Implementation of Internal Quality Control in Clinical Laboratories of Portuguese Speaking Countries

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INTRODUCTION

ProMeQuaLab (Laboratory Quality Improvement Project for Portuguese-Speaking Countries) is an ongoing project started in 2015, aiming to improve the quality of laboratory results in Portuguese-Speaking countries (PLP). It focuses on training in laboratory quality control, implementation and monitoring of quality indicators, and the organisation of a biennial congress.

In 2023, within the scope of ProMeQuaLab and in collaboration with the National Health Institute Doctor Ricardo Jorge (INSA) and the Faculty of Pharmacy of University of Lisbon, the Master's thesis "Development of tools and documentation for implementation of laboratory Quality Control in Portuguese-Speaking countries" is being carried out.

AIMS

- Development and application tools for implementation of Internal Quality Control (IQC) in the areas of Clinical Chemistry (CQ) and Haematology, in PLP laboratories, from February to August 2023.

MATERIAL

- **Remote Education** with: **1)** Presentation of thesis proposal **2)** Two training sessions and follow-up meetings concerning quality control **3)** Video demonstration of patient sample pool preparation.
- **Elaboration of Quality management documents**: **1)** Questionnaires to characterise the 7 participating laboratories from Cape Verde (n=3), Guinea Bissau (n=3) and S. Tomé and Príncipe (n=1); **2)** Patient blood collection procedure and preparation of serum pools (patient serum samples were used); **3)** IQC procedure and Working tools in Excel files (with formulas to calculate the coefficient of variation and standard deviation) in order to record results.
- **Control samples**: Commercial control samples (CCS), patient samples whole blood EDTA (PS) and patient pool serum (PPS) in area of CQ (glucose, creatinine, urea, aspartate aminotransferase (AST), total cholesterol and iron) and Haematology (haemoglobin, white blood cells, red blood cells, platelets).
- **Statistical Analysis** of reproducibility and repeatability of results from the participant laboratories was SD and CV%. Formulas used to evaluate the quality indicators, SD and CV%:

a) $SD = \sqrt{\frac{\sum d^2}{2n}}$ b) $SD = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n}}$ c) $CV(\%) = \frac{SD \times 100}{\bar{x}}$

(S.D. – standard deviation; d – difference between two determinations; n – number of samples; C.V – coefficient of variation), $\bar{x}$- média

- **Quality specifications:** reproducibility CV% results were compared based on the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM) biological variability.
- **Expert Laboratory**: INSA laboratories were expert in the validation of the methodology and the analysis of results.

RESULTS

- Presentation and divulgation of the work via email and Microsoft Teams, questionnaires were sent to 25 laboratories (5 in Cape Verde, 4 in Guinea Bissau, 8 in Angola, 3 in Mozambique and 5 in S. Tomé e Príncipe), of which 7 (28%) participated: 3 performed the IQC with commercial control samples (CCS) and patient samples (PS) , 3 with PS and 1 with CCS.
- The parameters that didn´t meet the minimum CV% specifications were creatinine (4.0 to 11.4), glucose (3.9 to 4.0), AST (7.4 to 7.8), and haemoglobin (2.1), results obtained from commercial and patient samples (Table 1). For the repeatability studies with patients samples, creatinine was the parameter with the highest variability, 6.2% (Table 2).
- The stability of the method/equipment has been evaluated by analysing 10 samples in two runs, approximately two hours apart. If the difference between the two determinations is ≤ 2SD, calculated using formula a), the run is acceptable. Two of the three participating laboratories, presented values with a statistically significant difference between measurements (>2DP), for the platelet parameter.

PARAMETERS	SAMPLE CONTROL	EXPERT LAB		REPRODUCIBILITY CV (%)					SPECIFICATIONS EFLM (MINIMUM /DESIRED/OPTIMAL) CV %
		N	MEDIA VALUE	EXPERT Lab	Lab 1	Lab 2	Lab 3	Lab 4	
CREATININE mg/dL	Serum pool patient	25	0.7	4.4	5.7	-	-	11.4	3.4 / 2.3 / 1.1
	Commercial level 1	17	1.0	1.7	5.9	8.4	-	6.4	
	Commercial level 2	17	3.8	1.9	4.0	8.1	-	-	
UREA mg/dL	Serum pool patient	25	41.4	5.6	3.4	-	-	5.0	10.4 / 7.0 / 3.5
	Commercial level 1	17	39.5	2.8	3.6	5.4	-	4.2	
	Commercial level 2	17	119.7	2.5	1.9	5.1	-	-	
GLUCOSE mg/dL	Serum pool patient	25	85.6	2.5	2.5	-	-	-	3.8 / 2.5 / 1.3
	Commercial level 1	17	103.1	2.4	3.3	4.0	-	3.8	
	Commercial level 2	17	244.4	2.9	2.0	3.9	-	-	
AST UI/L	Serum pool patient	25	14.6	3.3	7.8	-	-	-	7.2 / 4.8 / 2.4
	Commercial level 1	17	45.1	0.7	5.1	7.4	-	5.6	
	Commercial level 2	17	142.0	1.1	4.8	5.7	-	-	
TOTAL CHOLESTEROL mg/dL	Serum pool patient	25	203.6	1.7	3.8	-	-	-	4.0 / 2.6 / 1.3
	Commercial level 1	17	104.3	1.5	1.3	3.9	-	3.9	
	Commercial level 2	17	165.4	1.5	1.3	3.9	-	-	
IRON mg/dL	Serum pool patient	25	82.2	6.6	8.0	-	-	6.7	15.5 / 10.3 / 5.2
	Commercial level 1	17	112.1	3.4	9.2	6.8	-	9.6	
	Commercial level 2	17	247.3	1.9	2.1	4.4	-	-	
HAEMOGLOBIN g/dL	Commercial level 1	33	4.2	0.7	1.6	0.9	2.1	-	2.0 / 1.4 / 0.7
	Commercial level 2	33	11.2	0.5	1.8	0.5		-	
	Commercial level 3	33	15.7	0.6	-	-	-	-	
WBC $X10^9$/L	Commercial level 1	33	3.3	2.0	5.4	1.4	5.2	-	8.1 / 5.4 / 2.7
	Commercial level 2	33	19.5	1.2	6.1	1.6	5.8	-	
	Commercial level 3	33	9.1	1.7	-	-	-	-	
RBC $X10^{12}$/L	Commercial level 1	33	1.6	0.6	1.4	2.0	0.6	-	2.0 / 1.3 / 0.7
	Commercial level 2	33	3.8	0.9	0.4	0.9	1.3	-	
	Commercial level 3	33	5.5	1.1	-	-	-	-	
PLATELETS $X10^9$/L	Commercial level 1	33	71.3	1.3	3.2	3.4	4.4	-	5.7 / 3.8 / 1.9
	Commercial level 2	33	443.2	1.7	1.3	1.6	4.7	-	
	Commercial level 3	33	227.5	2.2	-	-	-	-	

Table 1 – Coefficient of variation (CV%) of the participants (Lab 1 from S. Tomé e Príncipe; Lab 2 Lab 3 and Lab 4 – laboratories from Cape Verde) and expert laboratories obtained by reproducibility studies, with serum pool and commercial samples control for the chemistry and haematological parameters, and quality specifications. N= number of determination in different days.

PARAMETERS	SAMPLE CONTROL	REPEATABILITY (CV%) N=10			
		EXPERT Lab	Lab 1	Lab 2	Lab 3
CREATININE mg/dL	PPS	2.3	6.2	2	-
UREA mg/dL	PPS	1.1	3.2	0.8	-
GLUCOSE mg/dL	PPS	1.5	1.9	0.9	-
AST UI/L	PPS	0	1.5	1.3	-
TOTAL CHOLESTEROL mg/dL	PPS	0.7	1.8	0.7	-
IRON mg/dL	PPS	1.8	4	1.3	-
HAEMOGLOBIN g/dL	PS	1	1.8	0.4	0.6
WBC $X10^9$/L	PS	2.1	2	1.2	2.1
RBC $X10^{12}$/L	PS	1.1	2.4	4.5	0.6
PLATELETS $X10^9$/L	PS	1.8	3.8	3	4.3

Table 2- – Coefficient of variation (CV%) of the participants (Lab 1 from S. Tomé e Príncipe; Lab 2 and Lab 3– laboratories from Cape Verde) and expert laboratories obtain by repeatability studies, with serum pool samples (PPS) and whole blood in EDTA (PS). N= number of determinations in the same day.

CONCLUSION

It is necessary to raise awareness of the importance of performing the IQC to monitor and improve laboratory performance, in order to promote the increased participation of PLP laboratories in this study.

The use of patient samples (individually or in pools) as an alternative to commercial samples in case of unavailability was found to be useful to monitor the reproducibility of results.

Remote training has increased the capacity of laboratory health professionals to implement IQC according to their capacity/resources.

The evaluation of the reproducibility of the results, by analysing the CV%, generally showed compliance with the minimum specifications. However, it is necessary to carry out a detailed analysis of the improvement actions to be implemented, as well as to continue the training and monitoring of the participating laboratories in order to improve the quality of laboratory results.

BIBLIOGRAPHIC REFERENCES

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