Externalization of Internal Quality Control in Hematology

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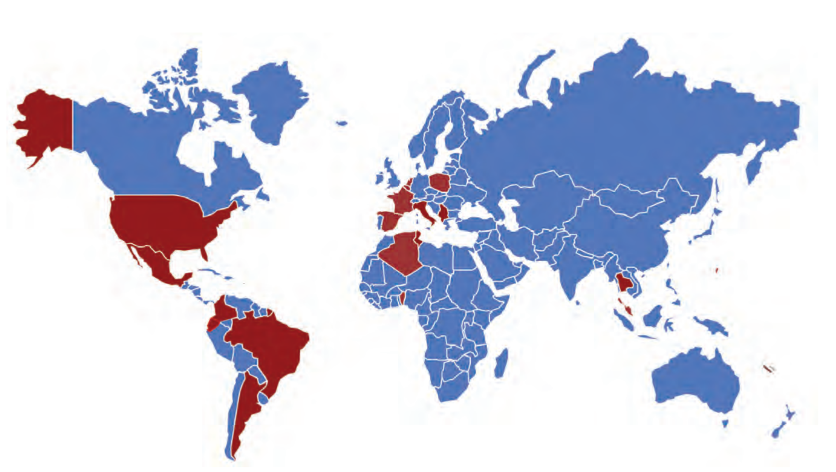
Introduction

The objectives of internal quality control are to detect immediate errors and monitor over time precision and accuracy of the method. However to lead an exhaustive self-evaluation, peer-related bias and relative imprecision should be taken into account. Standardization committees, such as the CLSI, suggest the integration of inter-laboratory programs in order to determine the individual laboratory bias relative to a peer group. This practice allows achieving two distinct but related aims. Inter-laboratory performances will delineate the optimum of the performances of the specific technology and define the state of art. Each laboratory can indeed evaluate and measure the individual results in comparison to the state of the art technology. In addition the inter-laboratory comparison consents the single laboratory to be aware of the relationship between the state of the art and the medical needs. Therefore participation in an inter-laboratory program provides an effective and real-time tool to complement external quality assessment programs (proficiency survey).
We present here the externalization of the internal quality control in HORIBA Medical hematology instruments.

Results

Six hundred (600) users in 26 countries regularly participate to QCP, providing more than 24,000 results that are processed every month.
The QCP provides a monthly report, comparing the lab results of the internal QC to the peers, and an annual report that allows to visualize the trend over the time. Finally some case studies are presented to exemplify the role of QCP to help the lab in quality assurance.



Material & Methods

The ABX Quality Control Program (QCP) is an online inter-laboratory comparison for all HORIBA Medical hematology customers that can be accessed at the website http://qcp.horiba-abx.com.
Each laboratory has an online account where quality control results can be submitted daily or monthly (detail or summary report) to externalize the internal control data.
All results are centralized and processed in real time for a preliminary follow-up and monthly for a final and more detailed report. At any time and in real time the user can access the preliminary report of comparison with the peer group. The preliminary report is updated day by day.
The peer groups are constituted of customers using the same type of control on analogous instruments. The mean value obtained worldwide defines the TRUE VALUE of each parameter.

The QCP reports:

. Results of the laboratory: average, CV and standard deviation of the Internal Quality Control (IQC)

and provides:

. Inter-laboratory comparison: the precision index (PI) and accuracy index (SDI or Z-score) are compared to a world group of similar analyzers.
. Calculation of the uncertainty: the uncertainty defines an interval around the measurement result within which the value of the measure can be confidently expected to lie.
. Evaluation of the performances through the Sigma values (Westgard, 2001): The "Sigma value" is the capacity of an analytical system calculated by the ratio between actual performances and required performances or medical needs, (Ricos & al). This is then compared to the Sigma Objective that defines the state of the art capacity in agreement with the medical needs (Total error allowable (TEa) =6).

Monthly report

Each laboratory, having submitted its data, receives a monthly report including its results of the IQC, the comparison indexes (PI et SDI orZ-score), to the peer group performances, and QCP alert if the values are outside the range, the uncertainty calculation and the sigma value.

IQC Results. Table 1 summarizes for each parameter for three levels (low, normal, high) the laboratory performance compared to peers.

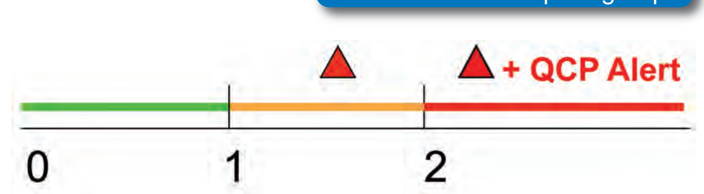
Table 1

Parameter		▲	Laboratory Mean	Laboratory CV	Laboratory SD	Group Mean	Comparison Precision	Comparison Z-score
WBC	L		2.20	1.82	0.04	2.23	0.45	-0.35
	N		7.60	1.45	0.11	7.46	0.48	0.63
	H		18.00	0.94	0.17	17.83	0.35	0.36
HCT	L		18.70	1.39	0.26	19.17	0.66	-1.20
	N		34.90	0.86	0.30	35.66	0.45	-1.12
	H		43.60	0.92	0.40	44.21	0.49	-0.75
MCV	L	▲	76.00	0.55	0.42	77.80	0.43	-1.84
	N	▲	78.00	0.47	0.37	79.85	0.37	-1.84
	H		85.00	0.66	0.56	86.25	0.53	-1.19

Precision Index interpretation

$$CVI = PI = \frac{CV_{Lab}}{CV_{peer\ group}}$$

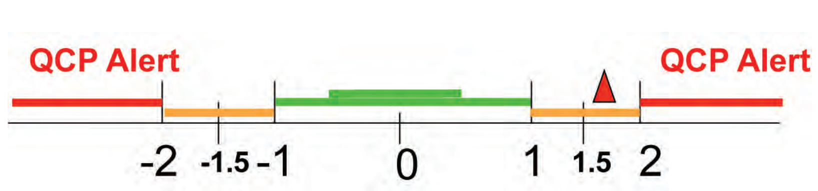
PI should be < 1 with optimal value at 0.5
If PI>1, a red alert triangle ▲ is triggered. If PI>2, in addition, a QCP alert is generated and informs the HORIBA Medical Technical Service in order to plan intervention and actions.



Z-score Index interpretation

$$SDI = Z\text{-}score = \frac{(\bar{X}_{Lab} - \bar{X}_{peer\ group})}{SD_{peer\ group}}$$

If -1.5< Z-score <1.5 results are acceptable with ideal value at 0. If the value falls between -1.5 and -2 or 1.5 and 2, a red alert triangle ▲ is triggered. If the value is <-2 or >2, in addtion, a QCP alert is generated and informs the Horiba Medical Technical Service in order to plan intervention and actions.



Inter-laboratory comparison. The graph (Fig.1) represents the level of precision (blue) and the accuracy (red) for all parameters of a lab compared to the peer mean indicated by the zero level. In this particular example, precision is correct, however, MCV accuracy and of course HCT are inaccurate. These representations, as shown below, allow to seize at a glance the global performance of the laboratory and distinguish the defective parameters in order to promptly plan actions.

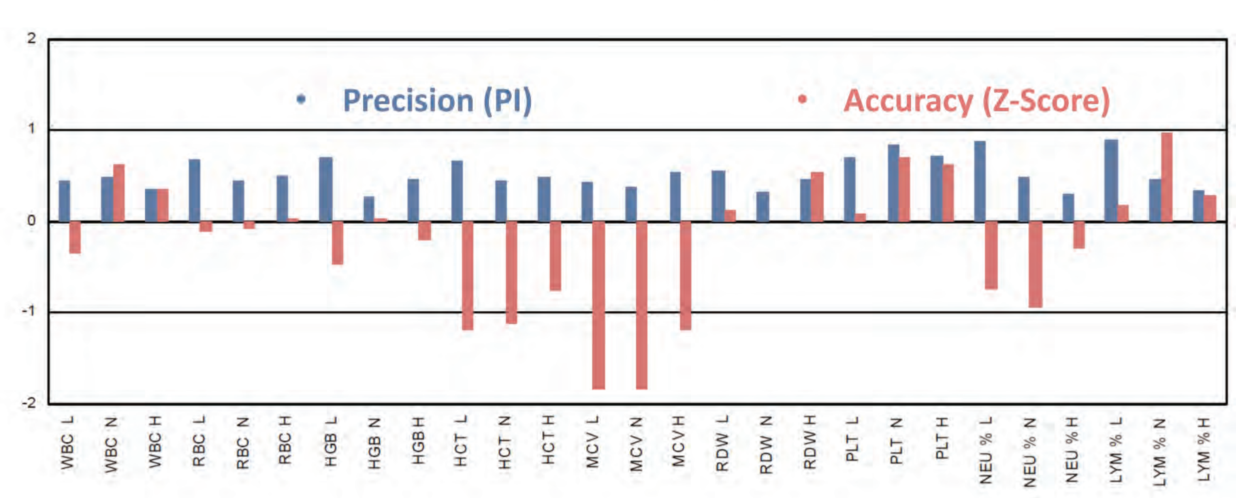


Fig.1

Uncertainty calculation

$$u(C)_{IQC} = \sqrt{\left(\frac{bias}{\sqrt{3}}\right)^2 + (SD)^2}$$

The uncertainty, required by ISO 15189, is automatically provided (Table 2).

Table 2

Parameter		Uncertainty R	Sigma Lab	Sigma Obj
WBC	L	2.20 +/- 0.09	7.37	7.33
	N	7.60 +/- 0.28	8.91	9.79
	H	18.00 +/- 0.39	14.67	10.99
HCT	L	18.70 +/- 0.75	1.21	3.99
	N	34.90 +/- 1.06	2.36	4.35
	H	43.60 +/- 1.07	3.05	4.49
MCV	L	76.00 +/- 2.24	0.23	3.88
	N	78.00 +/- 2.26	0.28	3.89
	H	85.00 +/- 1.83	1.56	4.05

Sigma calculation

$$Sigma\ obj = \frac{(TEa\ \%)}{0{,}5 \times CV\ \%}$$

$$Sigma = \frac{(TEa\ \% - bias\ \%)}{cv\ \%}$$

The Sigma Lab allows positioning the lab performances to the medical requirement where the Sigma Obj refers to the technological limits (Table 2).

Annual report

The annual report contains the same analysis as the monthly report but in addition permits to follow the progression of performances over the time; it also provides the uncertainty calculation taking into account the bias variability in that lapse of time.

WBC Level N

Period	Lot	Lab Result	Ref Val	SD	Bias	u(CIQ)
201102	PX011N	8	8.24	0.18	-0.24	0.23
201103	PX031N	7.9	7.85	0.21	0.05	0.21
201104	PX031N	7.8	7.83	0.16	-0.03	0.16
201105	PX051N	7.7	7.78	0.10	-0.08	0.11
201106	PX051N	7.7	7.77	0.13	-0.07	0.14
201107	PX071N	7.7	7.77	0.09	-0.07	0.10
201108	PX071N	7.6	7.71	0.10	-0.11	0.12
201109	PX091N	8.2	8.13	0.13	0.07	0.14
201110	PX091N	8.1	8.14	0.12	-0.04	0.12
201111	PX111N	7.6	7.69	0.10	-0.09	0.11
201112	PX111N	7.7	7.68	0.13	0.02	0.13
201201	PX012N	8	7.95	0.15	0.05	0.15

Table 3

The Fig 2 shows the monthly trend of the WBC parameter over a year.

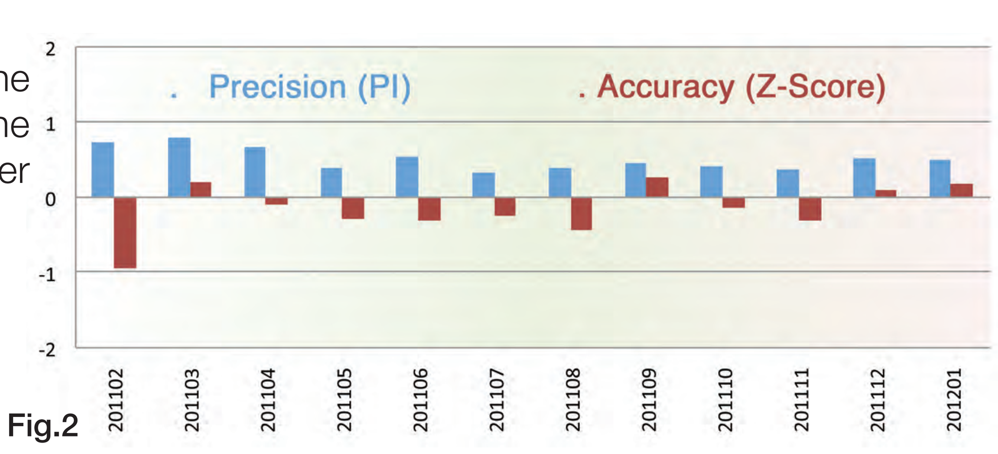


Fig.2

On Fig. 3, the Sigma monthly trends are displaid compared to the medical requirements (6 as green line) and the state of the art (8.6 as blue line).

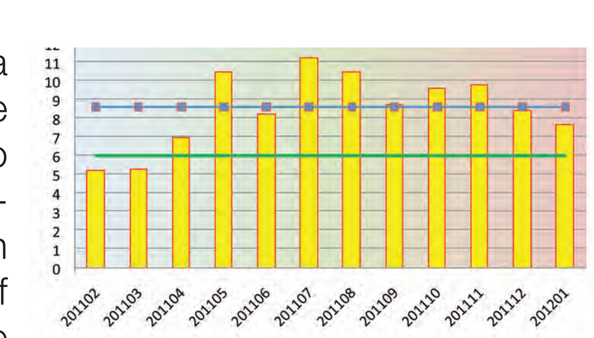


Fig.3

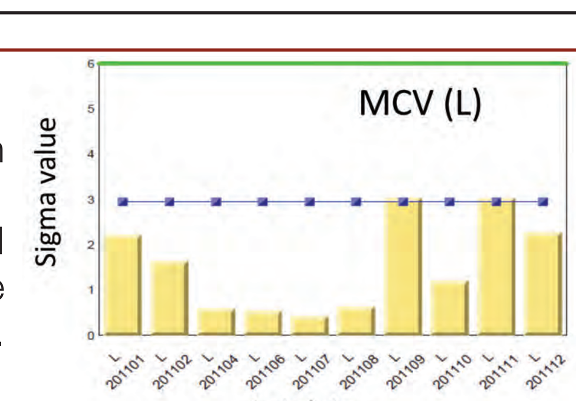
The uncertainty on the analytical results is recalculated taking into account the mean, the SD and bias over the year (Table 3). Table 4 shows statistical description of external quality assessment bias of normal level of WBC.

Table 4

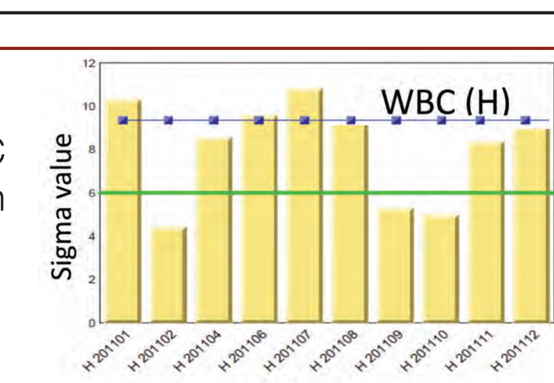
Mean of Bias	SD of Bias	Minimum	Maximum	Range of Bias	Number	u_c(CIQ+Ext)
-0.04	0.09	-0.24	0.07	0.31	12	0.17

Annual report

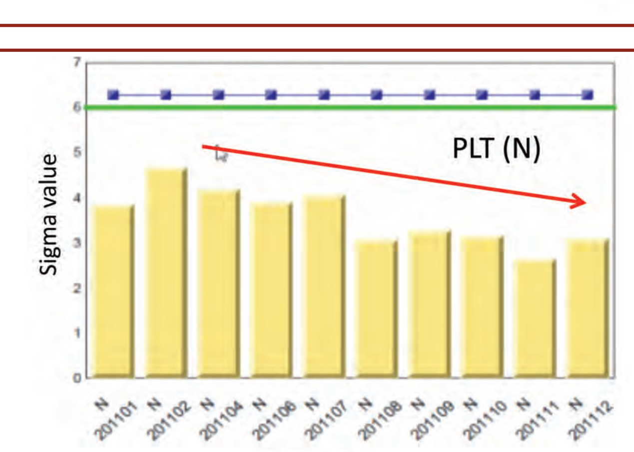
EXAMPLE 1
In the graph, the MCV of the IQC is not in agreement with the defined needs.
This may be due to the aknowledged fact that the control RBC are stabilized cells whose volume increases over the time. The state of the art is lower than the medical needs.



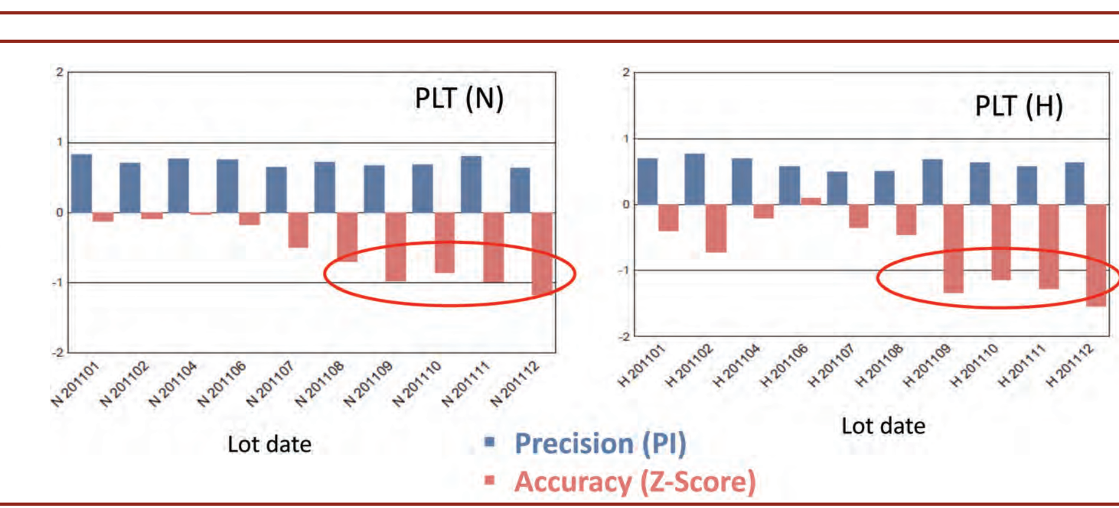
EXAMPLE 2
For other parameters such as WBC (H) of the IQC the performances of the instrument are better than the medical needs.



EXAMPLE 3
We show here that for the PLT (level N), the state of the art and the medical needs are similar.
However the performance of the instrument can be improved since the capability has been decreasing over the last year.



The SDI/PI graph shows that precision can be improved and that accuracy has been degrading over the last 6 months. The bias on the high level confirms this derivation.



Conclusions

The QCP is a powerful tool conceived to collect the laboratory results world-wide, make statistical elaboration based on the recognized recommendations and finally send a dedicated analysis back to each customers in real time and over a period of one year to visualize the progress of performances. Through these indexes, each lab precisely knows in which period and for which parameter actions must be realized and therefore it can define the adequate strategy.
Finally the QCP helps to improve the lab performance and contributes to meet the requirements of regulation and accreditation organizations by making statistical analysis .

Bibliography

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