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Background: During laboratory procedures, errors are frequent and continue to be a serious problem for health services, quality standards and patient safety (1). Most of the studies that have been carried out suggest that the majority of errors occur in the pre-analytical stage of the process (2), representing approximately 46-68% of all errors (3). In this phase errors can be found in the study request form, in the identification of the patient, in the identification labels of the tubes, in the collection of the sample, in the incorrect handling of samples and in their transport (4). Automation using software and the improvement in infrastructure has been shown to reduce human errors in systematic procedures in various areas including health systems (5). The objective of this study was to design and test a software to prevent errors in the pre-analytical phase during the sampling process.

Methods: Based on an initial monitoring during March to July of 2017, cumulative errors were measured during the collection of samples (for HIV-1 viral load quantification and CD4 and CD8 cell count) in 4 Mexican centers that belong to the national HIV program. After applying surveys regarding the process, we proceeded with the development of a new software that certifies the correct identification of samples, based on previous records contained in a database. The software was implemented in two of the four centers (Tampico and Tlaxcala). In the other two (Reynosa and Queretaro) it could not be implemented due to logistical reasons and we used them as control sites. Measurements and monitoring were made of the type of error and the number of errors presented in each of the participating centers during the period from August to December 2017. Subsequently, the analysis of the measurements collected was carried out. Data was analyzed with Chi-square (MedCalc®, v17.8.6).

Results: Previous baseline monitoring revealed a cumulative proportion of errors of 10.23% (range 2.3 - 21.1%, n = 2944 samples) in the four centers. In the centers in which the strategy was implemented, the proportion of errors decreased from 13.78% to 5.34% (p <0.0001), while in the control group the proportion of errors increased from 8.47% to 11.22% (p = 0.0118) as showed in Fig. 1. The analysis showed that the implementation of the software was associated with the presence of fewer errors in the centers (p <0.0001). The highest identified proportion of errors occurred during the printing of the labels in the 5 months follow-up (4.35%) versus the list errors (3.53%). Results by each of the sites are showed in Table 1.

Fig. 1. Overall reduction of errors after strategy implementation

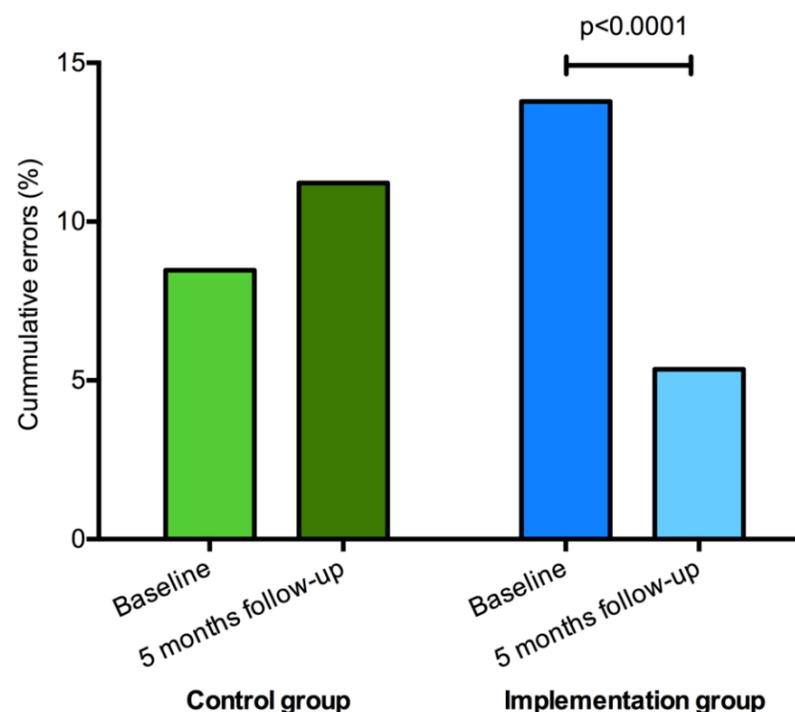


Table 1. Proportion of errors in each site at baseline and 5-month follow-up

Center	Baseline (n)	5-month follow-up (n)	p
Tampico*	21.18 (867)	7.42 (984)	<0.0001
Tlaxcala*	2.32 (591)	1.98 (606)	0.6851
Reynosa*	9.67 (607)	9.79 (521)	0.946
Queretaro ⁺	7.76 (879)	12 (975)	0.0024

*Implementation site; +control site.

Conclusions: The analysis showed a reduction of 8.44% in the errors that were associated with the implementation of the software in the participating centers. One of these, Tampico, with the highest basal error rate (21.18%) showed a reduction of 13.76%. In the center of Tlaxcala, the error rate remained without significant changes (with a reduction of 0.34%), so we consider that the use of our software was not associated with an increase in the frequency of errors. The persistence of this proportion of error in Tlaxcala is possibly associated with other types of errors within the workflow in the site. In this case, other types of strategies in order to reduce these particular errors inside the center could be recommended.

Our strategy proved to be effective in reducing errors during the pre-analytical phase and can be extended to other sampling centers to improve the healthcare services for patients with HIV/AIDS. We consider that this strategy could also be useful for centers that require sending a large number of samples to central or reference laboratories regardless of the area of expertise.

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