

Harmonization of CBC evaluation criteria for European EQAS

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Comparison with other analytical goals

Parameter	WHO	Biological variability	CLIA	Opinion clinicians
RBC	4	4.4	6	
Hemoglobin	4	4.1	7	3.6
Hematocrit	4	4.1	6	5.4
MCV	5	2.3		3.2
WBC	10	14.6	15	16.4
TBC	15	13.4	25	
Reticulocytes	30	16.8		

* Skendzel et al. Am J Clin Pathol 1985; 83:200-205

Data cleaning and checking



- **435018** data collected from the different EQA organizers participating in the study.
- **422454** data left after blank results and rarely used analysers were removed.
- **279935** data left after removal of peer groups with multimodality.
- **273840** data free from outliers (6095 outliers were deleted)
- Peer groups with at least 10 results (**238933** data left)
- Data analysis was performed with **238933** results.

Number of results and samples per EQA organizer

EQA organizer	Number of results	Number of samples
ANSM (France)	19030	1
CSCQ (Switzerland)	161267	201
CTCB (France)	4476	8
DEKS (Denmark)	680	1
PNAEQ (Portugal)	18002	24
SEHH (Spain)	53980	20
UKNEQAS (England)	148834	36
WIV-ISP (Belgium)	16185	10
Total	422454	301

Number of analysers and results per parameter

Parameter	Number of analysers	Number of results
RBC	128	73404
HCT	140	75179
Hb	144	79025
MCV	138	57659
WBC	133	74445
RETIC(NBR)	41	11300
RETIC(%)	29	5633
TBC	124	45809
Total	-	422454

Statistical tools

- Characteristic function
- Quantile regression

Characteristic function

Thompson (2011, 2012)

TBC

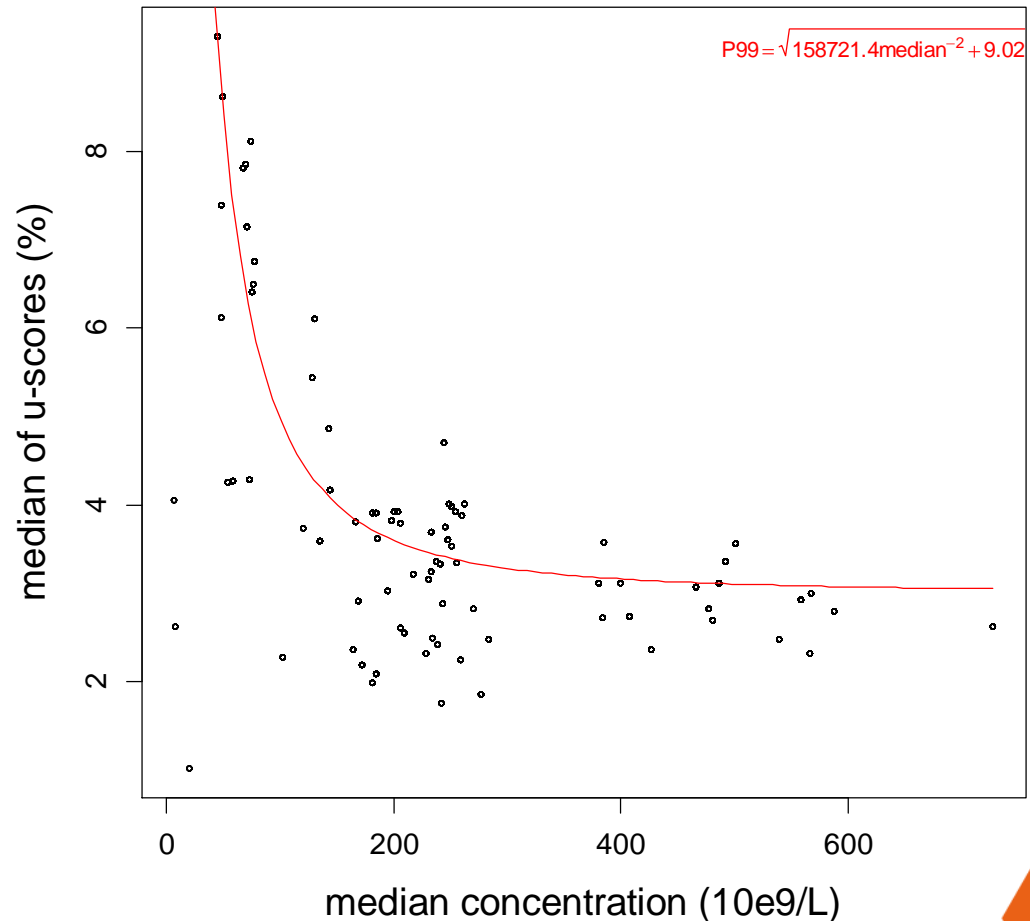
$$\square SD = \sqrt{\alpha^2 + \beta^2 \text{concentration}^2}$$

$$\square CV = \frac{SD}{\text{concentration}}$$
$$= \sqrt{\frac{\alpha^2}{\text{concentration}^2} + \beta^2}$$

(*100 to express in %)

α Determines relation for low concentrations.

β Determines relation for high concentrations.

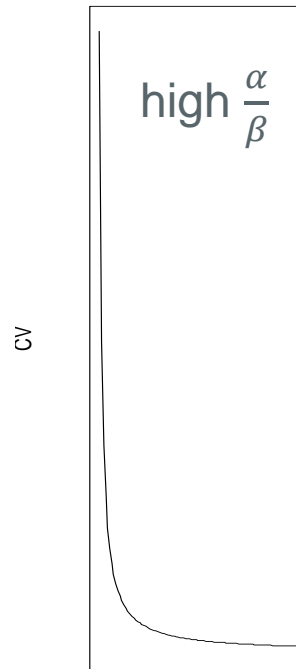


Characteristic function: comments

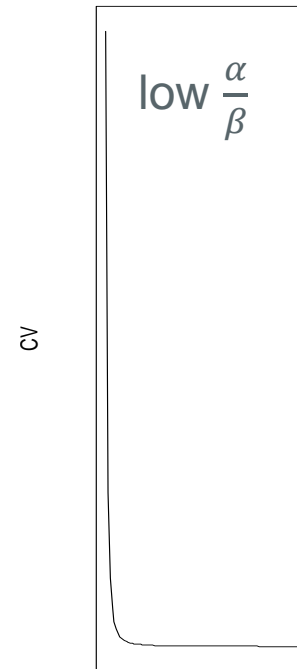
$$CV = \sqrt{\frac{\alpha^2}{\text{concentration}^2} + \beta^2}$$

(*100 to express in %)

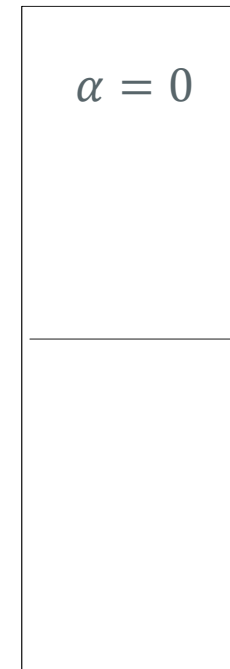
Curvature depends on $\frac{\alpha}{\beta}$
The higher $\frac{\alpha}{\beta}$, the more curved



concentration

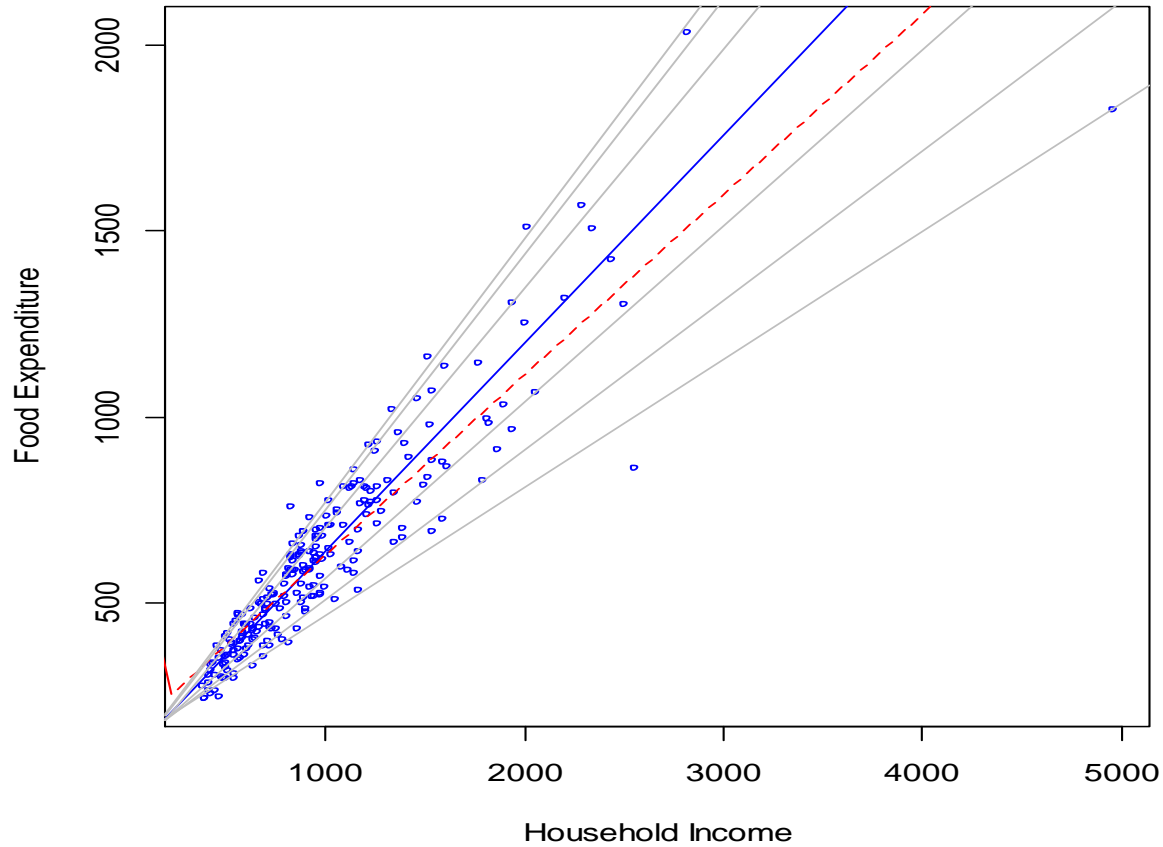


concentration



concentration

Quantile regression



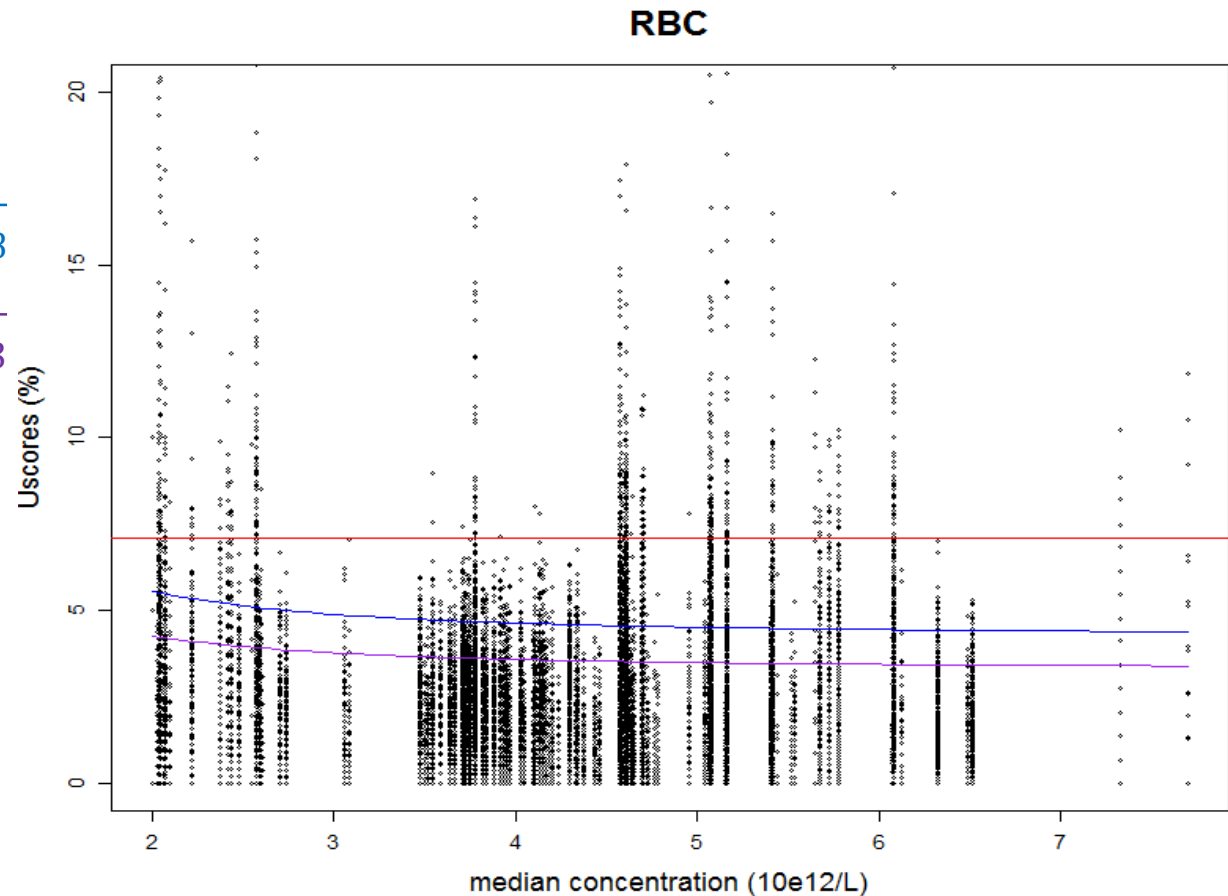
Red Blood Cells

□ $P99 = 7.11$

□ $P95 = \sqrt{\frac{49.53}{median^2} + 18.38}$

□ $P90 = \sqrt{\frac{28.82}{median^2} + 11.03}$

- 7% for the 99th percentile
- 5% for the 95th percentile
- 4% for the 90th percentile



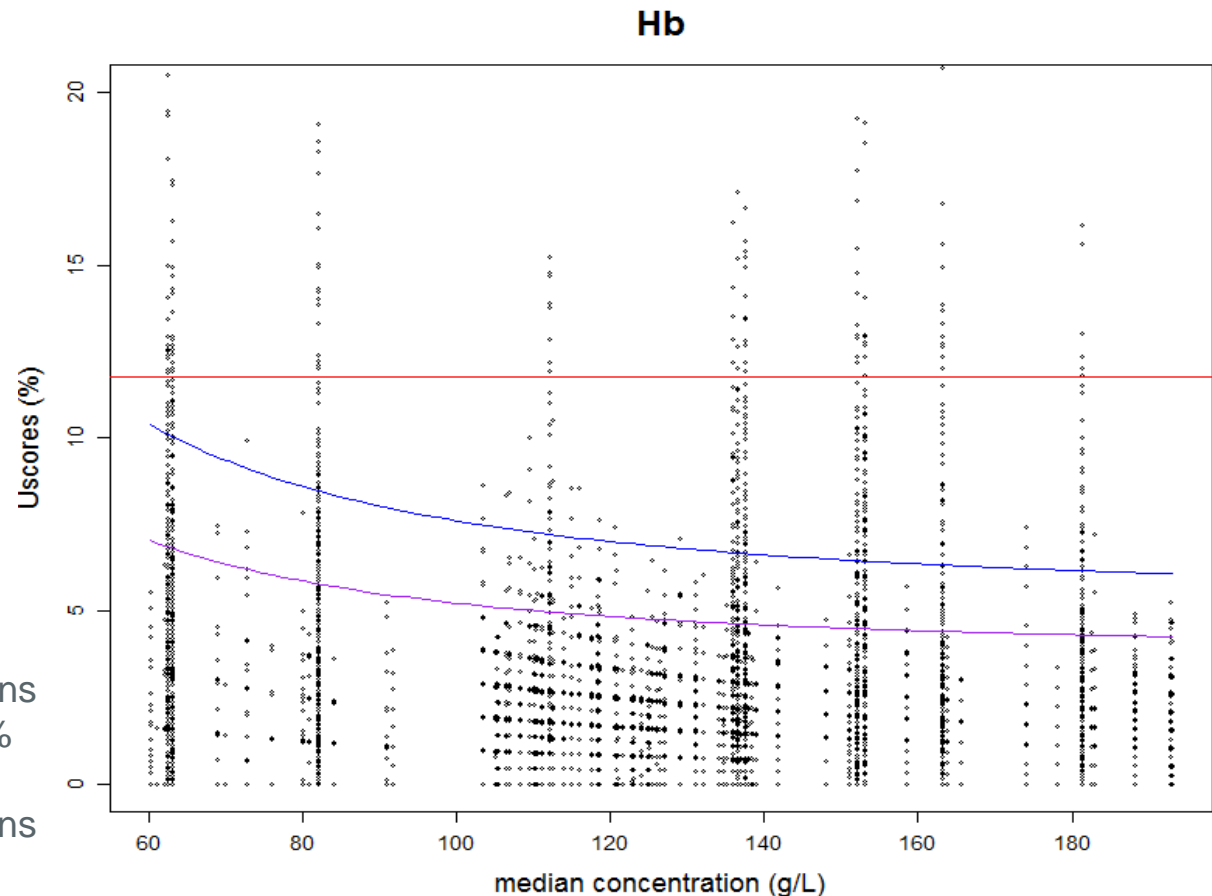
Hemoglobin

□ $P99 = 11.77$

□ $P95 = \sqrt{\frac{285032.4}{\text{median}^2}} + 29.35$

□ $P90 = \sqrt{\frac{125771.3}{\text{median}^2}} + 14.76$

- 12% for the 99th percentile
- 95th P : 8% for concentrations above 140g/L and up to 10% for lower concentrations.
- 90th P : 5% for concentrations above 140g/L and up to 7% for lower concentrations.



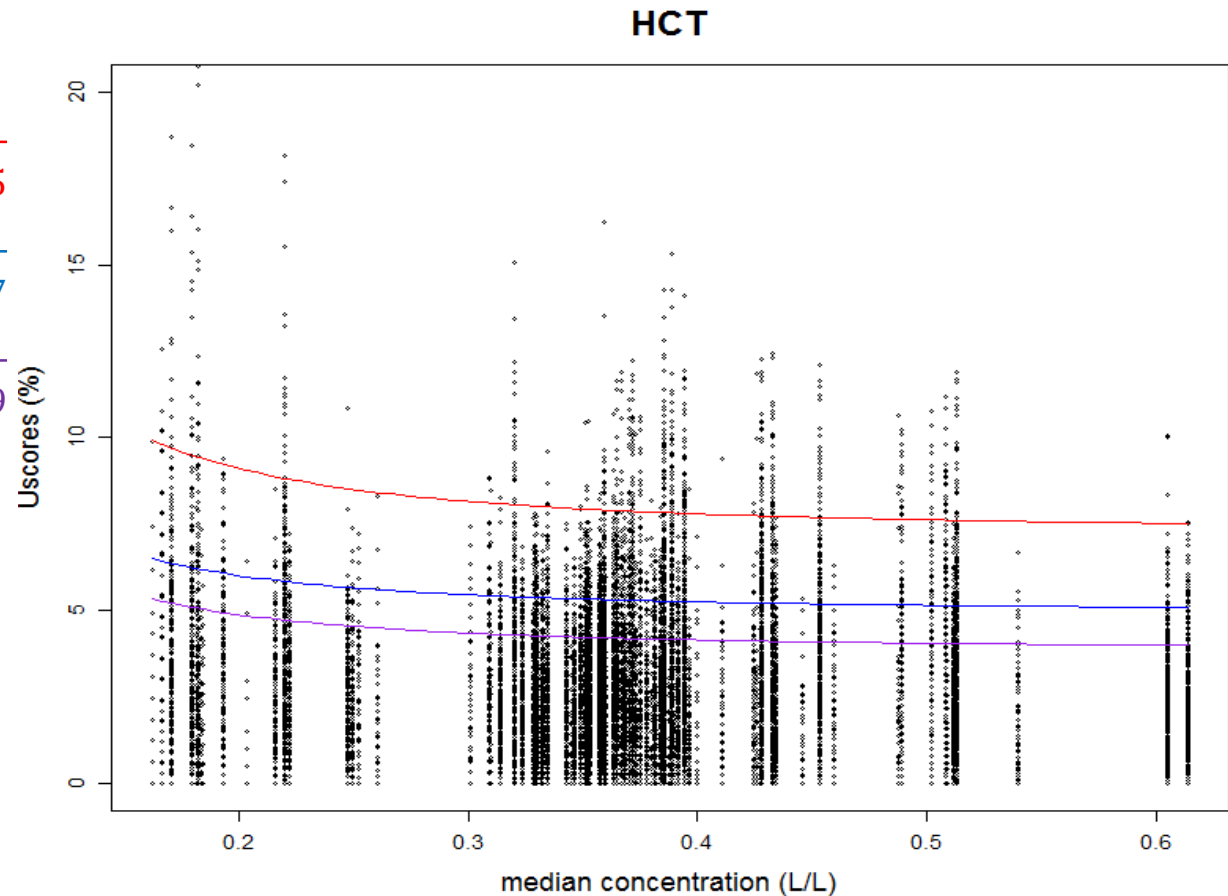
Hematocrit

$$\square P99 = \sqrt{\frac{1.18}{\text{median}^2} + 53.35}$$

$$\square P95 = \sqrt{\frac{0.46}{\text{median}^2} + 24.67}$$

$$\square P90 = \sqrt{\frac{0.35}{\text{median}^2} + 14.99}$$

- 9% for the 99th percentile
- 6% for the 95th percentile
- 5% for the 90th percentile



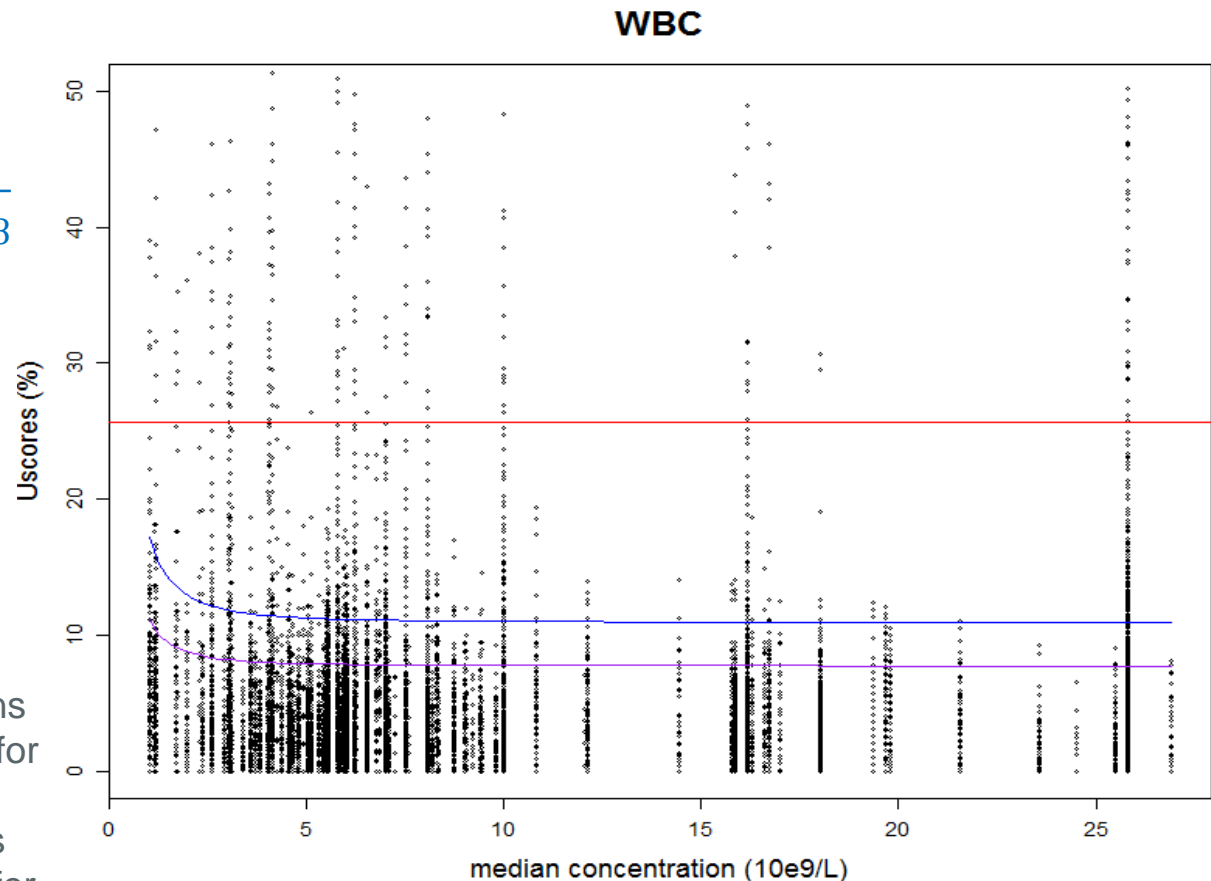
White Blood Cells

□ $P99 = 25.61$

□ $P95 = \sqrt{\frac{184.2}{\text{median}^2} + 119.78}$

□ $P90 = \sqrt{\frac{66.29}{\text{median}^2} + 60.05}$

- 26% for the 99th percentile
- 95th P : 12% for concentrations above $3 \cdot 10^9/L$ and up to 17% for lower concentrations.
- 90th P : 9% for concentrations above $3 \cdot 10^9/L$ and up to 11% for lower concentrations.



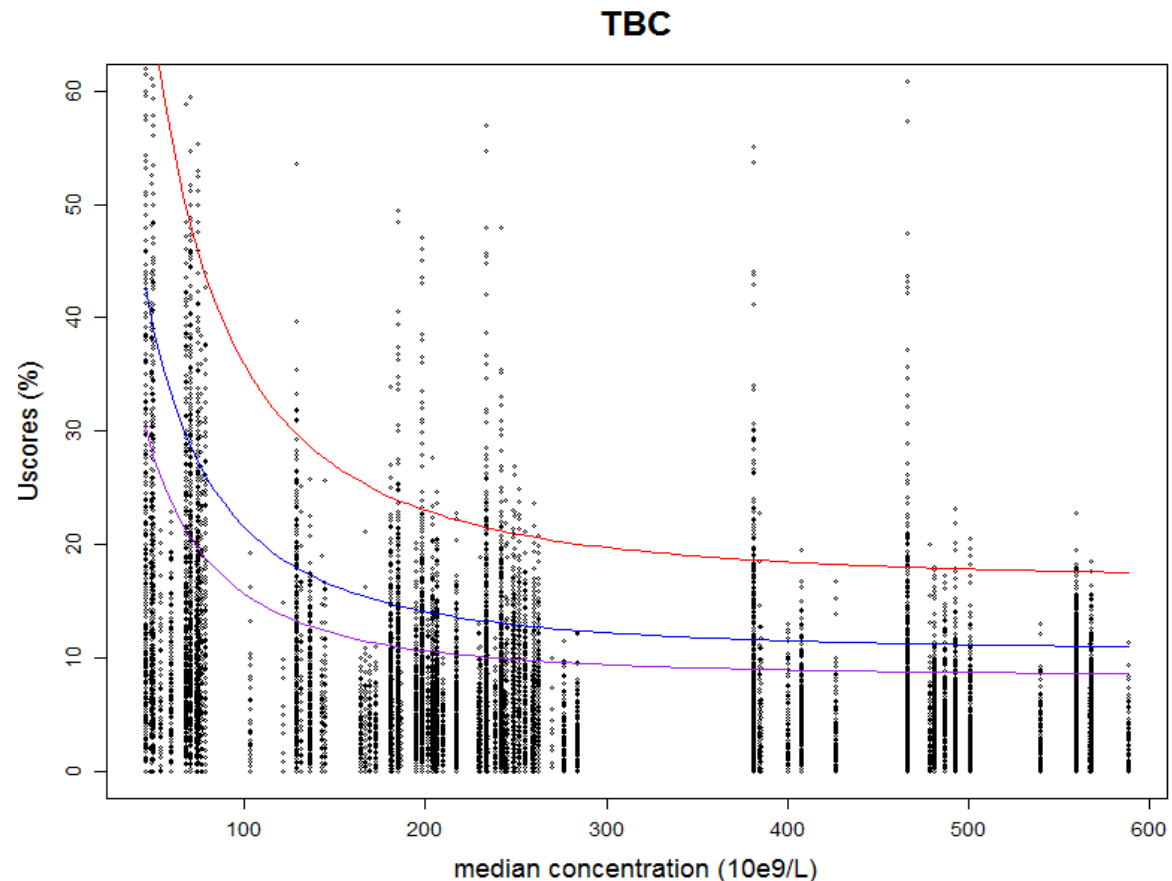
Thrombocytes

$$\square P99 = \sqrt{\frac{10044482}{\text{median}^2}} + 278.42$$

$$\square P95 = \sqrt{\frac{3506488}{\text{median}^2}} + 110.83$$

$$\square P90 = \sqrt{\frac{1755171}{\text{median}^2}} + 69.08$$

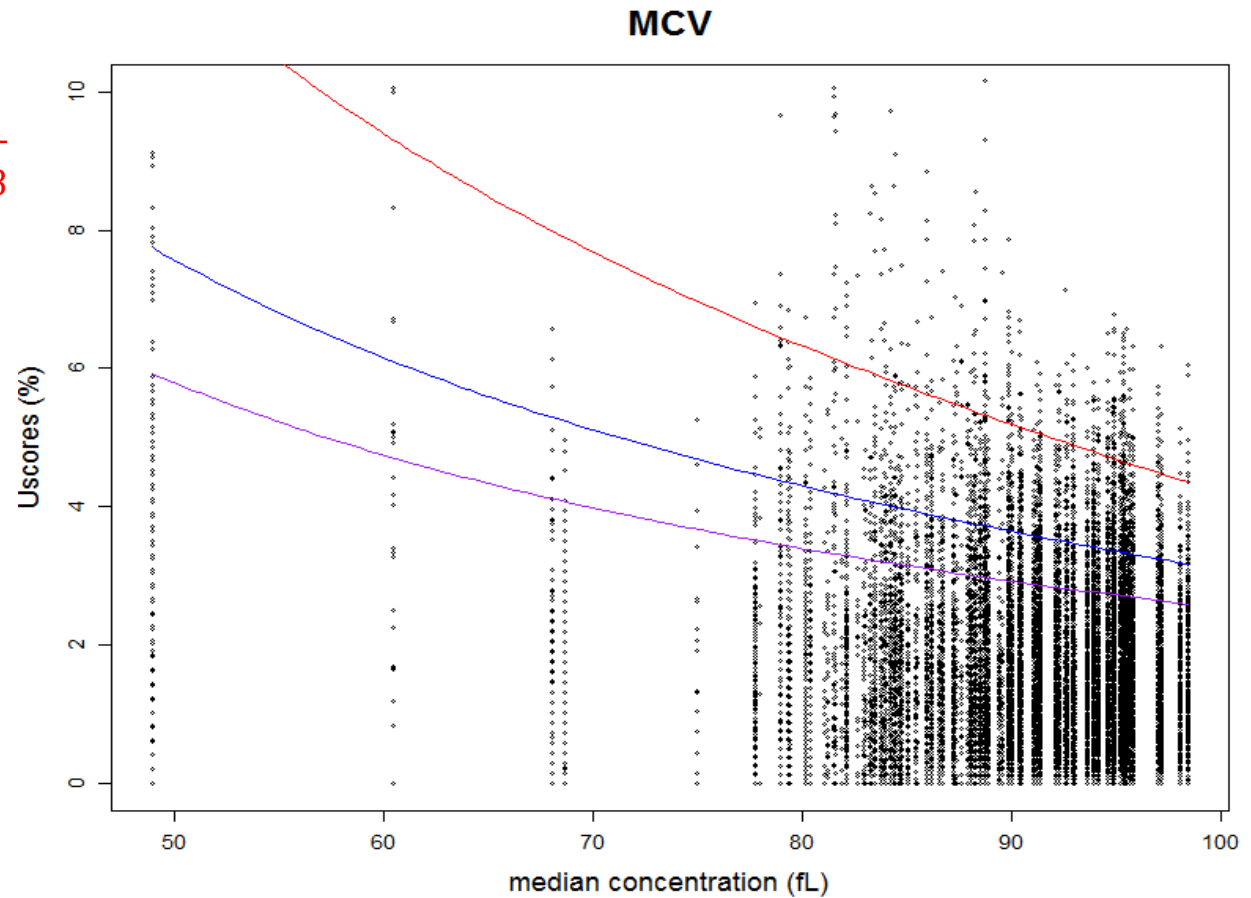
- 99th P : 20% for concentrations above 300.10⁹/L and up to 70% for lower concentrations.
- 95th P : 12% for concentrations above 300.10⁹/L and up to 43% for lower concentrations.
- 90th P : 10% for concentrations above 300.10⁹/L and up to 28% for lower concentrations.



$$\square P99 = \sqrt{\frac{397601}{\text{median}^2}} - 22.08$$

$$\square P95 = \sqrt{\frac{159279.9}{\text{median}^2}} - 6.38$$

$$\square P90 = \sqrt{\frac{90491.66}{\text{median}^2}} - 2.61$$



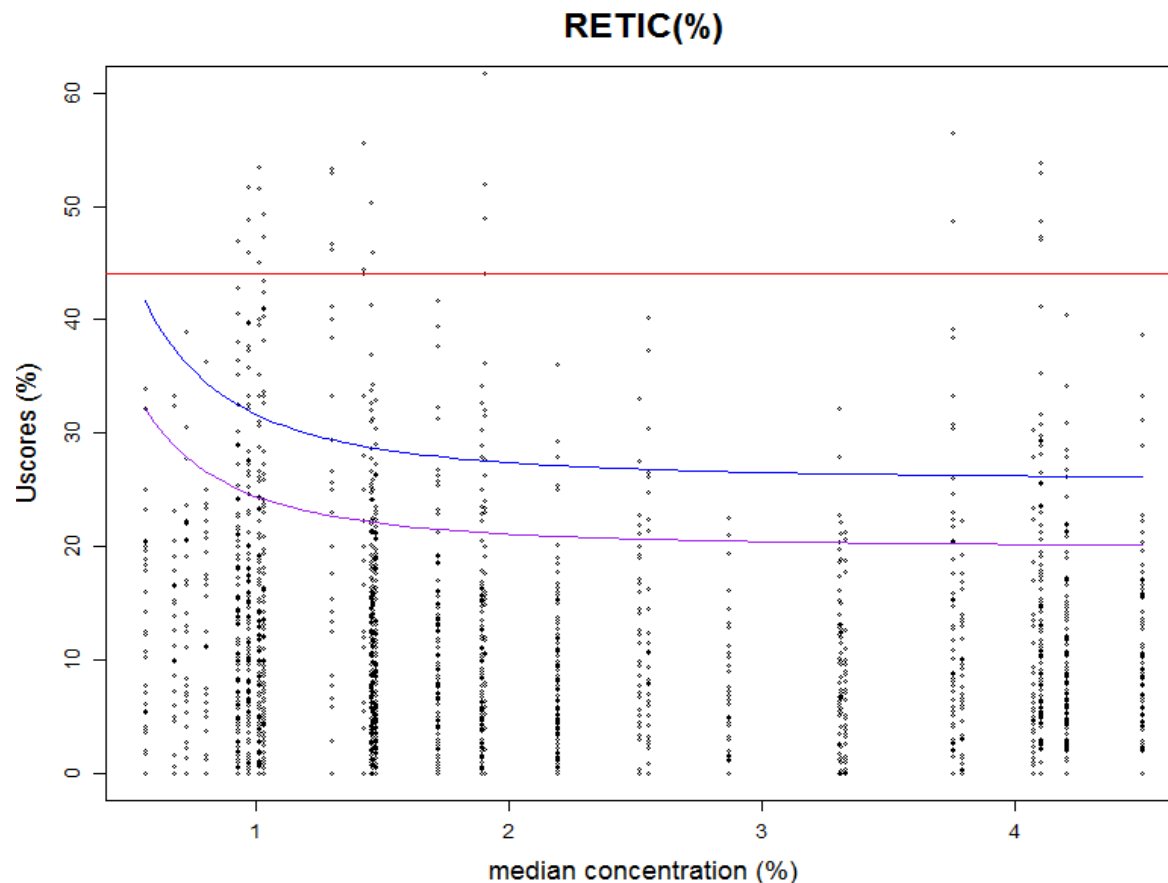
Reticulocytes (% RBC)

□ $P99 = 44.09$

□ $P95 = \sqrt{\frac{334.75}{median^2}} + 666.98$

□ $P90 = \sqrt{\frac{200.03}{median^2}} + 395.32$

- 44% for the 99th percentile
- 95th P : 28% for concentrations above 2.5% and up to 42% for lower concentrations.
- 90th P : 21% for concentrations above 2.5% and up to 32% for lower concentrations.



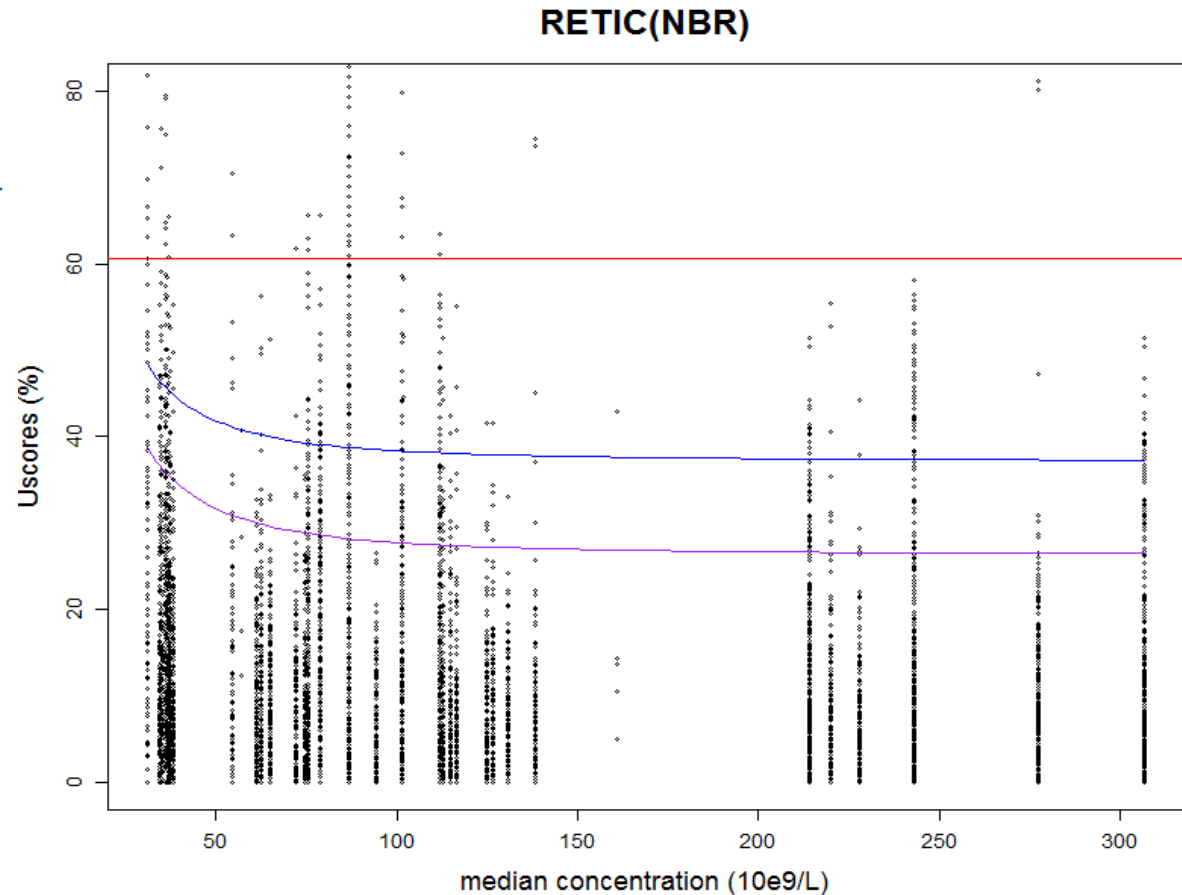
Reticulocytes (10⁹/L)

□ $P99 = 60.51$

□ $P95 = \sqrt{\frac{923073}{median^2}} + 1379.03$

□ $P90 = \sqrt{\frac{779570.2}{median^2}} + 691.42$

- 60% for the 99th percentile
- 95th P : 40% for concentrations above 100.10⁹/L and up to 50% for lower concentrations.
- 90th P : 30% for concentrations above 100.10⁹/L and up to 40% for lower concentrations.



Percentage of flagged results



Parameter	EQA limits	P99	P95	P90
RBC	1238 (1.7%)	1756 (2.4%)	3925 (5.4%)	6999 (9.7%)
HCT	1982 (2.7%)	2030 (2.8%)	4791 (6.6%)	8155 (11.2%)
Hb	2373 (5.1%)	1450 (3.1%)	2500 (5.4%)	4124 (8.9%)
MCV	927 (1.7%)	1078 (2%)	3200 (6%)	5972 (11.2%)
WBC	1563 (2.1%)	1011 (1.4%)	3080 (4.2%)	5965 (8.1%)
RETIC(NBR)	2548 (22.9%)	443 (4%)	860 (7.7%)	1367 (12.3%)
RETIC(%)	2053 (41.1%)	183 (3.7%)	350 (7%)	551 (11%)
TBC	2242 (5%)	1100 (2.5%)	2772 (6.2%)	4797 (10.8%)
Total	14926	9051	21478	37930

Still to be done

- comparing the percentage of bad performers per instrumentation.
- Matching our limits with the evaluation procedure currently used by EQA organizers.
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**Thank you for your
attention**