2023	61 13/02/2024	62 05/03/2024	63 02/04/2024	64 30/04/2024	65 28/05/2024	66 25/06/2024
	...2023_07_a	...2023_08_a	...2023_09_a	...2023_10_a	...2023_11_a	...2023_12_a	...2024_01_a	...2024_02_a	...2024_03_a	...2024_04_a	...2024_05_a	...2024_06_a
Target value	144.4 (ZS 2.2)	139.8 (ZS 1.4)	142.6 (ZS 3.3)	144.1 (ZS 2.3)	141.6 (ZS 4.5)	144.3 (ZS 2.8)	139.6 (ZS 1.6)	155.3 (ZS 1.8)	147 (ZS 2.6)	169 (ZS 2.8)	156.5 (ZS 2.9)	149 (ZS 1)
N.Lab/Res	36 / 36	8 / 8	8 / 8	26 / 26	44 / 44	34 / 34	15 / 15	18 / 18	7 / 7	18 / 18	25 / 25	17 / 17

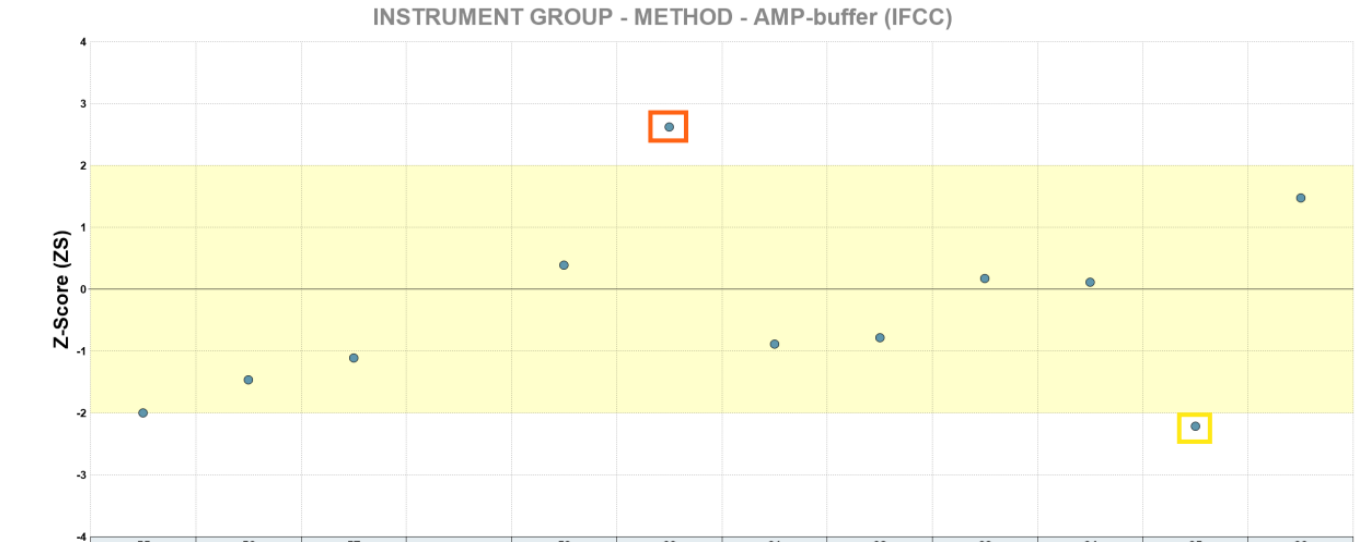


	55 31/07/2023	56 28/08/2023	57 25/09/2023	58 07/11/2023	59 27/11/2023	60 18/12/2023	61 13/02/2024	62 05/03/2024	63 02/04/2024	64 30/04/2024	65 28/05/2024	66 25/06/2024
	...2023_07_a	...2023_08_a	...2023_09_a	...2023_10_a	...2023_11_a	...2023_12_a	...2024_01_a	...2024_02_a	...2024_03_a	...2024_04_a	...2024_05_a	...2024_06_a
Target value	1.147 (ZS -1.9)	1.192 (ZS -2.2)	1.137 (ZS -2.3)	5.021 (ZS -2.3)	3.521 (ZS -1.3)	4.981 (ZS -1.8)	1.204 (ZS -1.8)	4.195 (ZS -1.7)	1.704 (ZS -3.7)	5.274 (ZS -0.5)	4.2 (ZS -1.5)	1.464 (ZS -1.5)
N.Lab/Res	21 / 21	10 / 10	11 / 11	19 / 19	18 / 18	29 / 29	20 / 20	20 / 20	13 / 13	23 / 23	33 / 33	24 / 24

1.6 Occasionally high deviation of z-score for individual analytes (Shewhart chart)

Possible Causes	Investigation
Occasional improper operation of the instrument	•Check for a pattern in re-occuring deviations (e.g. personnel, maintenance cycles, temperature, laboratory environment)
Incorrect reconstitution/preparation of EQA samples	•Check if ESfEQA IFU was followed correctly (volume, appropriate diluent) •Check if the correct IFU was used
Inappropriate handling or storage of the samples	• Check if the samples were handled according to the ESfEQA IFU •Check if the samples were stored according to the ESfEQA IFU •Check performance of other samples that were delivered in the same shipment
Concentration of samples at or beyond the measuring range of the application	• Check the linearity of your test by comparing the target value of the EQA sample with the measuring range of the analytical device, indicated in the IFU of the reagent

Example 1.6



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○	...2023_07_a	...2023_08_a	...2023_09_a	...2023_10_a	...2023_11_a	...2023_12_a	...2024_01_a	...2024_02_a	...2024_03_a	...2024_04_a	...2024_05_a	...2024_06_a
Target value	91.64 (ZS -2)	93.12 (ZS -1.5)	83.84 (ZS -1.1)	229.7 (ZS 4.5)	183.8 (ZS 0.4)	240.9 (ZS 2.6)	90.7 (ZS -0.9)	331.2 (ZS -0.8)	87.41 (ZS 0.2)	259.2 (ZS 0.1)	331.5 (ZS -2.2)	91.07 (ZS 1.5)
N.Lab/Res	18 / 18	10 / 10	10 / 10	18 / 18	13 / 13	27 / 27	23 / 23	19 / 19	13 / 13	21 / 21	28 / 28	20 / 20

2.0 Qualitative EQA

2.1 Qualitative results are incorrect

Possible Causes	Investigation
Recording error, e.g. selection of incorrect result from drop-down list during result submission in TEQA	•Compare raw data of instrument with submitted results in TEQA
Sample mismatch	•Check if the samples were mixed up. Check ID of samples 1a, 1b, etc
Use of inappropriate cut-off	•Check if the cut-off of the reagent matches the cut-off of the analyte description in Teqa • Check if the correct reference range (e.g. children, adults) was used
Insufficient sensitivity of the analytical device used	•Check comments in the EQA report •Check the sensitivity limit of the analytical device as described in the manual of the reagent/instrument
Improper operation of instrument	•Check maintenance issues •Check instrument is correctly calibrated •Check instrument settings •Check for any instrument error messages •Check performance of the internal quality control
Incorrect reconstitution/preparation of EQA samples	•Check if ESfEQA IFU was followed correctly (volume, appropriate diluent) •Check if the correct IFU was used
Submission error: results submitted for the wrong sample	•Check if the results were sent for the correct survey, e.g. results sent for sample 5a with data of sample 6a

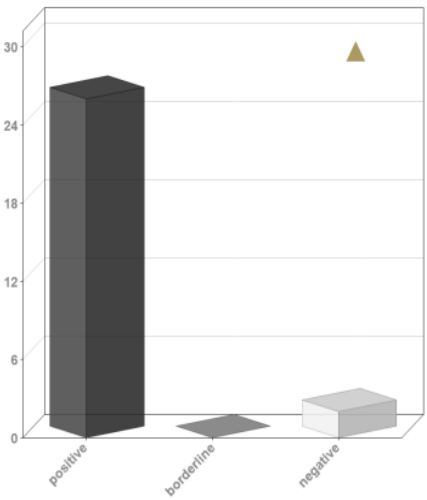
Example 2.0

sample: **HAV_2024_02_b**

Expected Result: **positive**

Evaluation	positive	borderline	negative
general	26	0	2
INSTRUMENT			
BIOTEK INSTRUMENTS ELISA reader	1	0	0
INSTRUMENT GROUP			
Roche Cobas	4	0	0
DIASORIN LIAISON (XL)	4	0	0
BECKMAN COULTER ACCESS/DXI	2	0	0
bioMérieux VIDAS/ mini VIDAS	2	0	0
Manual Testing	2	0	2
ABBOTT Architect	9	0	0
ERBA Mannheim	2	0	0

Lab result: **negative**



Handout

Handout for root cause analysis	
Laboratory Name:	EQA Program:
User:	Sample Identification:
Description of the observation (e.g. only one analyte have high z-score):	
Result of Root Cause Analysis:	
Result of Investigation:	
Corrective Action: ( )	Prevention Action : ( )
Analysis Date:	
Signature:	

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