Final report on the situation analysis of the information systems of supranational laboratories, national reference laboratories, and national networks of TB laboratories in 17 countries.

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Abbreviations

BK	Baciloscopy (Sputum Smear Test)
SWOT	Weaknesses, Opportunities, Strengths, and Threats
EQA	External Quality Assessment
GTRL-TB	Regional Working Group of TB Laboratories
OR	Operational Research
NRL	National Reference Laboratory
LSN	Laboratories Supranational
MDR	Multidrug-resistant
MTB	Mycobacterium tuberculosis
MyE	Monitoring and Evaluation
PAHO	Panamerican Health Organization
PCR	Polymerase chain reaction
DST	Drug Susceptibility Testing
NTP	National Tuberculosis Program
RIF	Rifampicin
MR	Main Recipient
SR	Sub Recipient
NLN	National Laboratory Network
TB	Tuberculosis
TB-DR	Tuberculosis Drug-Resistant
VIH	human immunodeficiency virus (HIV)
PHS	Public Health Surveillance

1. Executive Summary

Analyze the situation of the information systems of the tuberculosis LSN, NRL and NLN in the 17 countries participating in the regional project of the Global Fund to Fight AIDS, Tuberculosis and Malaria, for the "Strengthening of the network of tuberculosis laboratories in the region of the Americas" 2020-2023, would allow proposing solutions to overcome the weaknesses found. This multi-country grant has among its objectives to contribute to the development, harmonization and implementation of information systems in national and regional networks of TB laboratories, with an interprogrammatic approach.

To collect the information, a survey was applied with variables that make it possible to identify the current state of the information systems of the LSN, NRL and the 17 NLN. The survey was previously validated by experts whose contributions were considered to adjust the final version that was sent to the LSN and NRL coordinators during the months of November and December of the year 2022.
The results allowed to have an updated panorama of the information systems in technological, management aspects, of the different implementation processes, availability, possibility of analysis, diffusion, and appropriation of the knowledge of the activities of the laboratory in the NRL and the NLN, and its articulation with the NTPs of the 17 countries.

The analysis carried out contributes to the generation of strategies to strengthen the information systems, based on the gaps identified, the needs, opportunities, and particular strengths of the LRN and RNL of each country.

2. Introduction

The "End TB Strategy" aims to eliminate the global tuberculosis epidemic as a public health problem by reducing the number of deaths by 95% and the incidence rate by 90% between 2015 and 2035, ensuring that no family has to face catastrophic expenses due to tuberculosis.

The End TB strategy has 10 components organized into 3 pillars and 4 principles. Within its components are defined early diagnosis, including DST; a universal health coverage policy and regulatory frameworks for case notification, quality, and rational use of medicines; the development and application of new instruments, interventions, strategies and operational research to promote innovation supported by appropriate technological tools for the registration, analysis and generation of new knowledge of data in laboratories in a timely manner.

The information system of the LSN and NRL includes formats, tools, software, information flows and human talent necessary to collect, consolidate, process and disseminate data related to the execution of laboratory activities in a timely, efficient and effective manner, with in order to enable decision-making through monitoring and evaluation processes.

3. Background

Between 2017 and 2019, ORAS-CONHU was the main recipient (MR) of the regional grant from the Global Fund to Fight AIDS, Tuberculosis and Malaria (GF), for the technical-managerial strengthening of tuberculosis laboratory networks. in the region, in which 20 countries of the Americas participated. The Executive Secretariat of the Council of Ministers of Health of Central America and the Dominican Republic (SE-COMISCA) and the Pan American Health Organization / World Health Organization (PAHO/WHO) participated as sub-recipients (SR).

The three institutions were responsible for the execution of activities at the level of the 20 countries. PAHO/WHO stands out as a technical entity for the interventions carried out, ORAS-CONHU and SE-COMISCA are intergovernmental instances of integration in health in their respective subregions, for which reason they had an important political weight in the construction of the sustainability of the actions developed during the implementation of the project.

From November 1, 2020, to October 31, 2023, ORAS-CONHU as MR and SE-COMISCA and PAHO/WHO as SR, are the implementers of a new regional grant from the GF to continue strengthening the laboratory diagnosis of TB, on this occasion in 17 countries of the Americas. Of these, 15 were part of the 2017-2019 project and there are 2 recently incorporated: Haiti and Suriname.

The current grant "Strengthening Laboratory Diagnosis of Tuberculosis in the Region of the Americas" has the general objective of contributing to improving the quality of TB diagnosis in laboratory networks in the Americas by strengthening installed capacity in the region; being its specific objectives: i) Consolidate the commitment of the countries with the sustainability of the Supranational (LSN) and National (LRN) Reference Laboratories through the monitoring of activities and the development of capacity in terms of management and promotion. ii) Promote the adoption of international recommendations regarding the diagnosis of TB in national health policies and their implementation. iii) Contribute to the development, harmonization, and implementation of information systems, connectivity, and multiple platforms in national and regional TB laboratory networks, with an interprogrammatic approach.

The activities to strengthen the information systems of the LSN/NRL and the National Tuberculosis Programs (NTP) of the 17 countries have focused on strengthening the quality of the data, the analysis of the information, and the monitoring and evaluation of indicators of each country.

The information systems component in the first phase of the grant included: analysis of the situation of information systems in the 20 countries, an international workshop on information systems, and monitoring and evaluation of laboratory indicators delivered to 20 countries, and the visit of technical assistance in information systems to the 3 LSNs.

In the second phase of the project, an instrument was developed and applied to standardize the indicators of the LSN/NRL and NTP, the systematic monitoring of the quality of TB information, its link with other programs and the results of the indicators. As a result of this activity, the standardization of the LSN/NRL and NTP indicators was achieved based on the information sent by each country, and a dashboard platform for data visualization for the region, country, and region was developed and delivered. province/department that allows analyzing the information from the LSN/NRL and NTP indicators defined and validated according to the standardized structure. This activity contributes to the analysis and use of information from the data reported in the “global TB report”.

The project has followed up on these activities through individual meetings with the 17 countries to monitor the data and indicators of the LSN/NRL and NTP. Technical assistance was provided to 7 countries: Argentina, Chile, Mexico, Guatemala, Honduras, El Salvador, and Paraguay to strengthen the information systems of the LSN/NRL and the NTP.

This study is based on the application of a similar survey in 2017 to analyze the situation of the information systems that the LSN/NRL and NLN have. In addition, activities to strengthen information systems have been carried out in the 17 countries during the current grant, related to data quality, information analysis, and M&E of indicators.

4. Overall objective

Carry out the situation analysis of the information systems of the supranational laboratories and the national networks of TB laboratories of the 17 countries that participate in the subsidy of the PROGRAM "Strengthening of TB laboratory diagnosis in the Region of the Americas"

5. Specific objectives

- Obtain the final version of the survey format to be applied
- Generate the database of the 17 surveys completed by the LSN and NRL
- Carry out the analysis of the results and delivery of the final report

6. Methodology of the study

A descriptive study was carried out about the information systems of supranational laboratories, national reference laboratories and national networks of TB laboratories in 17 countries that participate in the grant "Strengthening of TB laboratory diagnosis in the Region of the Americas".

The variables and the survey instructions were reviewed, which were built and reviewed by the GTRL-TB team and the PAHO Regional TB Program in the 2017 version, and variables were included to address new issues in this measurement. The final version of the survey was reviewed by the PAHO regional TB program and the ORAS CONHU.

The survey is distributed as follows:

- General laboratory data
- Information flows and periodicity of laboratory information reports in the NRL
- Reporting and management of the LRN information system
- Data quality processes of the different reports
- Information security
- Analysis of information and laboratory indicators
- Knowledge management in the laboratory information system
- Budget for information systems

The components to be analyzed include the use of the instruments provided by the project to support the verification and evaluation of the data quality of the NTP and NRL, and the visualization tool for the indicators that are reported to WHO, to assess the adoption of these instruments.

A web application based on the free tool LimeSurvey was built in order to complete the survey via the web. The survey was sent in PDF format and the access link to the platform for online data entry. Doubts about filling out the survey were resolved by email and video calls.

The information from the platform was exported to Excel for descriptive analysis and the generation of graphs and tables. For the elaboration of the maps, the free tool SIGEPI of PAHO was used.

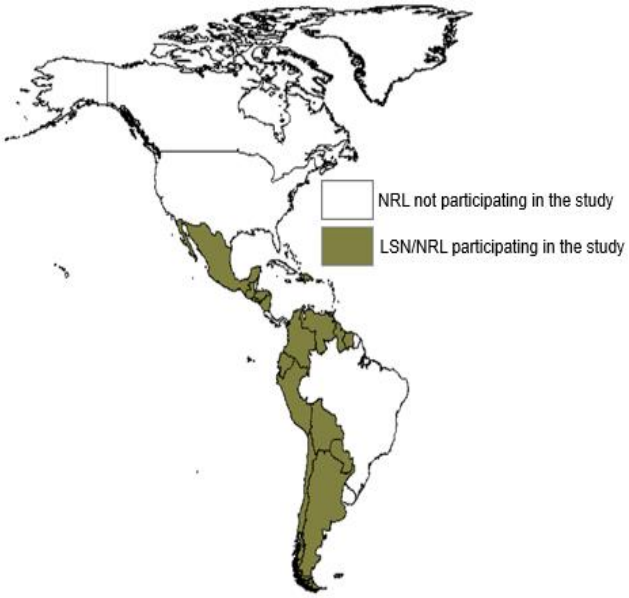
It was possible to obtain 100% of the countries with the information registered in the database, so that all could be included in the analysis.

A chapter was included for the comparative analysis of the progress of the information systems, considering the countries that participated in the first and second phase of the project.

7. Results

The surveys from the 17 countries that participated in the study were registered on the online platform. 100% of the LRNs responded to the survey, including the three LSNs (Chile, Argentina and Mexico). The analysis of the results is presented below (figure 1).

Figure 1. Map of the LSN and NRL participating in the study



Laboratory Type	Country
LSN/NRL	Argentina
	Chile
	México
NRL	Colombia
	Ecuador
	Paraguay
	Perú
	El Salvador
	República Dominicana
	Guatemala
	Honduras
	Nicaragua
	Venezuela
	Bolivia
	Guyana
	Haiti
	Surinam

Source: Result of the survey applied to LSN and LRN November – December 2022

7.1 General results of the analysis of the information system of the NRLs of 17 countries

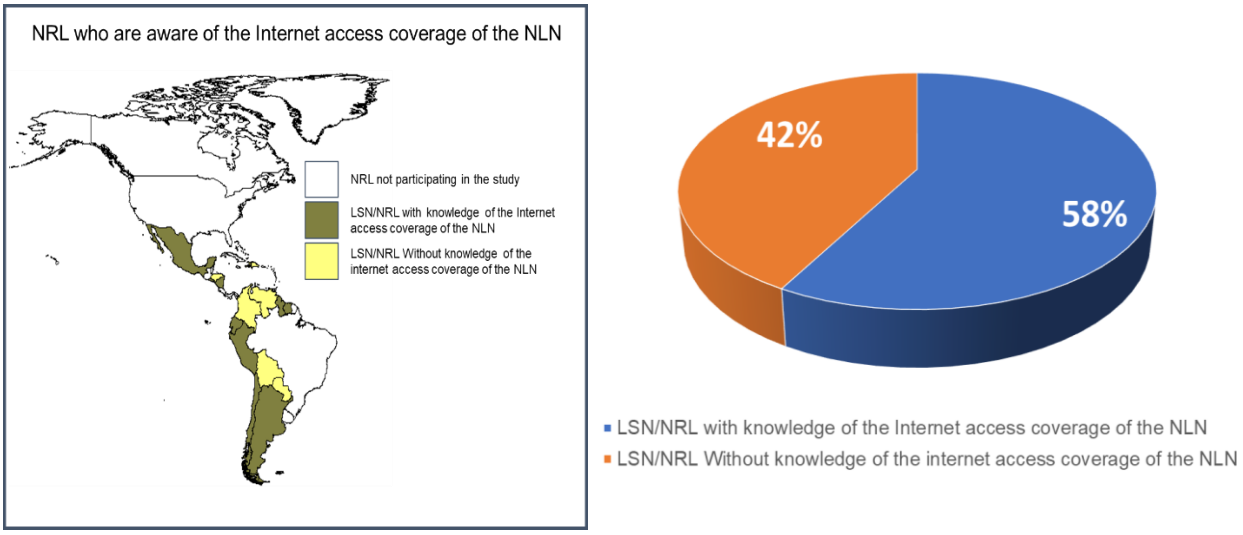
This chapter emphasizes the technological infrastructure, the human resources available to support the information systems, the structure of the NLN and its articulation with the NTP.

One of the main results of the study is that 100% of the NRL have formed and are operating the NLN, and work in coordination with the NTP. In a certain country, the TB NLN laboratories may refer the information to the NTP and this, in turn, to the NRL.

Considering the technological infrastructure of the NRL and the NLN, it was found that 58% of the NRL surveyed (Argentina, Chile, Mexico, Ecuador, El Salvador, Guyana, Haiti, Nicaragua, Peru and Suriname) know the number of laboratories of the RNL who have access to the internet. 42% of the LRN surveyed (Colombia,

Guatemala, Paraguay, Dominican Republic, Bolivia, Honduras, Venezuela) do not know the number of RNL laboratories that have Internet access (figure 2).

Figure 2. Number and percentage of NLN laboratories that have internet access.



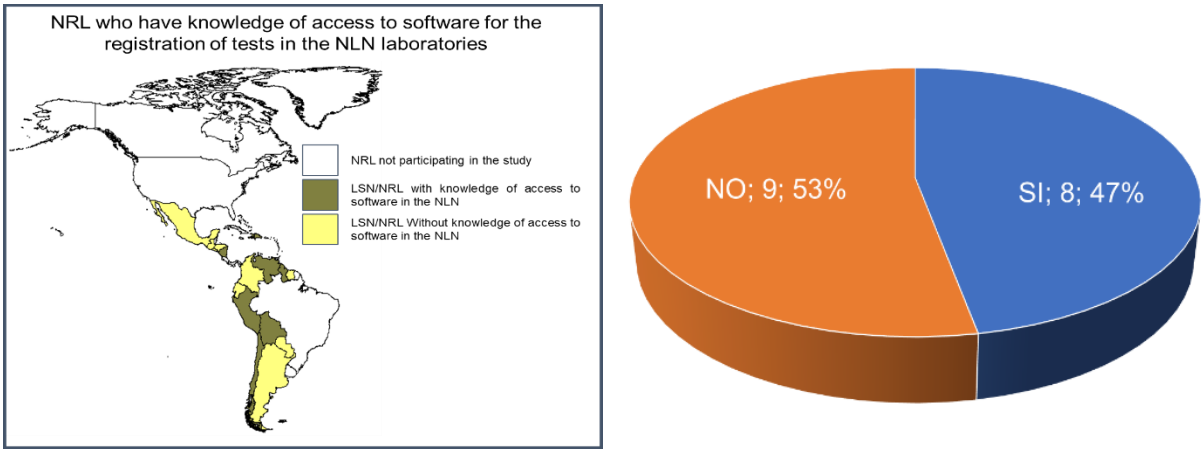
Source: Result of the survey applied to LSN and LRN November – December 2022

The NRLs of Bolivia, Honduras, and Venezuela, despite not knowing the conditions in all the peripheral laboratories, reported the number of public health NLN laboratories at the departmental level that have Internet access.

Considering the knowledge of the internet coverage in the NRL, it is identified that 60% of the NRL has access to the internet in their NLN.

The analysis of the knowledge that the NRL have about the existence of access to a software that allows recording the laboratory tests from the reception of the samples to the issuance of the results (traceability) in the NLN laboratories was carried out (figure 3).

Figure 3. Number and percentage of NRLs that are aware of the access of their NLN's laboratories to software for recording tests from the reception of samples to the issuance of results.

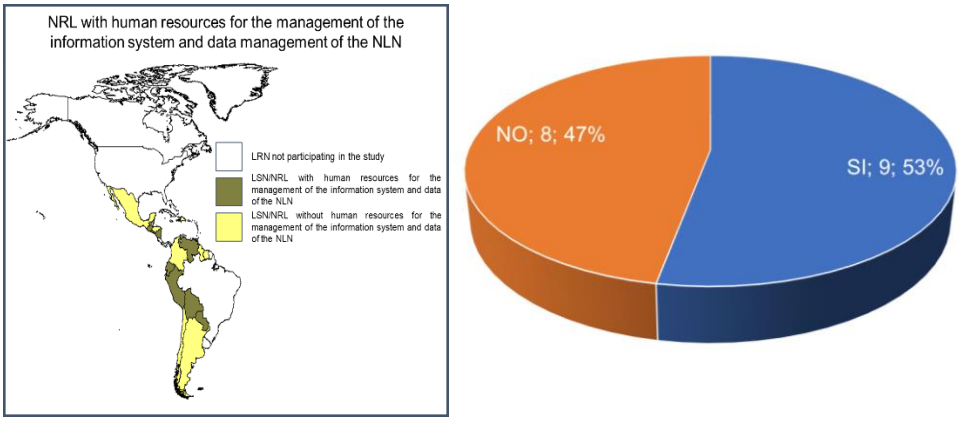


Source: Result of the survey applied to LSN and LRN November – December 2022

47% of the NRL are aware of the number of NLN laboratories with software that allows recording laboratory tests from the reception of the samples to the issuance of the results (traceability).

Regarding the human resources that support the NRLs in their information system, the following profiles were considered: graduate or professional in information systems, systems engineer, statisticians, epidemiologists, monitoring and evaluation professionals, among others directly related with the handling of information by the LRN. 53% of the LRN have human resources that support the processes of the information systems and data management in the RNL (figure 4).

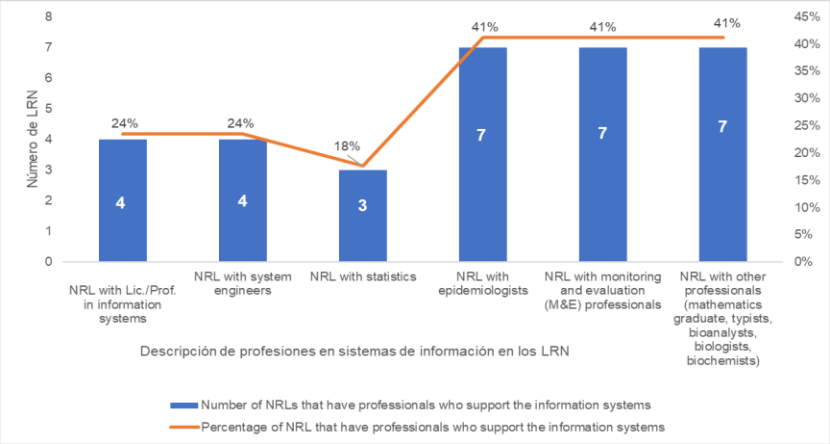
Figure 4. Number and percentage of LRN with human resources for the management of the information system and data management of the RNL



Source: Result of the survey applied to LSN and LRN November – December 2022

When the human resource variable is analyzed for each of the professions that supports the information system in the follow-up to the RNL reports, the support for the analysis of the LRN information, the development of new modules in the information system of the LRN, the support for the crossing or interoperability with the information of the PNT, among others, the following results are obtained (figure 5):

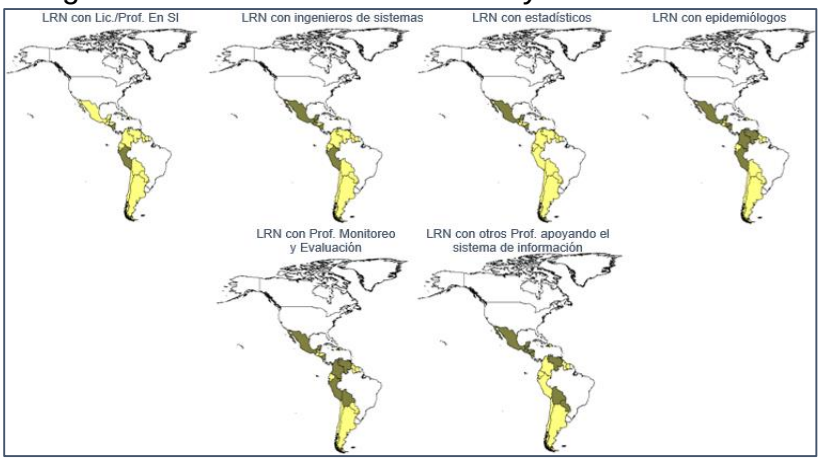
Graph 1. Number and percentage of LRN with professionals in information systems described by profession.



Source: Result of the survey applied to LSN and LRN November – December 2022

The most prevalent human resources for supporting the management of information systems in the NRLs are monitoring and evaluation professionals, epidemiologists, and other related professions. Each of these categories accumulates 41% of the NRL surveyed, followed by graduates in information systems and systems engineers with 24% of the NRL. Finally, there are the statisticians with 18%. Next, the countries are described according to the profession for the management of the NRL information system and the NLN data

Figure 5. NRL according to professionals with human resources for the management of the NRL information system and the NLN data



Source: Result of the survey applied to LSN and LRN November – December 2022

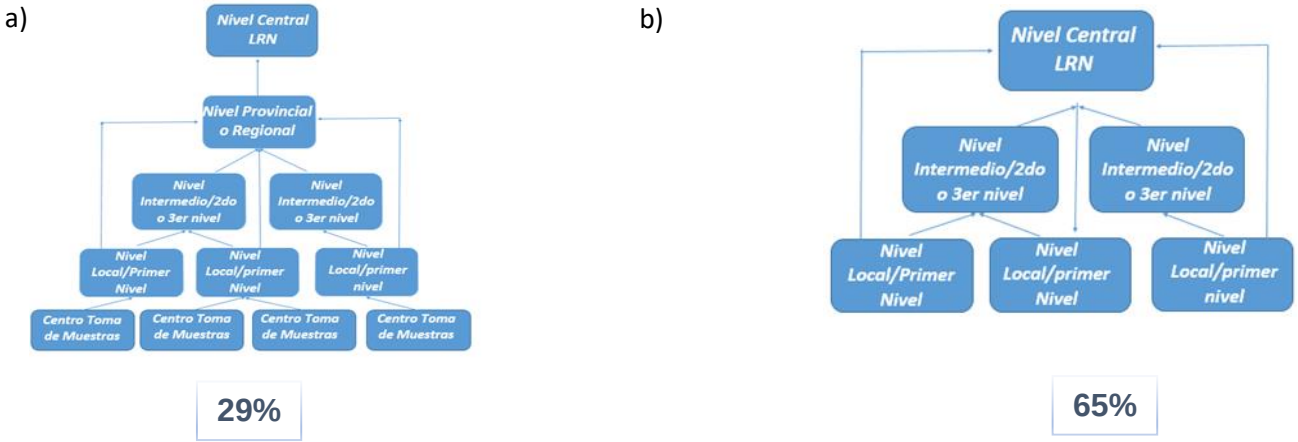
Although it was found that 11 NRL receive support from at least one professional in information systems, systems engineers, epidemiologists, statisticians or other professionals with expertise in information systems, there are 6 laboratories that do not have any permanent support. This is the case of Argentina, where the epidemiological information on the number of cases, location, etc., is handled by professionals from the Dr. Emilio Coni National Institute of Respiratory Diseases. In

Peru there is an area that manages the entire public health information system and monitoring is carried out from the laboratory (by health biologists and epidemiologists). In Guatemala, from the systems area of the Public Health Laboratory, only support is provided for the information system used by the NRL.

7.2 Data flows and periodicity of the reports of the information generated in the RNL to the LRN

In this section, the structure of the NRL of the 17 countries was analyzed, and it was found that they have levels of information that start from an origin or source of the data and this, in turn, is informed or transmitted through the different technological means by different information flows to store, consolidate, group, analyze and make decisions aimed at compliance with NRL indicators. The levels and information flows of the NRLs are described below.

Figure 6. Description of NRL information flows



Source: Result of the survey applied to LSN and LRN November – December 2022

Analyzing the structure of the NRL, 65% of the laboratories have the following flow of information:

The basic hospital sends the samples to the second, third level or intermediate level laboratories with the patient's information for carrying out the tests and subsequent recording of the results. Subsequently, all the information is consolidated (grouped) to be sent to the central level.

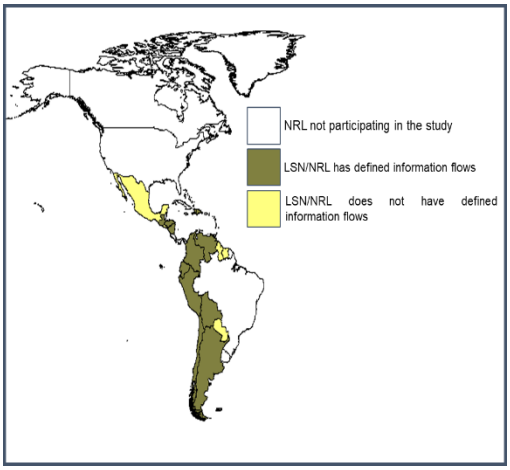
For their part, 29% of the laboratories have sampling centers or health centers that record the data of the people examined and the results of the tests carried out. They send the information to a local level or a first level (basic) hospital for consolidation (grouping). The hospital or basic level consolidates and sends the information from culture tests, molecular tests, or DST to the intermediate level or directly to the regional level. The basic hospital sends the samples to the second, third level or

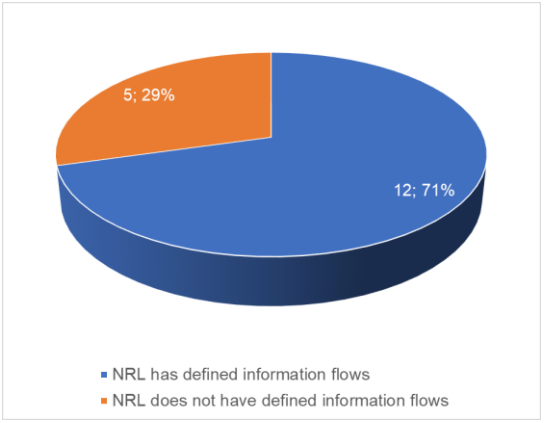
intermediate level laboratories with the patient's information for carrying out the tests and subsequent recording of the results. Second, third or intermediate level hospitals consolidate (group) all the reported information and send it to the provincial or regional level, which consolidates (groups) what all the laboratories report and, subsequently, this information is sent to the central level.

6% of the NRL do not have a defined NLN, and only act as a reference laboratory to carry out the analysis. For this reason, the information on the implemented methodologies is collected by the laboratory technical assistance component of the NTP and the information that the NRL needs is requested from the NTP. According to what has been recorded, the articulation between the NRL and the NTP is permanent in 100% of the 17 countries.

71% of the NRL have defined and socialized the information flows based on documents, manuals, protocols, etc., that describe the different sources of data, reports, and results. 29% of NRLs do not have defined information flows (figure 8).

Figure 7. NRL with information flows defined describing the sources of information for the NRL, including molecular tests.

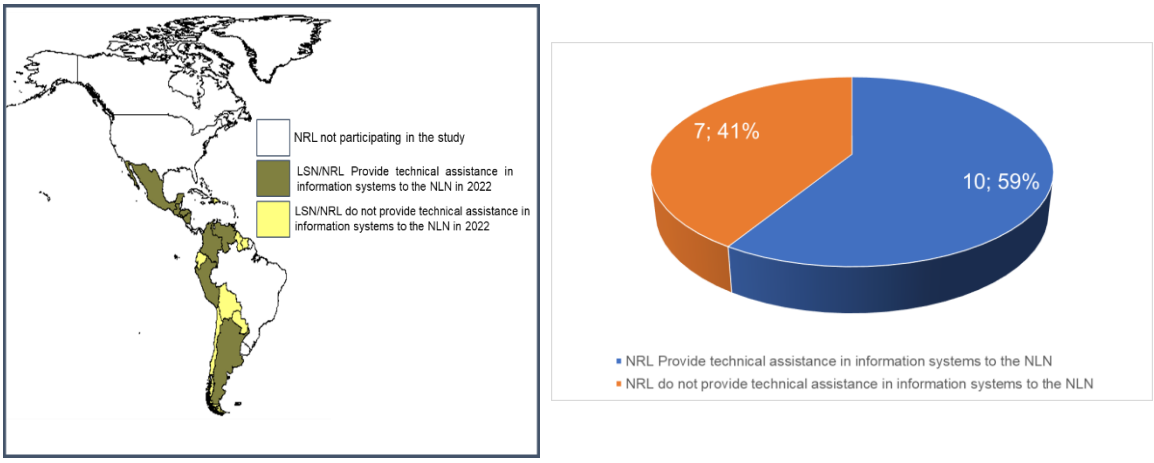




Source: Result of the survey applied to LSN and LRN November – December 2022

NRLs that do not have information flows from documents, manuals, protocols, etc. They are Suriname, Mexico, Paraguay, El Salvador, and Guyana.

Figure 8. NRL that perform technical assistance in information systems in the NLN.



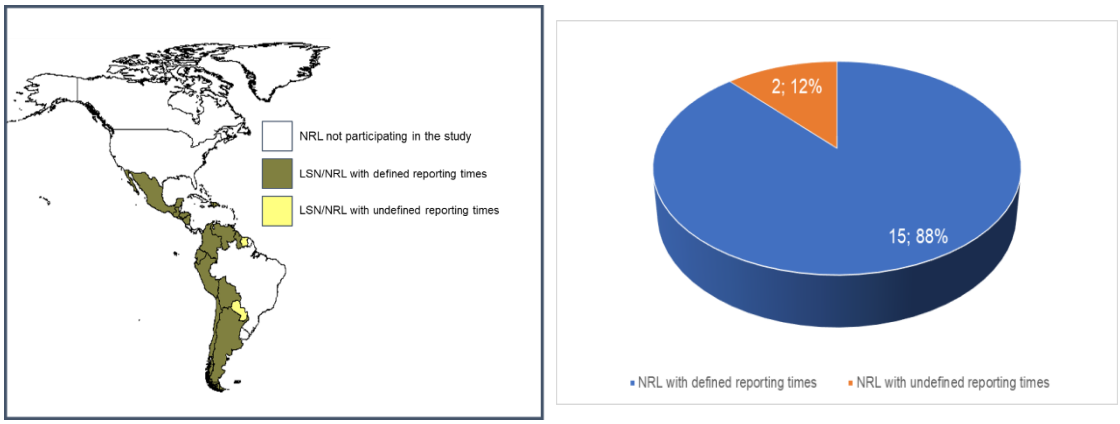
Source: Result of the survey applied to LSN and LRN November – December 2022

59% of the NRL provide technical assistance in information systems to the NLN. The NRL of the countries that do not carry it out are those of Bolivia, Chile, Ecuador, Guyana, Paraguay, the Dominican Republic, and Suriname.

In total, technical assistance was provided to 442 NLN laboratories, which is equivalent to 6% of the total number of laboratories registered in the survey belonging to the 17 countries.

To guarantee adequate and timely decision-making, it is essential to have quality information, understood as a chain of conditions that must be met from the moment the data is captured at the primary source until the final moment of decision-making.

Figure 9. NRL with defined reporting times between information sources.



Source: Result of the survey applied to LSN and LRN November – December 2022

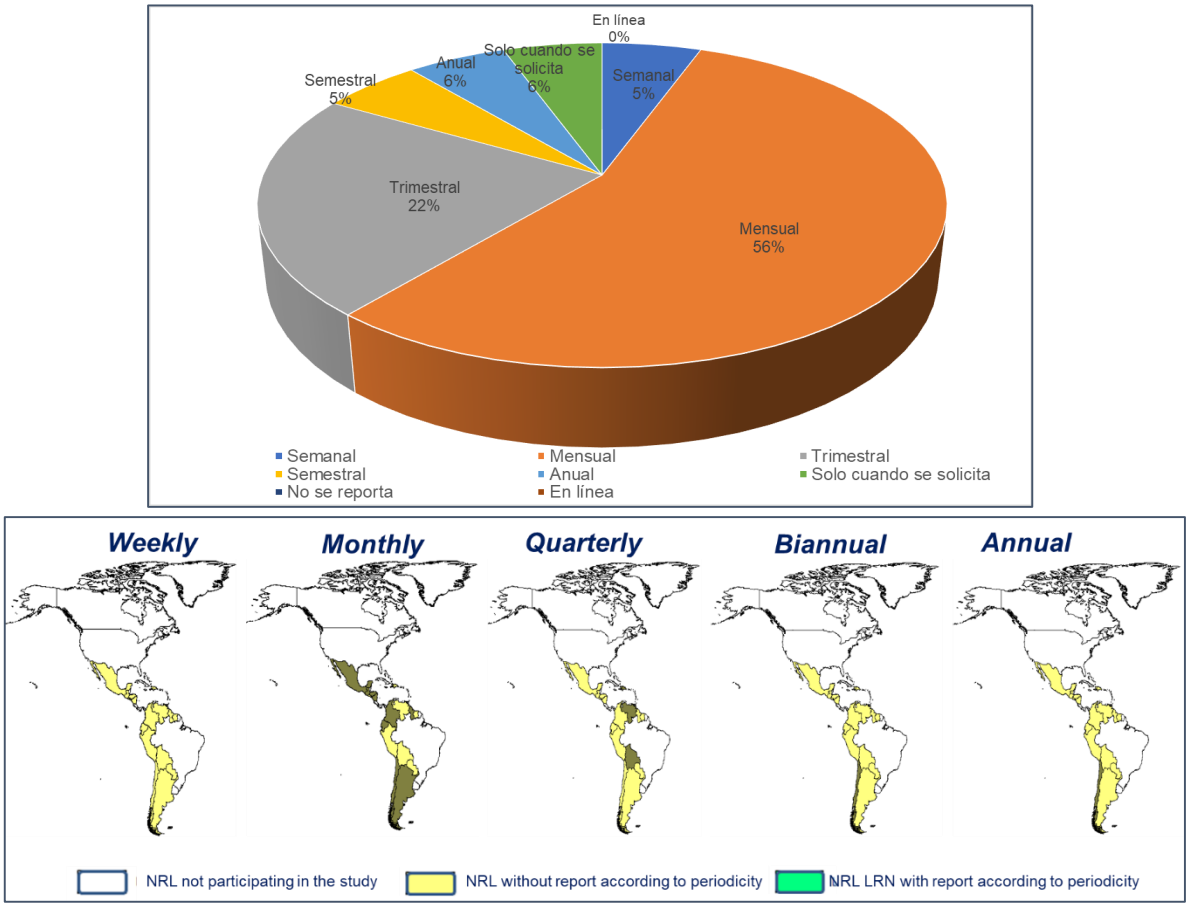
88% of the NRL have defined reporting times between the different sources of information for the data report. 12% of the laboratories have not defined it (Suriname and Paraguay).

7.2.1 Periodicity of the BK report, culture, molecular tests, and DST

The periodicity of the report was analyzed and the opportunity to send the RNL data for BK, cultures, molecular tests, and DST to the NRLs was quantified, considering parameters weekly, monthly, quarterly, semi-annually, annually, only when information is requested or online. A category of "non-sending information" is included. The following results were obtained:

The maps describe each country and the periodicity of the report. Some report weekly and monthly and/or quarterly, semi-annually and annually. For the calculation of the indicator, the report with the greatest opportunity was taken.

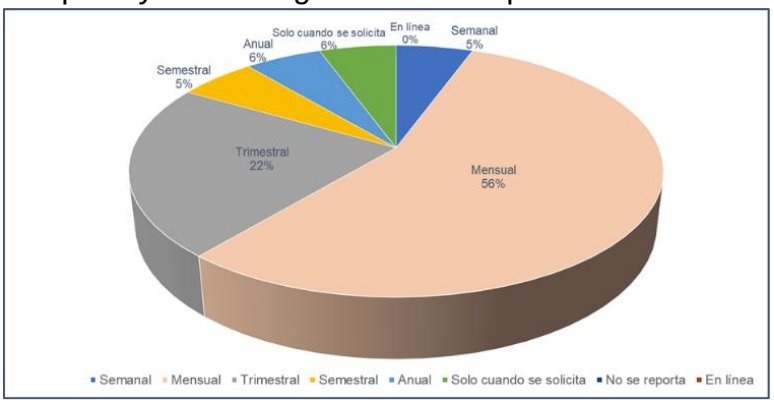
Figure 10. Frequency of sending the smear microscopy report from the NLN to the NRL

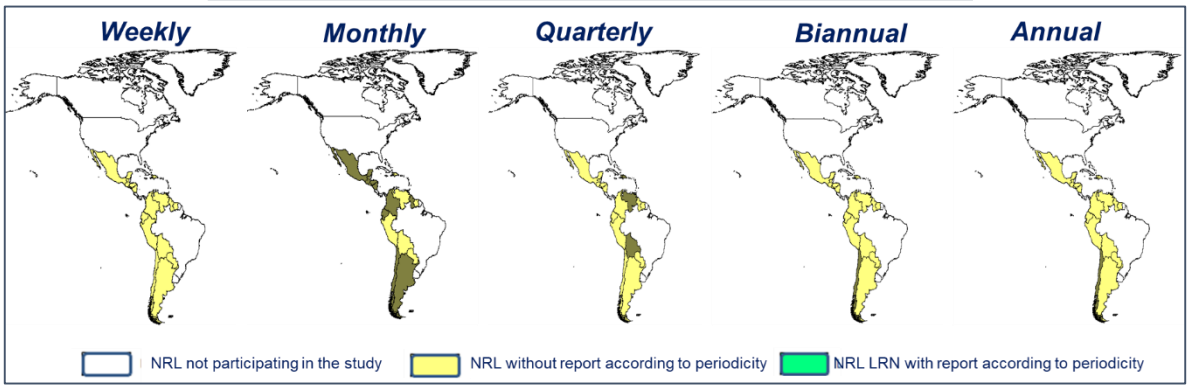


Source: Result of the survey applied to LSN and LRN November – December 2022

56% of the NRLs receive BK information from their NLN's laboratories monthly, followed by 22% quarterly. In the case of Peru, it is only reported when the information is requested, and El Salvador reports weekly. In no laboratory is received online.

Figure 11. Frequency of sending the culture report from the NLN to the NRL

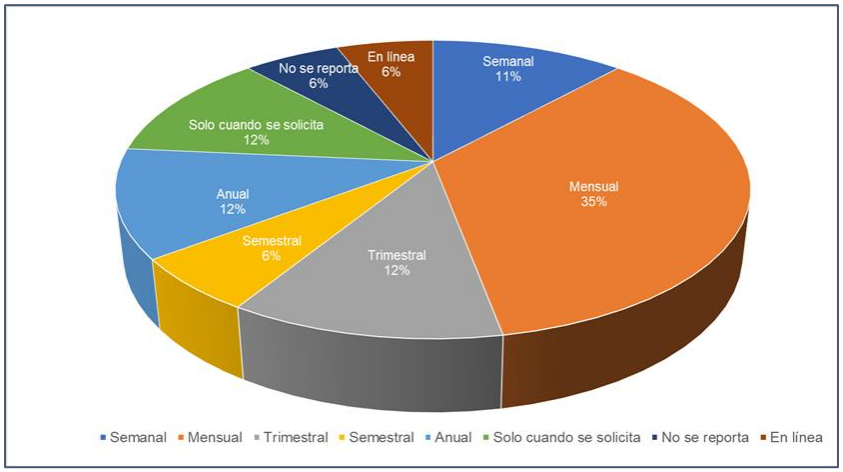


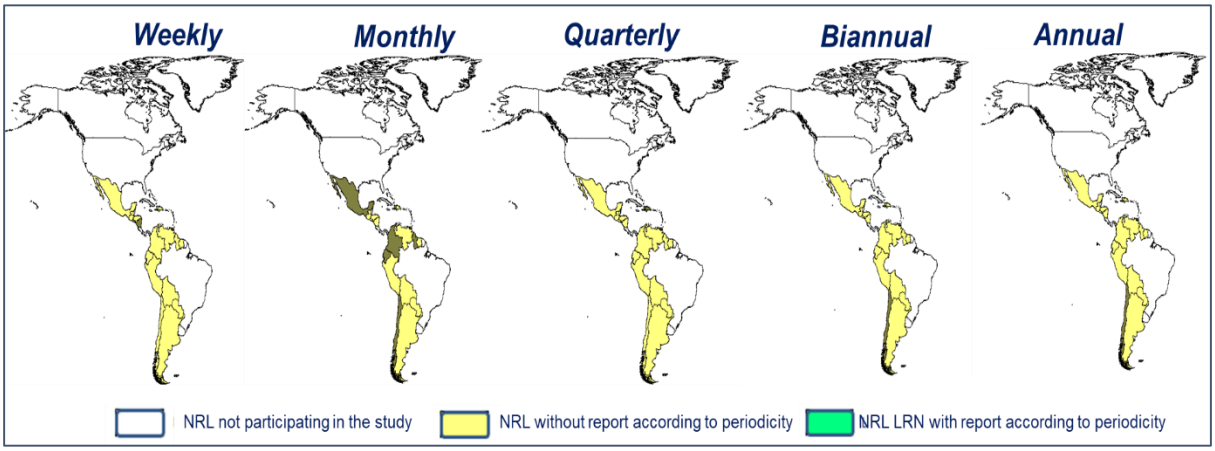


Source: Result of the survey applied to LSN and LRN November – December 2022

56% of the LRN receive crop information from the RNL monthly, followed by 22% quarterly. In the case of Peru, it is only reported when the information is requested, and El Salvador reports weekly. In no laboratory is received online.

Figure 12. Frequency of sending the DST report from the NLN to the NRL

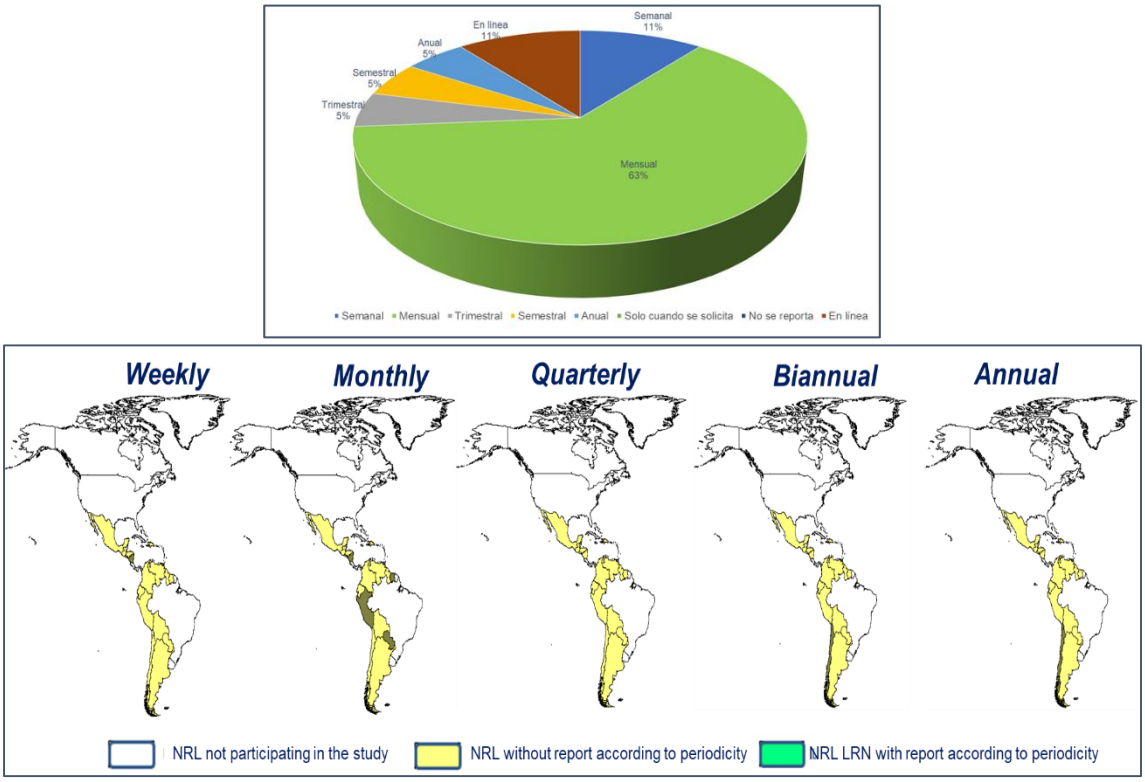




Source: Result of the survey applied to LSN and LRN November – December 2022

The Graph shows that 35% of NLNs report DST information to NRLs monthly, followed by 12% quarterly, annually, and only when requested. The results show a report and availability of DST information at the national level with 64% in the quarter, which can support the NTP in decision-making. The remaining 36% are distributed as follows: Chile quarterly, semi-annually and annually; Argentina online and annually; Peru and Bolivia only when information is requested; in Venezuela it is not reported; and Honduras replied that only the NRL processes DST, therefore it does not receive information from the NLN.

Figure 13. Frequency of sending the report of molecular tests from the NLN to the NRL



Source: Result of the survey applied to LSN and LRN November – December 2022

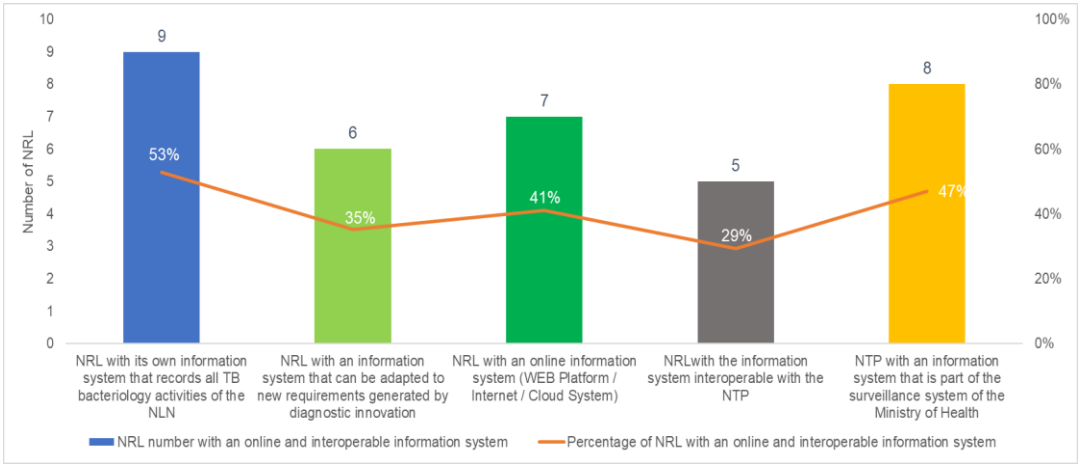
63% of the NLN reports the molecular tests to the NRL on a monthly basis, followed by “online” and “weekly” 11%, respectively. The NRLs of Paraguay and Suriname replied that they did not have a periodicity for reporting molecular tests.

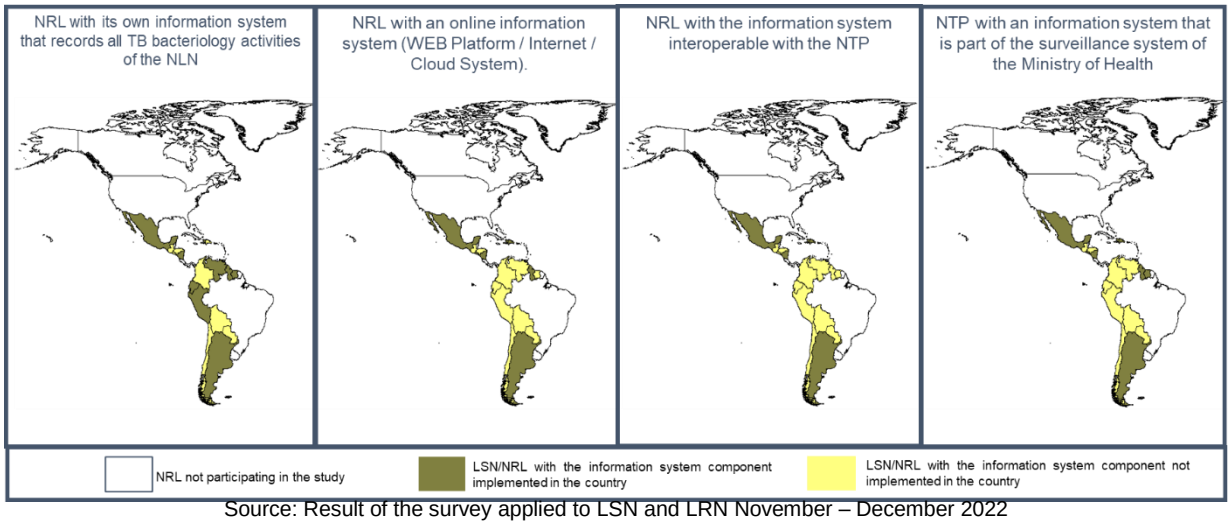
Considering the online, weekly, and monthly reporting period, 85% of NLNs from NRLs report testing within a month. This result contributes to decision-making in a timely manner between the NTP and the NRL.

7.3 Reporting and management of the NRL information system

The analysis of the progress of the information system, the capacity to be adapted to new requirements, the technological platform used for the report, interoperability, and articulation with the surveillance system of the Ministry of Health of each country was carried out.

Figure 14. Status of the NRL information system, its technological platform, interoperability, and articulation with the surveillance system with the Ministry of Health of each country



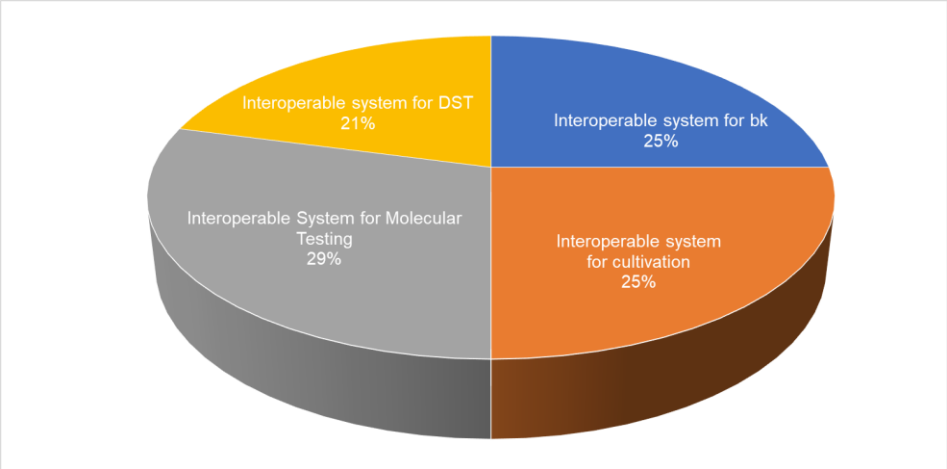


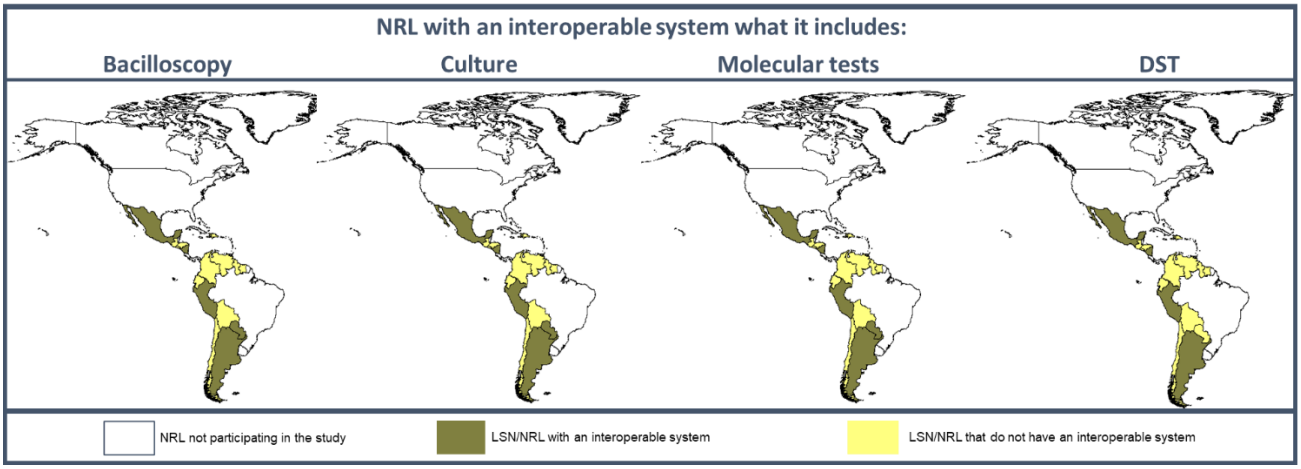
Source: Result of the survey applied to LSN and LRN November – December 2022

53% of the NRLs have their own information system for recording the TB bacteriology activities of the NLN. In 35% of NRLs, the information system can be adapted to new requirements generated by diagnostic innovation. 41% are developed online (web platform, internet, or cloud system), 29% report an interoperable system with the NTP and 47% are part of the surveillance system of the Ministry of Health.

The NRLs of Argentina, Mexico, Nicaragua, and Haiti reported having their own online information system, interoperable with the NTP and articulated with the surveillance system of the country's Ministry or Secretariat of Health.

Figure 15. NRL that have interoperability between the NLN and the NRL and allow obtaining information from bacilloscopy, culture, DST and/or molecular tests in real time.





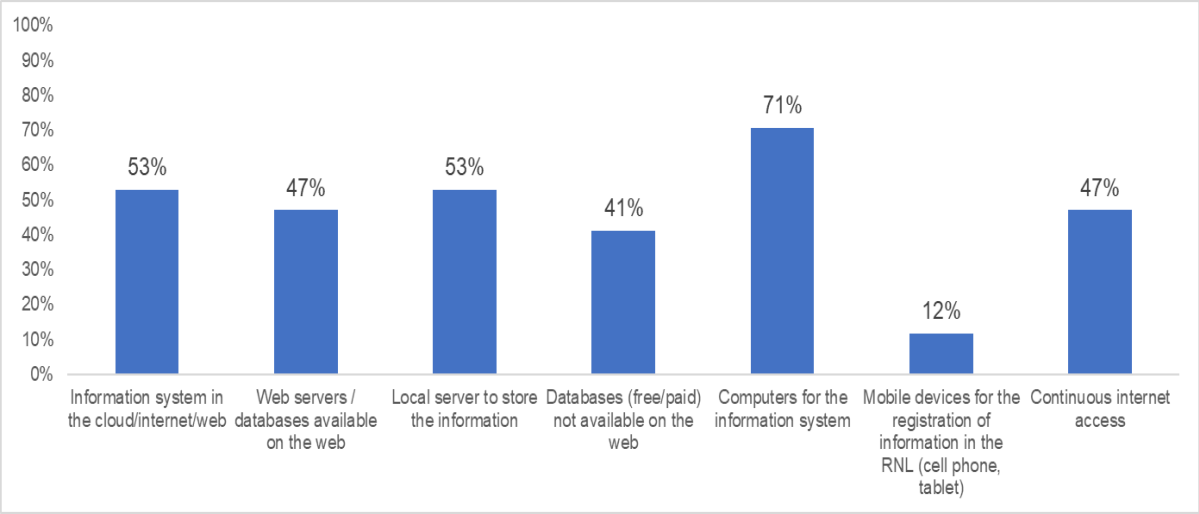
Source: Result of the survey applied to LSN and LRN November – December 2022

25% of the NRLs have an interoperable system between the NLN and the NRLs for reporting smear microscopy, culture, and molecular tests. These countries are Argentina, Mexico, Peru, Nicaragua, Haiti, and Paraguay.

21% of LRNs have an interoperable system for DST: Argentina, Mexico, Peru, Nicaragua, and Haiti

77% of the LRN found in the study can quantify the number of laboratories that report in a timely manner, that is, in the first 30 days after the end of the reporting period. Of these, 29% of the RNL laboratories report in a timely manner. The LRN of the countries that cannot quantify the delivery of information in a timely manner are Chile, Colombia, Guyana, and Bolivia.

Graph 2. Percentage of NRL with technological components for the information system



Source: Result of the survey applied to LSN and LRN November – December 2022

In the results of each one of the technological components proposed for the study, 53% of the NRLs are registered with an information system in the Cloud/Internet/Web, which allows recording, consulting, and generating analysis online.

47% of NRLs have a web server or databases available on the web. This resource allows to identify the access or availability to generate online queries of the NLN information. 53% of the NRL have a local server to store information, 41% of them with databases not available on the web, where the consolidated information is available. This resource allows for the consolidation of the information reported by different means of data transmission and analysis locally and not online.

71% of the NRL have computers for the laboratory information system. 12% have mobile devices to record the activities carried out in the field and/or in areas of difficult access. 47% of NRLs have continuous internet access.

In general terms, the result of the evaluation of the previously described technological components shows a positive regional panorama for the planning and implementation of information systems, either online or locally, despite the technological gaps in each country.

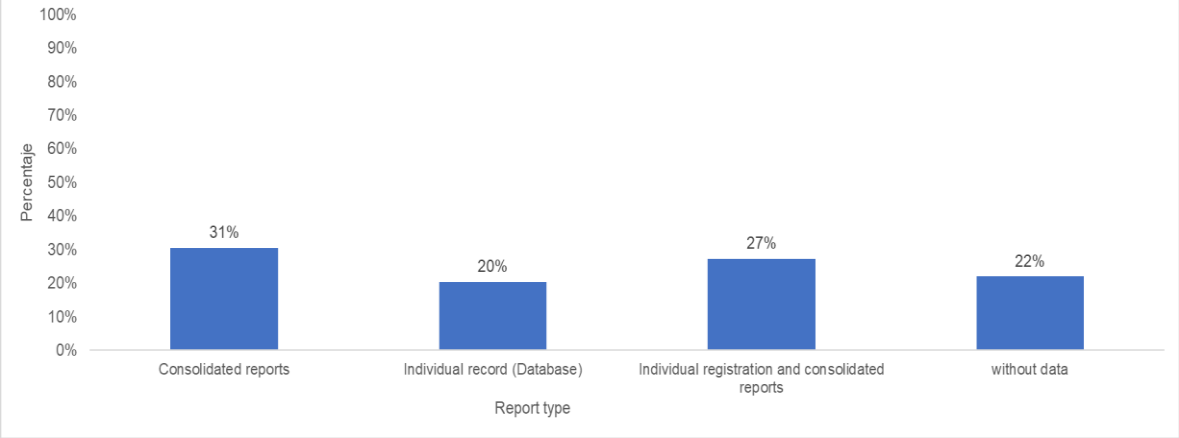
According to what has been recorded, among the countries with the greatest technological gap are Chile and Bolivia, with no component implemented, followed by Colombia, Venezuela, and Honduras with only one of the components described above.

7.3.1 Reporting and management of information for each of the components of the NRL

Considering that the NLN registers and reports the information of the different processes and activities to the LRN, the analysis is carried out for each of the information sources. There is an information management indicator for BK, culture, molecular tests, and DST. The type of report to the NRL is defined, that is, if it is a consolidated report where the number of tests or activities carried out by the NLN is recorded in a given time, or if it is an individual record, equivalent to a database that allows consolidate, add, verify the quality of the data, and cross information with other sources to perform different analyzes.

7.3.1.1 Reporting and management of smear microscopy information

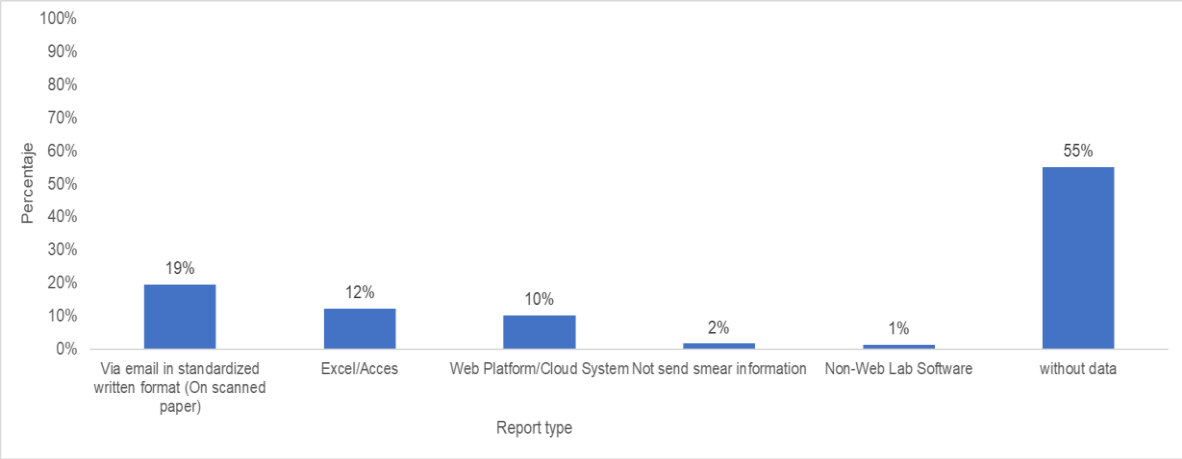
Graph 3. Reporting and management of bacilloscopy information from the NLN to the NRL



Source: Result of the survey applied to LSN and LRN November – December 2022

47% of the NRLs receive the BK information from the NLN in a nominal registry or consolidated reports, which allows the development of information management processes, analysis, data crossings between the different NTP sources and public health surveillance. 31% of the NRL receive consolidated information (reports with general data), and 22% answered without data (they were not recorded or it is not known how the data is reported).

Graph 4. Type of reports according to the format that present the smear information from the NLN to the NRL

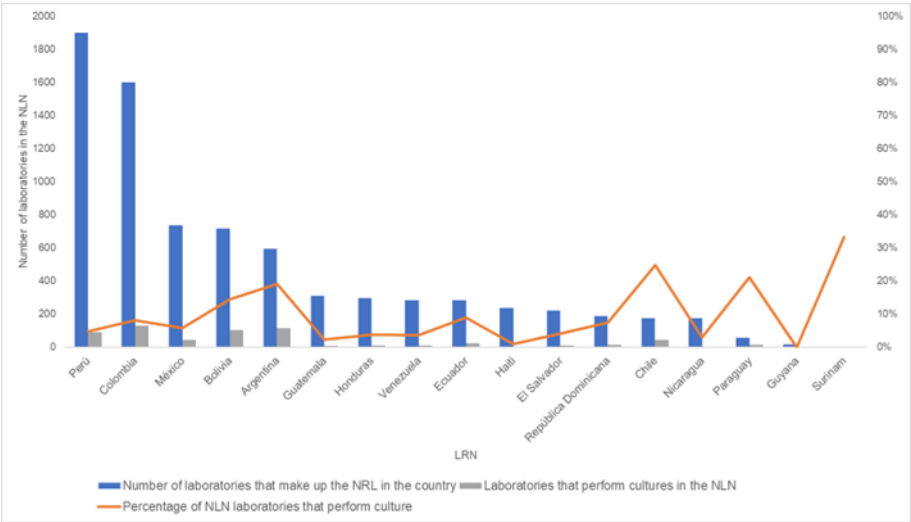


Source: Result of the survey applied to LSN and LRN November – December 2022

19% of the NLNs send the information to the NRLs via email in a standardized written format, followed by 12% in Excel or Access templates, and 10% have an implemented web platform. 55% of NRLs did not answer how their NLN's laboratories report data.

7.3.1.2 Culture information management and reporting

Graph 5. Number and percentage of laboratories that carry out cultures in the NLN of each country.



Source: Result of the survey applied to LSN and LRN November – December 2022

The RNL with the largest number of laboratories that perform cultures is the NRL of Colombia with 130 laboratories out of 1600 that make up the NLN, followed by the NLN of Argentina with 113 out of 593.

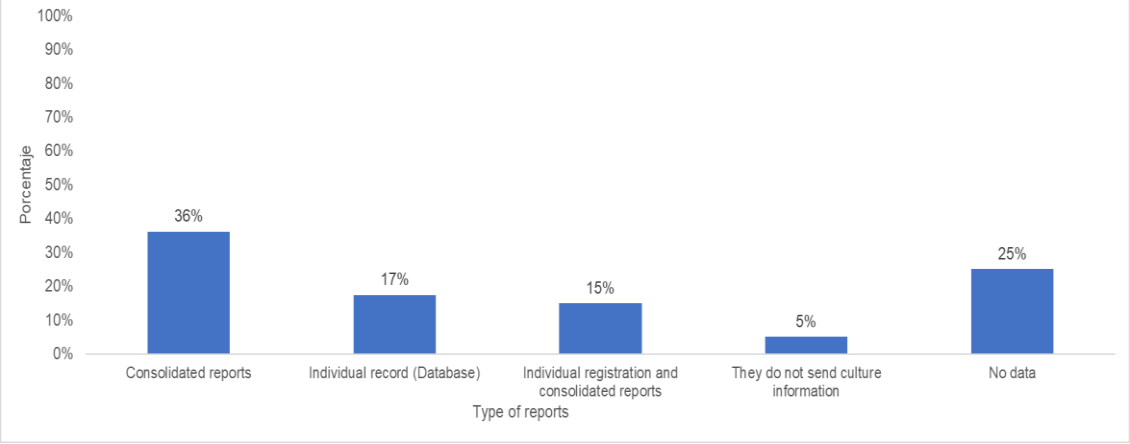
Table 1. Report and management of culture information from the NLN to the NRL

Country	Number of laboratories that perform cultures in the NLN	Number of NLN laboratories that report according to the type of report				Number of NLN laboratories according to the reporting medium			
		Individual record (Database)	Consolidated reports	Individual registration and consolidated reports	They do not send culture information	report via email in standardized written format (on scanned paper)	Excel/Acces	report in non-web lab software	Web platform/cloud system
Argentina	113	34	14	34	31	0	0	0	113
Surinam	1	1	0	0	0	0	1	0	0
México	42	42	27	27	0	42	27	0	27
Honduras	11	11	0	0	0	0	11	0	0
Chile	43	0	29	0	0	0	29	0	0
Perú	90	0	0	0	0	0	0	0	90
Nicaragua	5	5	5	5	0	5	5	0	5
Venezuela	10	0	10	0	0	0	10	0	0
Colombia	130	0	0	0	0	0	0	0	0
Ecuador	25	0	25	0	0	0	25	0	0
Bolivia	104	0	104	0	0	104	0	0	0
Haiti	2	2	2	2	0	2	0	0	0
Paraguay	12	12	0	0	0	0	0	0	12
Guatemala	7	0	7	0	0	0	7	0	0
República Dominicana	14	0	0	14	0	0	14	0	0
El Salvador	9	0	0	9	0	0	9	0	0
Guyana	0	0	0	1	0	0	0	0	1
Total	618	107	223	92	31	153	138	0	248

Source: Result of the survey applied to LSN and LRN November – December 2022

Considering the percentage of laboratories vs number of laboratories, Chile is in first place with 25% of the NLN, followed by Paraguay and Argentina with 21% and 19% respectively.

Graph 6. Percentage of NLN laboratories that perform and report culture information by type of report

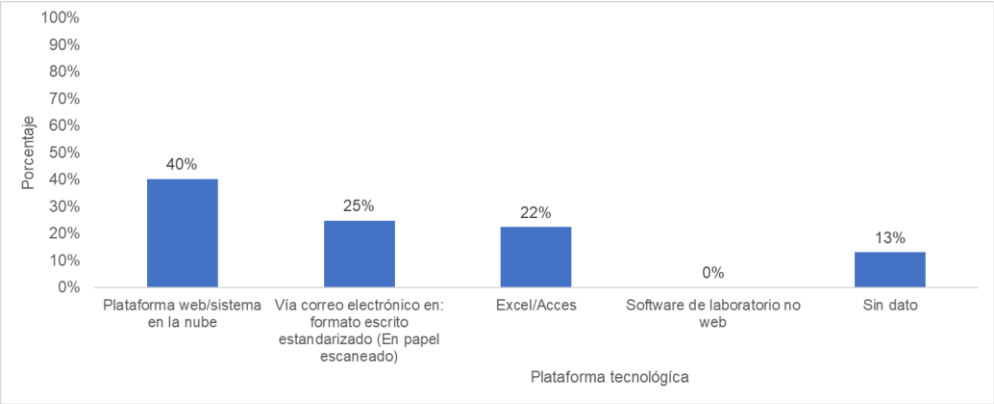


Source: Result of the survey applied to LSN and LRN November – December 2022

38% of the NRL receives the information on cultivation from the NLN in consolidated reports, followed by an individual record and consolidated reports with 35%, which allows the development of information management processes, analysis, and data cross-referencing between the different sources of information. NTP information. 5% of the NLN do not send culture information to the NRL. Of the 618 laboratories of the NLN that perform cultures, 25% do not have an answer on how they send the data to their NRL.

Considering that the laboratories of NLN that perform cultures and report the information to the NRL, variables were defined to identify the type of software (whether it is on a web platform or not), Excel or Access templates, standardized scanned formats, and the description of which platforms are implemented in the NRL.

Graph 7. Technological platform for reporting the cultivation of the NLN to the NRL



Source: Result of the survey applied to LSN and LRN November – December 2022

40% of the laboratories NLN that carry out cultures and report the information have implemented a web platform/cloud system that allows obtaining the information online, followed by 25% sending it via email in written or standardized formats. In 22% of the countries there is a web platform implemented and 13% did not answer this question in the survey.

Argentina has an interface for the laboratory in the National Health Surveillance System 2.0 and generates grouped TB laboratory information. Mexico uses a Google form for consolidated registration on the TB epidemiological surveillance platform. Peru uses Netlab software. Ecuador has matrices in Excel and Paraguay, the Expert system.

7.3.1.3 Reporting and information management of molecular tests

Table 2. Reporting and information management of molecular tests from the NLN to the NRL

Country / NRL	Number of laboratories that make up the NLN in the country	Number of laboratories that perform GeneXpert®	Percentage of laboratories of the NLN that perform GeneXpert®	Number of laboratories that report GeneXpert® information	Percentage of laboratories of the NLN that report GeneXpert® information	Number of Laboratories Performing Hain/Lipa	Percentage of Laboratories of the NRL Performing Hain/Lipa	Number of Laboratories Reporting Hain/Lipa Information	Percentage of Laboratories of the NLN Reporting Hain/Lipa Information
Perú	1900	40	2%	40	100%	6	0%	6	100%
Colombia	1600	68	4%	68	100%	50	3%	50	100%
México	737	67	9%	57	85%	1	0%	1	100%
Bolivia	718	21	3%	21	100%	2	0%	1	50%
Argentina	593	17	3%	17	100%	2	0%	2	100%
Guatemala	310	22	7%	22	100%	0	0%	0	SD
Honduras	297	11	4%	11	100%	0	0%	0	SD
Venezuela	285	16	6%	16	100%	1	0%	1	100%
Ecuador	282	28	10%	28	100%	1	0%	1	100%
Haiti	238	25	11%	25	100%	2	1%	2	100%
El Salvador	219	12	5%	12	100%	0	0%	0	SD
República Dominicana	188	23	12%	23	100%	1	1%	1	100%
Chile	174	41	24%	41	100%	1	1%	1	100%
Nicaragua	173	11	6%	11	100%	1	1%	1	100%
Paraguay	57	22	39%	22	100%	0	0%	0	SD
Guyana	18	7	39%	0	0%	0	0%	0	SD
Surinam	3	3	100%	2	67%	0	0%	0	SD
Total	7792	434	6%	416	96%	68	1%	67	99%

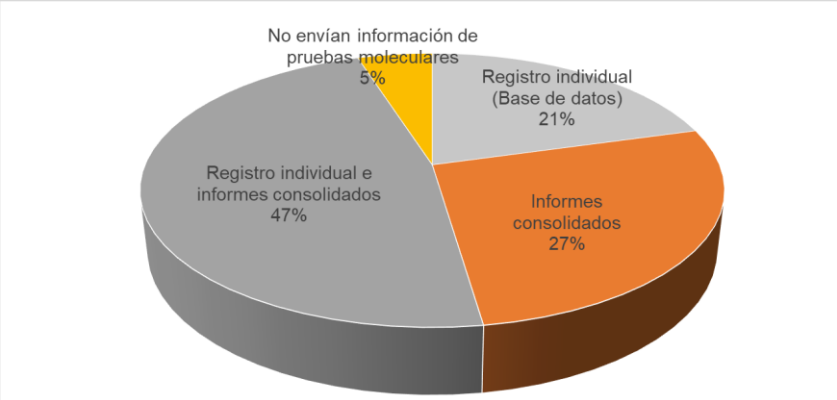
Source: Result of the survey applied to LSN and LRN November – December 2022

According to the registered information, 100% of the NRL have in their NLN laboratories that carry out GeneXpert®, of which 96% report the information at the national level.

The NRLs that in their NLN have a greater number of teams to carry out GeneXpert® MTB/RIF are Suriname with 100%, followed by Paraguay and Guyana with 39% of the teams from their country, and Chile with 24%. 50% of the GeneXpert® teams in the region are concentrated in Peru, Colombia, Mexico, and Chile. Regarding LPA or other PCR, 65% of the countries carry out this methodology with a total of 68 of laboratories of the NLN, of which 99% report the information at the national level.

As can be seen in Table 2, 6% of the 7792 of laboratories of the NLN out of the 17 NRL perform GeneXpert® and 1% perform Hain/Lipa.

Graph 8. laboratories of the NLN that report information on molecular tests in the different reports or databases.

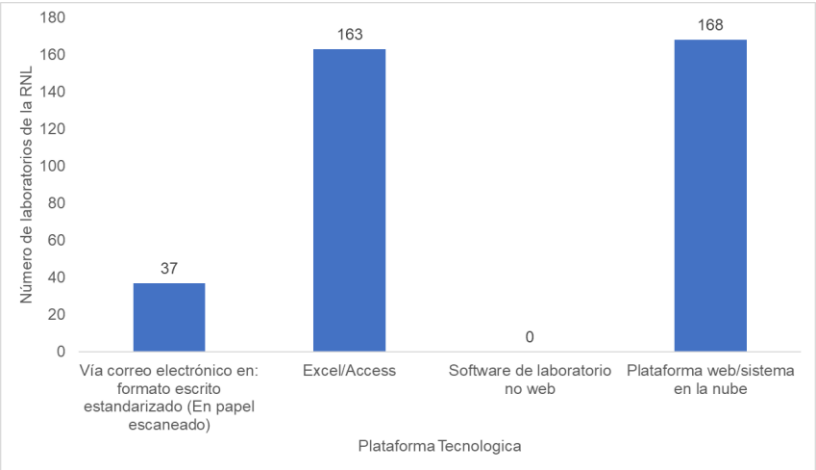


Source: Result of the survey applied to LSN and LRN November – December 2022

47% of the NLN laboratories send the information from molecular tests to their respective NRLs in an individual registry. 27% send consolidated reports to the NRL, and 21% send individual and consolidated reports. 5% of the laboratories NLN do not send information on molecular tests

For the analysis of the information reported from molecular tests, there is a total of 68% of the NRLs with information available in an individual registry that allows the development of information management processes, analysis, and data crossings between the different NTP sources. All this leads to improving knowledge management and adequate decision-making in TB surveillance.

Graph 9. Number of laboratories of the NLN with a technological platform implemented for the reporting of molecular tests to the NRL



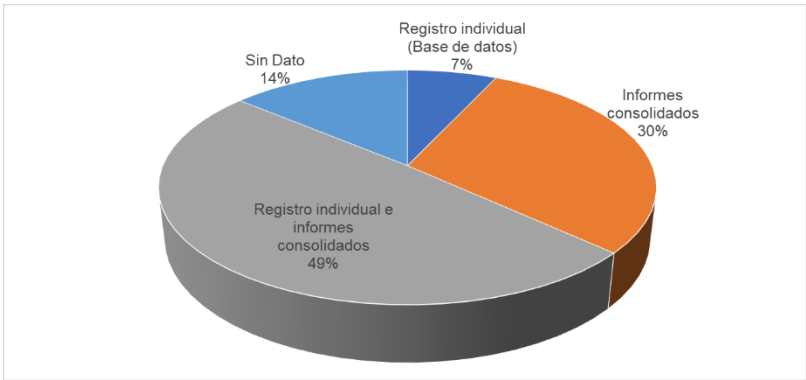
Source: Result of the survey applied to LSN and LRN November – December 2022

39% of the NRLs of the NLN that perform molecular tests have a web platform/cloud system for reporting molecular test data, followed by Excel and Access with 38%, and 9% via electronic format. standardized writing or scanned paper.

51% of the laboratories that carry out molecular tests provide timely feedback (less than 5 days after the test) the results to the NTP.

7.3.1.4 Reporting and information management of first-line DST

Graph 10. Reporting and management of information of DST from the first line of the NLN to the NRL.



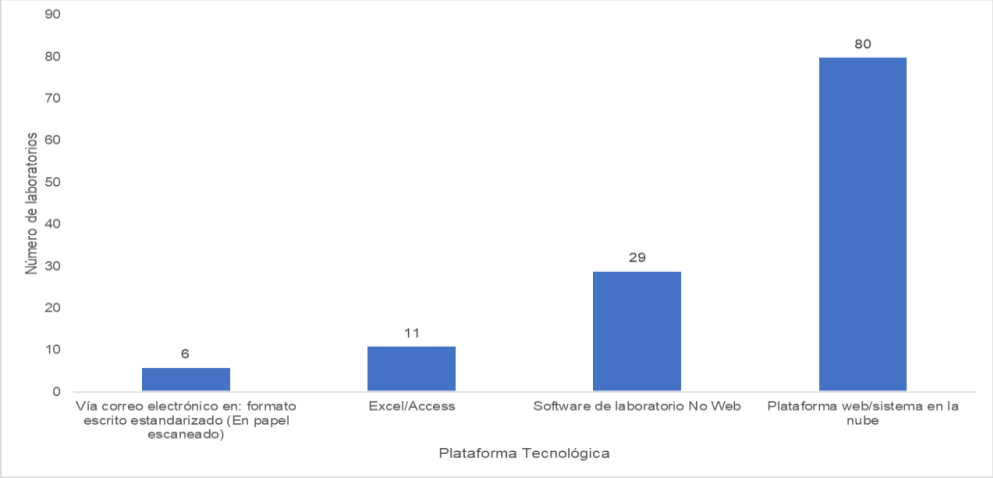
Source: Result of the survey applied to LSN and LRN November – December 2022

49% of laboratories of the NLN send first-line DST information to their respective NRLs in reports with an individual registry or consolidated databases and reports. 30% of the laboratories of the NLN send consolidated reports to the NRL. 7% only send in a nominal registry or databases. For 14% of the laboratories of the NLN, although they report information to the NRL, no response was obtained to the survey on in which medium the information is reported.

56% of the laboratories of the NLN have available an individual registry or first-line test databases that allow cross-references of databases between the NTP, the NRL, and the public health surveillance system, and generate information analysis with the different sources of the program. 100% of the laboratories NLN that perform first-line DST report the data to the NRL.

The countries that do not carry out first-line DST in the RNL are Guatemala, Suriname, and Paraguay.

Graph 11. NRL with a technological platform for first-line DST reporting.



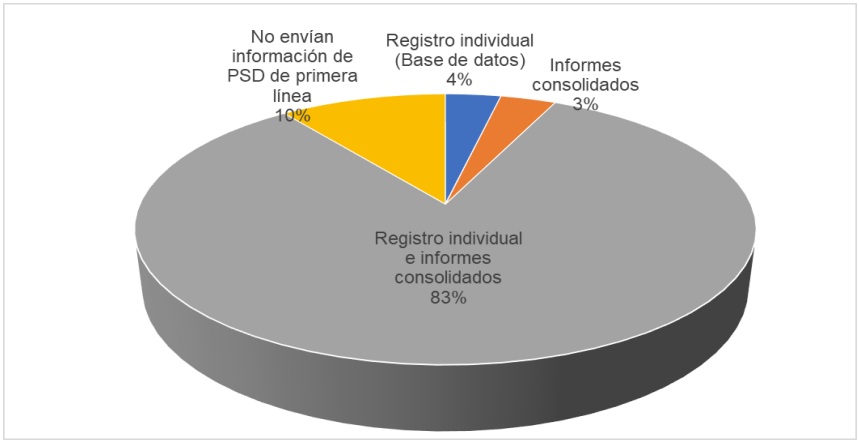
Source: Result of the survey applied to LSN and LRN November – December 2022

63% of NRLs performing front-line DST report data on a web platform/cloud system, followed by 23% of NRLs with non-web lab software. 9% report in Excel or Access and 5% via email on scanned paper.

89% of the NLN laboratories that perform first-line DST provide timely feedback (less than 5 days after the test) the results to the tuberculosis program.

7.3.1.5 Reporting and management of second line DST information

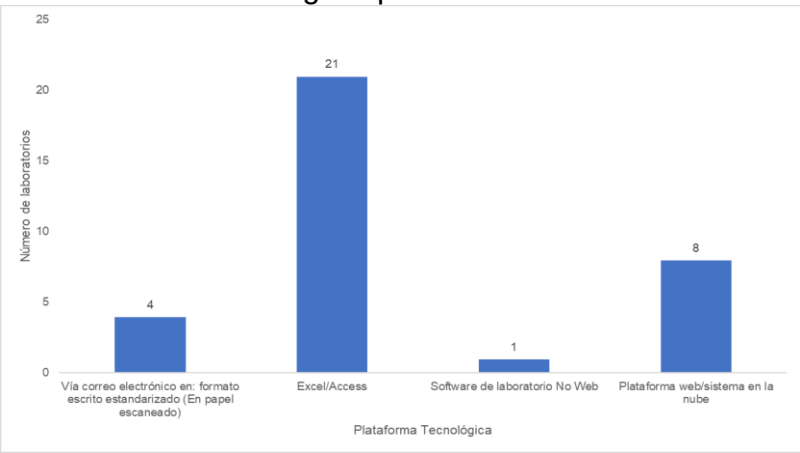
Graph 12. Reporting and management of second-line DST information from the NLN to the NRL.



Source: Result of the survey applied to LSN and LRN November – December 2022

97% of the laboratories of the NLN that perform second-line DST report the information to the NRL. 83% report the information to the NRL in an individual registry and consolidated reports, followed by 10% that do not send second-line DST information at the national level.

Graph 13. NRL with a technological platform for second-line DST reporting



Source: Result of the survey applied to LSN and LRN November – December 2022

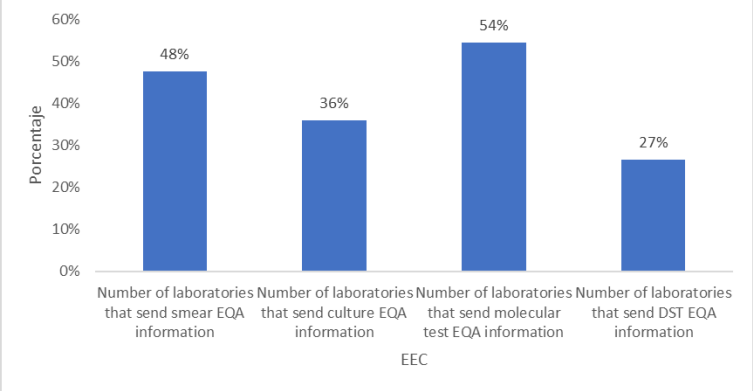
72% of NRLs that perform second-line DST report the information in Excel/Access, followed by 27% that do so in a web platform/cloud system. The NLN of the NRLs of Paraguay, Suriname and Guatemala do not carry out second-line DST. The NRLs of the Colombia and Guyana NRLs conduct PSD, but do not report the data at the national level.

59% of the 17 NRL that in their NLN perform second-line DST, feed back the results to the NTP in a timely manner (less than 5 days after the test). Of the 29 laboratories that in the 17 NLN perform second-line DST, 76% provide feedback to the NTP.

7.3.1.6 Reporting and management of EQA information in the NRL

The External Quality Assessment (EQA) makes it possible to identify the laboratory's capabilities and ensure its integration into national and international networks in order to promote the standardization of laboratory methodologies and processes. The participation of laboratories in the EQA strengthens quality assurance in all bacteriology activities carried out in the tuberculosis program.

Graph 14. Laboratories of the NLN that send information from the EQA to the NRL

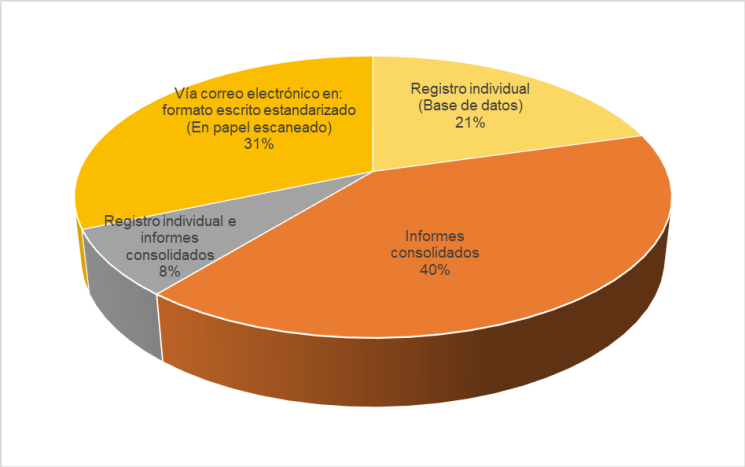


Source: Result of the survey applied to LSN and LRN November – December 2022

For the calculation of the indicator, the NRLs that carry out and send EQA information are considered. The denominator is different in each component.

According to the information registered on the sending of information from the EQA in the components of the TB laboratory, 48% of the NLN send the information from the EQA of BK, 36% send information from the EQA of the culture, 54% send information of EQA of molecular tests and 27% send the information of EQA from the DST to the NRL.

Graph 15. laboratories of the NLN that report EQA information in the different reports or databases.



Source: Result of the survey applied to LSN and LRN November – December 2022

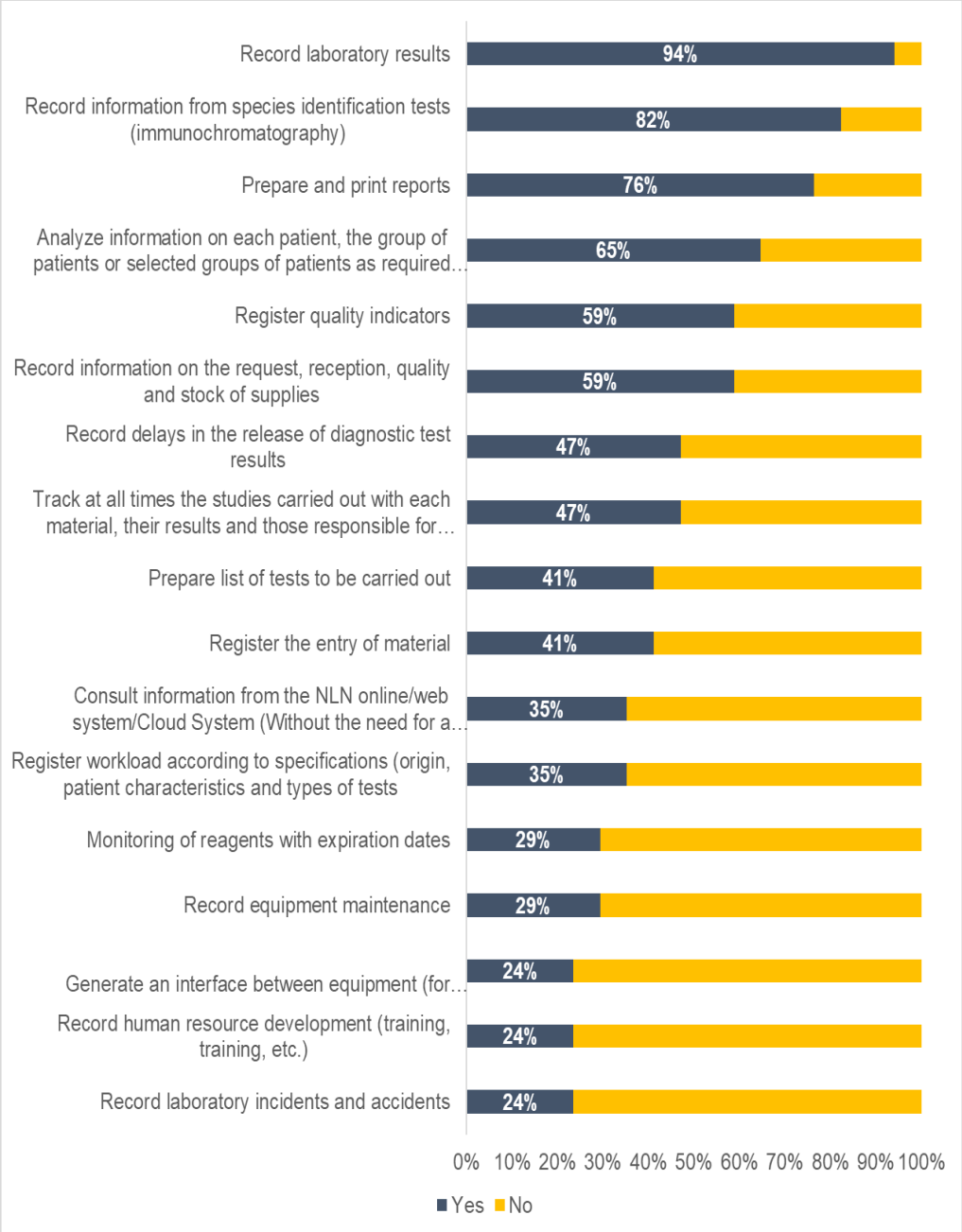
40% of NRLs receive the information in consolidated reports, followed by 31% who receive it via email on scanned paper, and 21% in individual records or databases.

46% of the laboratories of the NLN send the information via email on paper or scanned, followed by Excel/Access with 20% and 1% on a web platform or cloud system.

7.3.2 Management of the information system implemented in the NRL

In this chapter, the management capacity of the information systems implemented in the NRLs of each of the 17 countries participating in the survey was identified, considering the components of the information systems. Variables were defined to identify the registration, storage, processing and output processes, indicators, or results of the NRL activities.

Graph 16. NRL with components of the information system implemented that allows recording, monitoring, consulting and analyzing information on laboratory processes.



Source: Result of the survey applied to LSN and LRN November – December 2022

According to the results obtained, 94% of the NRLs have a system that allows the recording of laboratory results, followed by the recording of species identification tests and the preparation and printing of reports with 82% and 76%, respectively. 65% of the NRL have implemented the component to analyze the information of

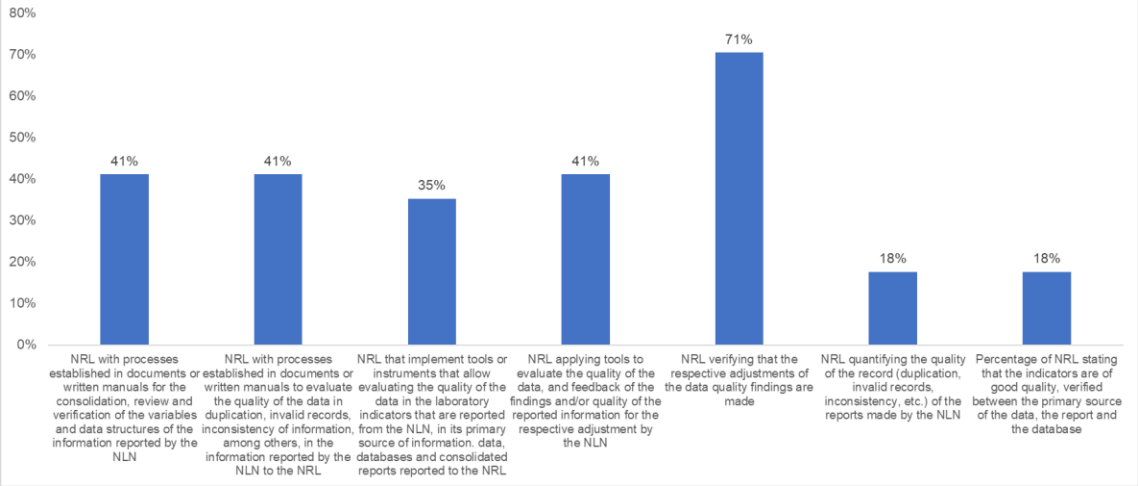
each patient and 59% record indicators of quality and request, reception, quality and stock of supplies.

The information system components that are least used are: the laboratory incident and accident record, the human resource development record, and the generation of interface with Genexpert and Bactec, with 24% each. The equipment maintenance record and the monitoring of reagents are collected in 29% each in the information system.

7.4 Data quality processes in the different reports, NRL databases and information security

Information systems must produce quality data that must pass through information flows. For this, it is necessary to have key functional components at all levels of the system – from service delivery points to intermediate levels, where information is consolidated in districts or health regions, to the M&E unit at the central level.

Graph 17. NRL with implemented data quality processes



Source: Result of the survey applied to LSN and LRN November – December 2022

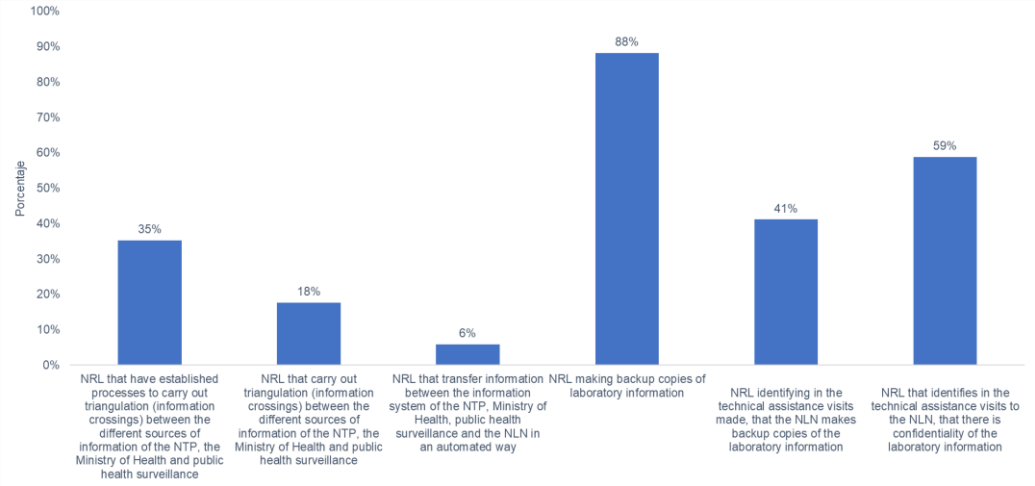
Regarding the quality of the data, 71% of the NRLs verify that adjustments are made to the data quality findings found and fed back by the NRL to the NLN, followed by 49% that do so by established processes for the consolidation, revision, verification of the data, development of manuals to evaluate the quality of the data and the use of tools to evaluate the quality of the data reported by the NLN.

35% of the NRL implement tools or instruments that allow evaluating the quality of the data of the laboratory indicators in the primary source of the data, the databases, and the consolidated reports.

The results of the information crossings carried out by the NLN, the NTP and other public health programs of the Ministry or Secretariat of Health have not been quantified.

406 RNL laboratories in the 17 countries have GeneXpert®, of which 18% are interconnected through a GeneXpert® connectivity platform.

Graph 18. Data triangulation process, backup copies and confidentiality of data in the NRL of the 17 countries.



Source: Result of the survey applied to LSN and LRN November – December 2022

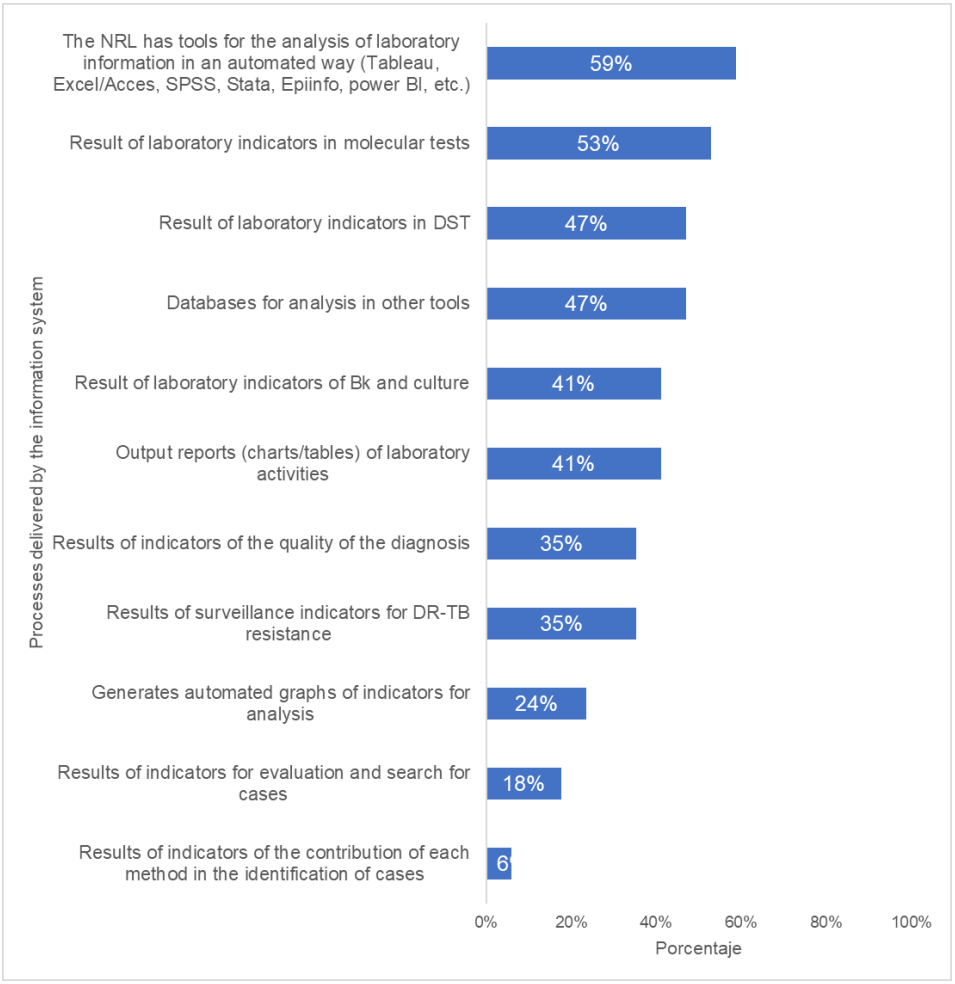
Considering the triangulation of the data, 35% of the NRL have processes implemented to carry out this activity between the different sources of information from the NTP, the Ministry of Health and public health surveillance (PHS). 18% carry out the triangulation of the data, however, the results of the information crossings carried out by the NLN, the NTP and other public health programs of the Ministry of Health have not been quantified.

7.5 Processes that contribute to the monitoring and evaluation of NRL indicators

For the analysis of this subject, the processes that support the analysis of the information from the information systems are considered, and the contribution to decision-making, according to the indicators automatically generated by the laboratory information system.

In the same way, the tools that serve as support for the processing and analysis of information are considered.

Graph 19. Processes delivered by the NRL information system.

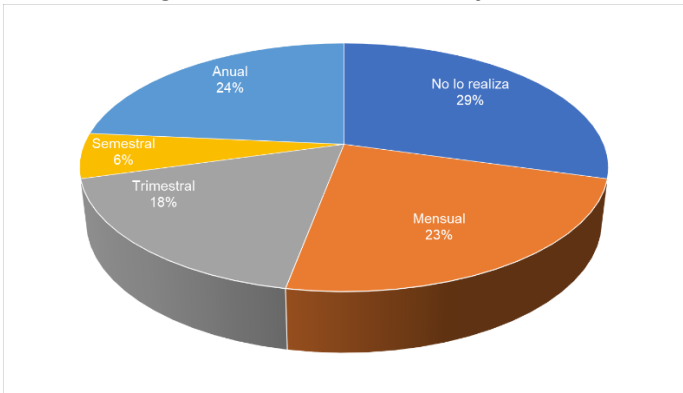


Source: Result of the survey applied to LSN and LRN November – December 2022

In 59% of the NRL there are tools for the analysis of the information in an automated way. In 53% the information system delivers the results of indicators from the molecular testing laboratory, followed by 47% with results of indicators in DST and databases for analysis in other computer tools. In 41%, output reports are delivered in tables/Graphs of laboratory activities and results of culture and bacilloscopy indicators. 35% of the NRLs deliver results of diagnostic quality indicators and TB-DR resistance surveillance, and 24% generate automated indicator Graphs for information analysis. The tools that are handled are Excel, Access, R, epiinfo, R Core Team, power BI, Stata.

88% of NRLs use data mining, data analytics, or artificial intelligence algorithms for advanced data analysis.

Graph 20. NRL that carry out the analysis of the information in conjunction with the NTP through tools that integrate the information system of the NRL and the NTP

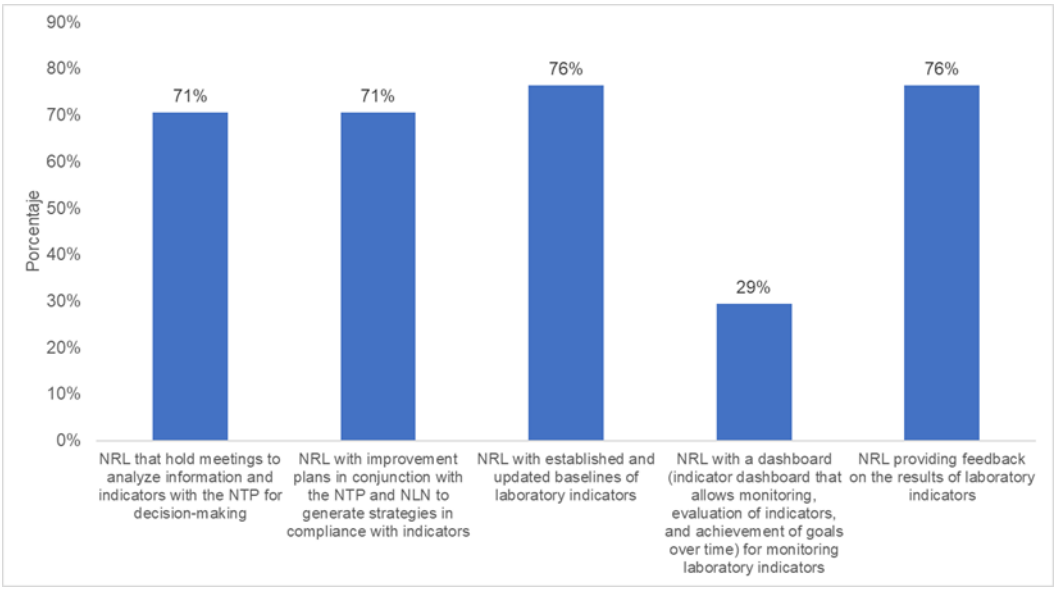


Source: Result of the survey applied to LSN and LRN November – December 2022

23% of the NRL and NTP have a monthly periodicity for the analysis of the information through tools that integrate the data from the NRL and the NTP, followed by 24% annually and 18% quarterly. The 29% of the NRL and NTP that do not carry out this process are Suriname, Peru, Colombia, Guatemala and Bolivia.

It is important to consider the feedback and the analysis of the information in conjunction with the NTP, this to strengthen decision-making at the operational level.

Graph 21. NRL that hold meetings, improvement plans, baselines, dashboards and feedback the results of indicators to the NLN in the 17 countries.



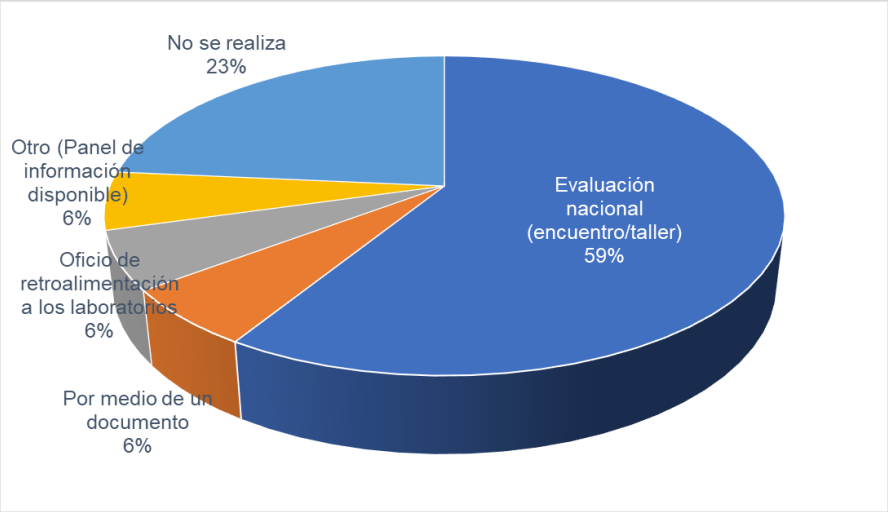
Source: Result of the survey applied to LSN and LRN November – December 2022

71% of the NRL hold meetings to analyze information and indicators with the NTP to strengthen decision-making, as well as improvement plans together with the NTP and the NLN to generate strategies that contribute to the fulfillment of indicators. 76% provide feedback on the results of the indicators to the RNL.

76% of the NRLs have established and updated baselines of the laboratory indicators and 29% have a panel or scorecard of indicators that allows monitoring, evaluation, and achievement of goals over time for the monitoring of laboratory indicators.

The way of giving feedback is important to identify the follow-up that is carried out at the NLN level.

Graph 22. How to provide feedback on the results of the NRL indicators to the NLN.



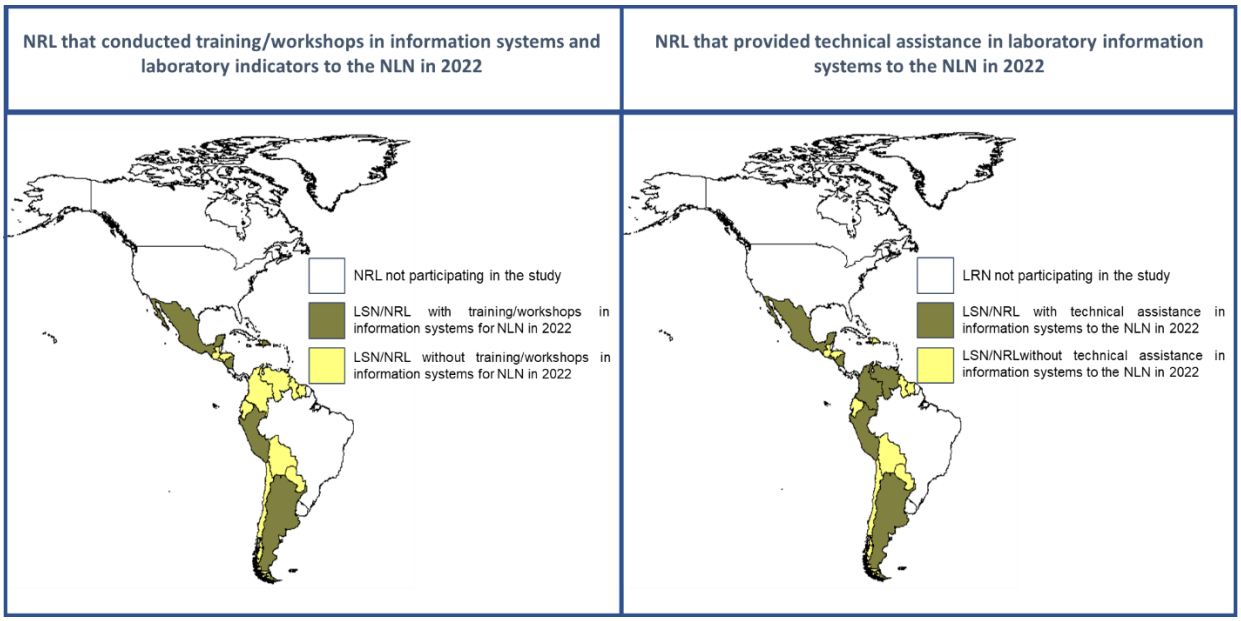
Source: Result of the survey applied to LSN and LRN November – December 2022

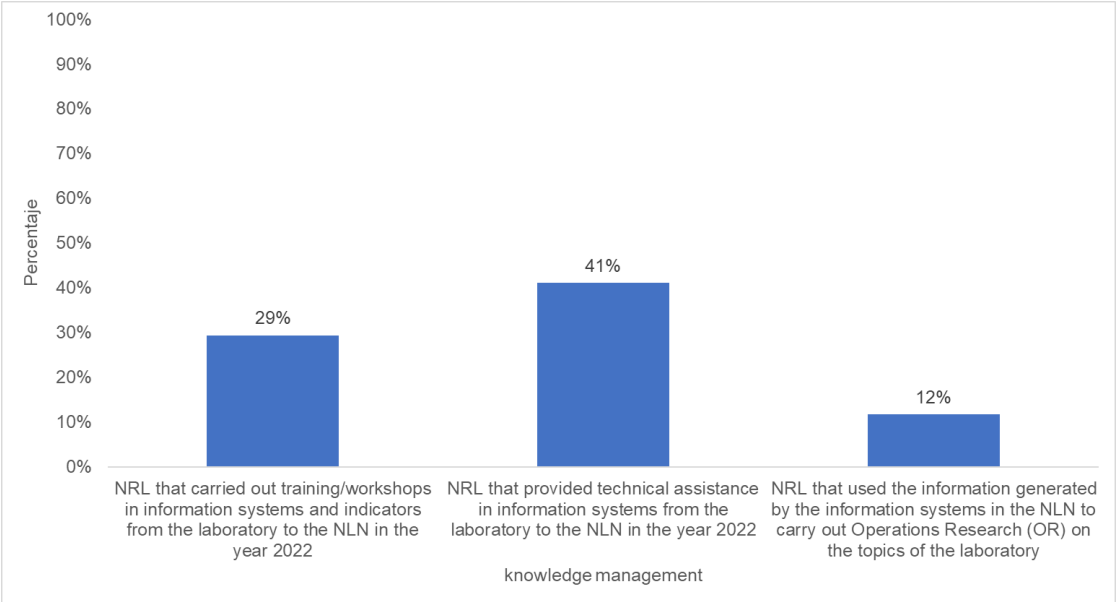
59% of the NRL provide feedback in a national evaluation (meeting/workshop), and 23% do not provide feedback (Colombia, Bolivia, Paraguay, and Guatemala). 6% do it through feedback letters, documents, or panels available for consultation by the NLN

7.6 Processes for NRL knowledge management

This chapter considers the variables of training, development of workshops, technical assistance, and the development of operational research for the dissemination of new knowledge that contributes to the evidence and management of NRLs.

Figure 16. NRL that carried out training/workshops and technical assistance in information systems and laboratory indicators to the NLN in 2022





Source: Result of the survey applied to LSN and LRN November – December 2022

29% of the NRLs (Argentina, Mexico, Peru, Nicaragua, and the Dominican Republic) carried out training/workshops on information systems and laboratory indicators to the NLN in 2022. 41% of the NRLs (Argentina, Mexico, Peru, Nicaragua, Venezuela, Colombia and El Salvador) provided technical assistance in laboratory information systems to the NLN in 2022.

12% of the NRL (Peru and Bolivia) used the information generated by the information systems in the NLN to carry out Operational Research (OR) on the laboratory topics. According to the report, two operational investigations were carried out by the NRL of Peru in 2021, the rest of the countries do not report having carried out OR.

Figure 17. Perception of the NRL and NLN information system and its interoperability with the NTP information system

Source: Result of the survey applied to LSN and LRN November – December 2022

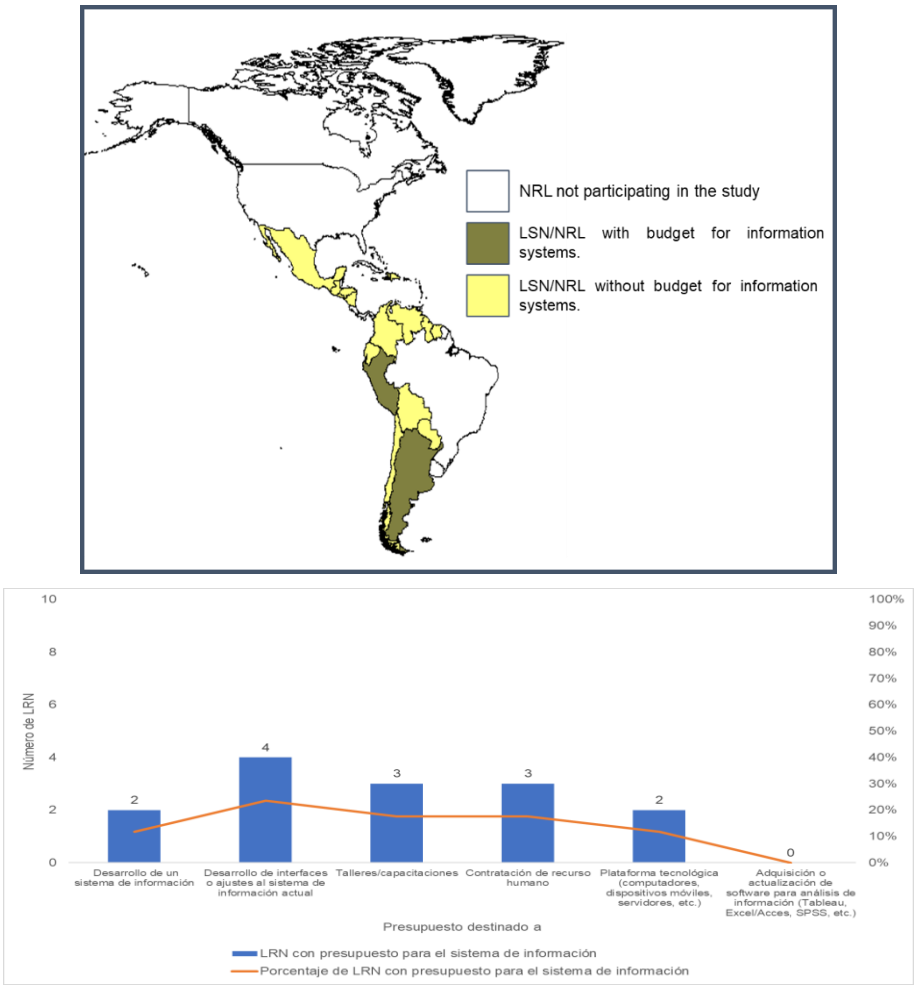
The analysis of the perception of the NRL and NLN information system and its interoperability with the NTP information system was carried out. It was found that 4 countries (Argentina, Paraguay, Nicaragua, and Guyana) have interoperability or cross data, or have a laboratory module in the NTP information system. In El Salvador and Peru, the information system is in the process of generating interoperability with the NLN and the NTP.

18.5% of the laboratories that carry out GeneXpert® of the NLNs of the 17 countries are interconnected through a connectivity platform and are concentrated in 24% of the NRLs (Peru, Nicaragua, Haiti, and El Salvador).

7.7 Budget for information systems and monitoring and evaluation of indicators

The analysis of the budget destined for the strengthening of information systems and the monitoring and evaluation of NRL indicators was carried out. Variables for the destination of these resources were included, finding very little investment in these two processes, as shown in the following analysis.

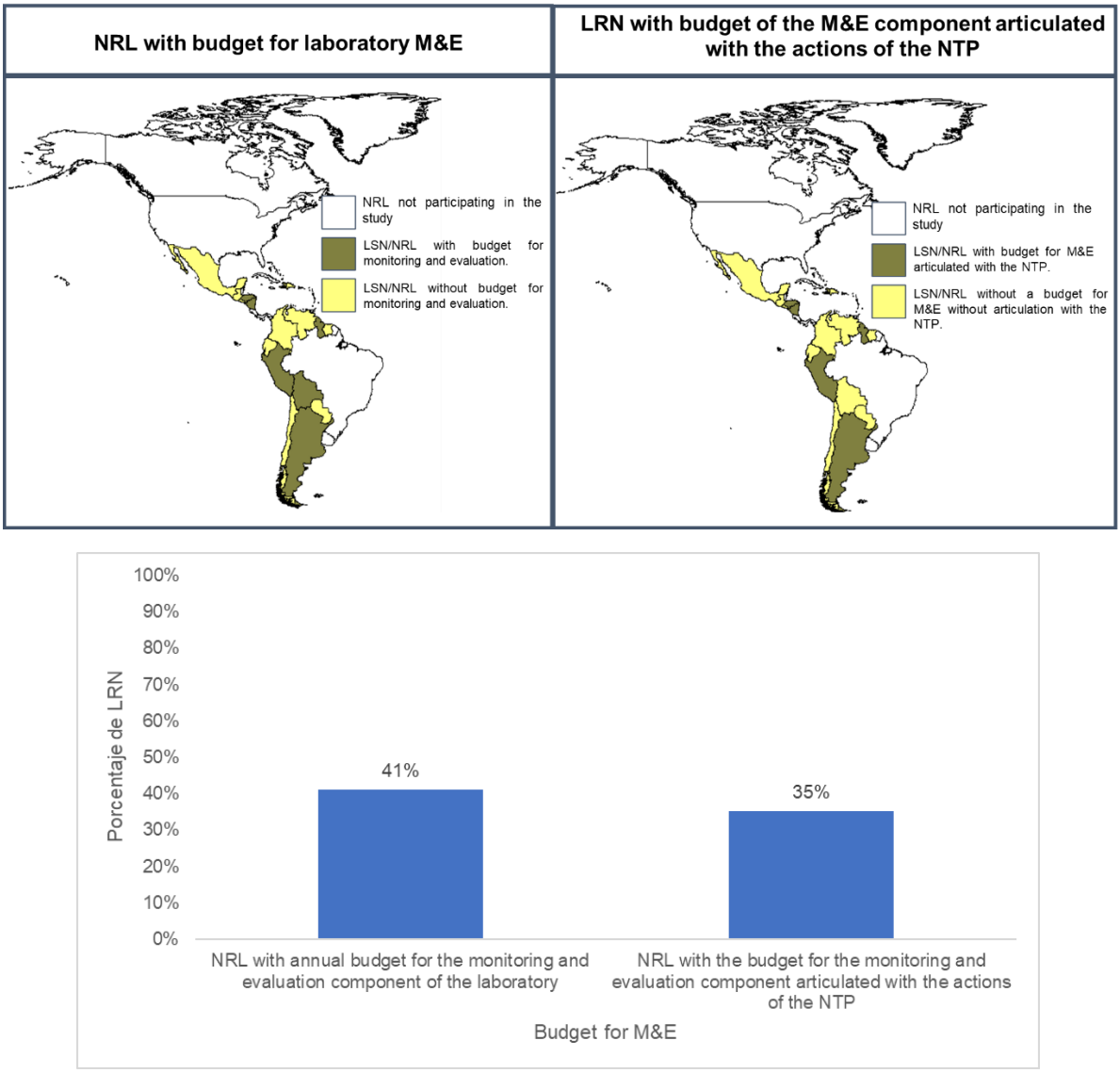
Figure 18. NRL with budget for information systems and the allocation of resources.



Source: Result of the survey applied to LSN and LRN November – December 2022

18% of the NRLs (Argentina, Haiti, and Peru) have a budget for information systems; the three countries allocate the resources for interface development or adjustments to the current information system, workshops or training, and hiring of human resources to the strengthening of the information system. Argentina and Haiti allocate the resource to the development of the information system, Peru and Haiti allocate it to the acquisition or updating of software for information analysis (tableau, Excel, SPSS, etc.). The responses do not specify the amount of resources.

Figure 19. NRL with budget for monitoring and evaluation of the laboratory and its articulation with the NTP.



Source: Result of the survey applied to LSN and LRN November – December 2022

41% of the NRLs have a budget for the monitoring and evaluation (M&E) of laboratory indicators: Argentina, Honduras, Nicaragua, Peru, Haiti, Guyana and Bolivia, in the latter, the budget is not articulated with the actions of the NTP.

8. SWOT analysis of the information systems of the 17 countries participating in the project

8.1 Needs

- NRL and NLN information system in real time and interoperable with the NTP, which includes alerts to improve data quality, generates online databases and complete reports and automatically calculated indicators for all NRL methodologies.
- Technological infrastructure (computer equipment, Internet availability at the primary level, training in information systems and specialized software for data analysis).
- Human resources in the NRL that support the management of the information system, the quality of the data and the analysis of the information in a timely manner
- Technical assistance in information systems and include processes that contribute to improving the quality of data and information analysis

8.2 Weaknesses

- In 65% (11/17) of the NTPs, LRNs, and their RNLs, there is no interoperable information system that allows loading laboratory data, TB programs, and automatically generates laboratory indicators.
- In the NRL or NTP that have implemented an information system, there is no flexibility for timely modification and updating of the system modules that allows for the introduction of international changes and recommendations.
- There is a lack of support from the authorities to strengthen the TB laboratory
- There is a lack of trained human resources for software development and maintenance, data loading and information analysis.
- There is a lack of internet connection, computers and tools for data recording and analysis in some health establishments.
- There is a lack of coordination with epidemiological surveillance for data triangulation.
- The unique identification document is not used in a mandatory manner and is not routinely registered, which makes it difficult to articulate and triangulate the data from the NRL, NLN and NTP.
- Data analysis is not performed in a timely manner, in some peripheral laboratories the reports are based on paper
- There is a deficiency in the quality of the data reported from the NLN and the TB programs.

- The indicators proposed by PAHO/WHO are not included in the information systems developed or in those that are in the process of development.

8.3 Opportunities

- 52% of the NRL laboratories that carry out molecular tests in the 17 countries, feed back the results of the molecular tests to the tuberculosis program in a timely manner (less than 5 days after the result), response time could be improved for the delivery and follow-up of the results, including obtaining the information in real time and carrying out the epidemiological analysis in a timely manner.
- Take advantage of the advocacy that is carried out from the NTP and the NRL to improve the load and quality of the data in the RNL laboratories.
- Possibility of connecting GeneXpert® with the NTP and NRL database.
- Implement demonstrative processes for the implementation of tests and contribution to the diagnosis and its concordance with the other tests, in addition to the integration of the different areas that make up the laboratories.

8.4 Strengths

- The standardization and integration of the records related to the TB case, such as laboratory, epidemiology and clinical results in a single system contributes and strengthens decision-making in the PNT and LRN.
- Countries that have a political commitment can advance in the development, implementation, and management of the PNT and LRN information systems.
- Good communication between the peripheral laboratories of the RNL, the LRN and the PNT.
- Countries that have trained human resources and that are part of work teams that contribute to the management of information systems in the NTP, NRL and NLN.
- The importance of having the identification document as a unique identifier that allows the triangulation of data with other sources of information is valued.
- There is historical information that contributes to decision making.

8.5 Threats

- The high costs and lack of budget associated with information systems limits the development and management of this, as well as its analysis and decision-making.
- There are countries with a lack of political commitment to advance in the development and management of information systems.

- The sustainability of the processes of the information systems is not always guaranteed (new developments, maintenance, management, and monitoring of the information registered with a good quality of the data, timely analysis, among others).
- Data vulnerability in Excel or Access based systems.
- The program or laboratory information is not recorded or reported in the information systems due to the workload of human resources in health establishments or peripheral laboratories.

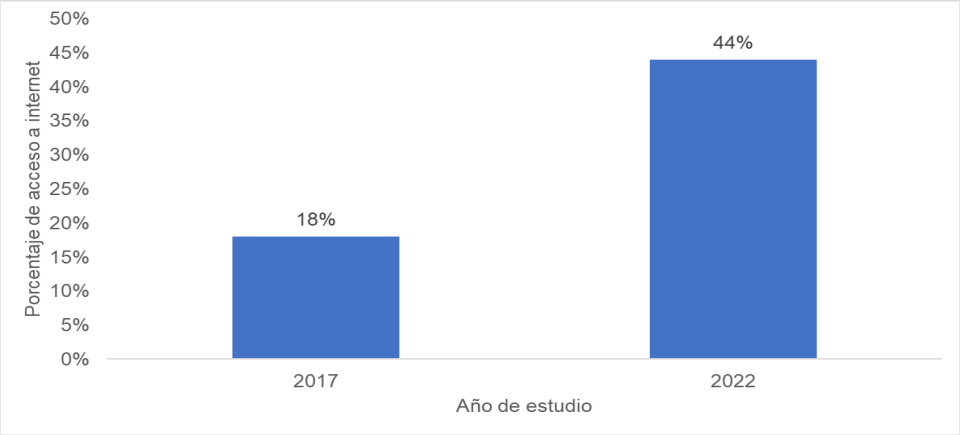
9. Comparative analysis of the progress of the information system of the countries that were part of the first phase and second phase of the project

For the comparative analysis of the progress of the information systems of the NRLs that were part of the first and second phase of the project, the countries of Argentina, Chile, Mexico, Colombia, Ecuador, Paraguay, Peru, El Salvador, Republic Dominican, Guatemala, Honduras, Nicaragua, Venezuela, Bolivia and Guyana, and tracer variables are used to visualize the progress between the first study and the current one.

Figure 20. LSN/NRL that participated in the study in the first and second phase of the project.

Source: Result of the survey applied to LSN and NRL in 2017 and 2022

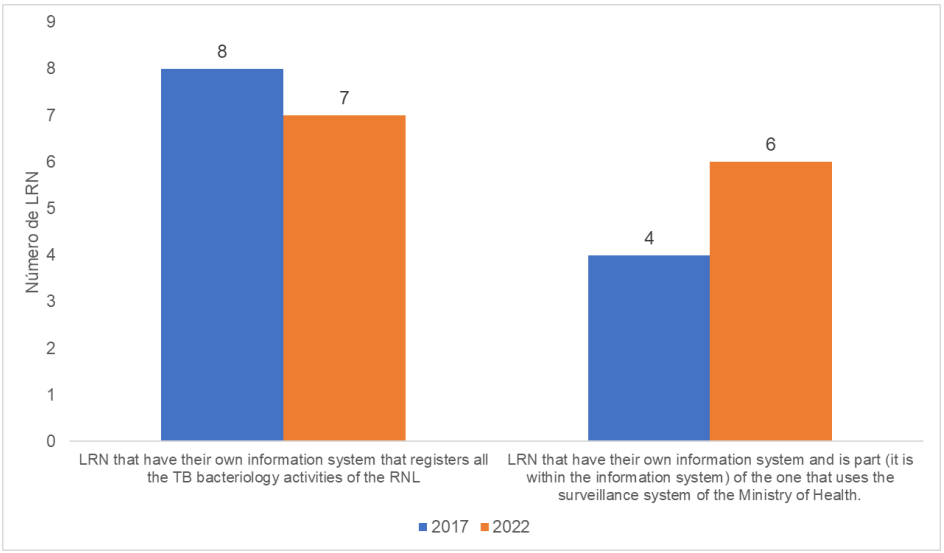
Graph 23. Comparative analysis of the internet access of the NLN in the NRL that participated in the first and second phase of the project, years 2017 – 2022



Source: Result of the survey applied to LSN and NRL in 2017 and 2022

The comparative analysis of internet connectivity in the NLN of the NRLs that participated in the first and second phase of the project was carried out, resulting in an increase in internet connection coverage in the NLN of the NRLs in 2022. going from 18% to 44% of NRL with internet connection.

Graph 24. Comparative analysis of the availability of an information system of the NRL that records TB bacteriology activities and if it is part of the surveillance system of the Ministry or Secretariat of Health.

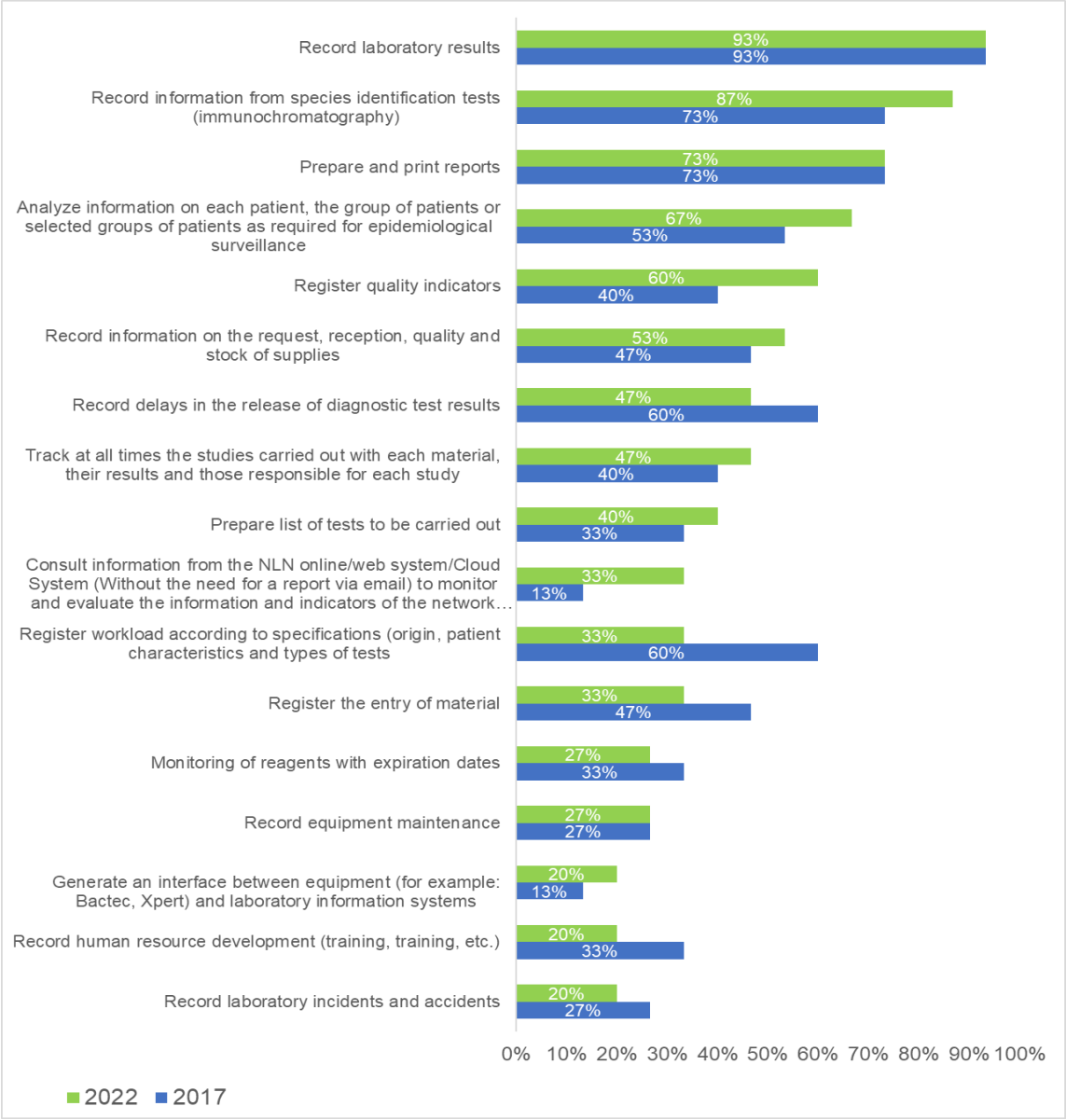


Source: Result of the survey applied to LSN and NRL in 2017 and 2022

The analysis of the availability of a proprietary information system that can record the TB bacteriology activities of the NLN was carried out, going from 8 to 7 NRL with availability of an information system. As for the system being part of the surveillance

system of the Ministry of Health, it was increased from 4 to 6 NRL, advancing in the articulation of data between the NRL and the NTP.

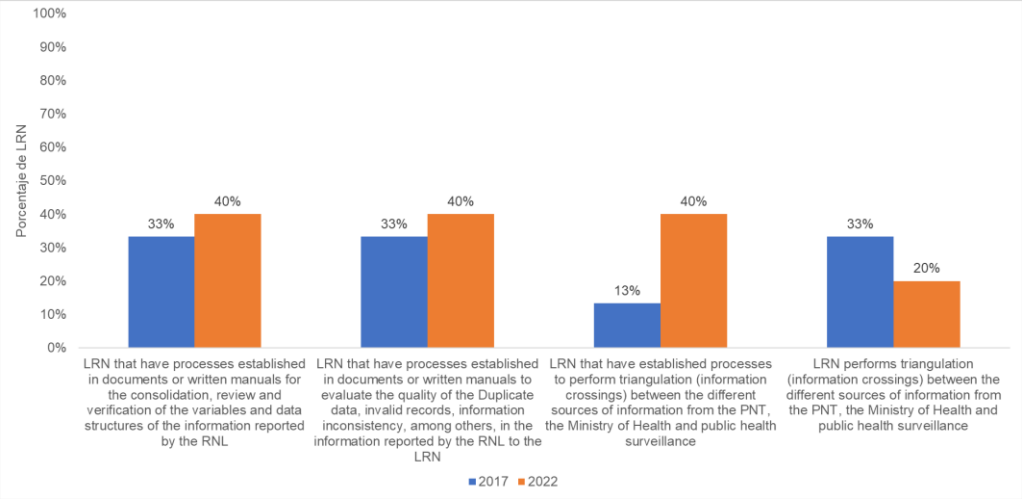
Graph 25. Comparison of the components of the information system implemented in the NRL, years 2017 - 2022



Source: Result of the survey applied to LSN and NRL in 2017 and 2022

When comparing the progress in the components of the information system in the NRL, there is evidence of progress in eight of the components, while in six there was a setback and two components are maintained. It is important to visualize these advances to continue strengthening the information systems in the NRLs of the countries participating in the project.

Graph 26. Percentage of NRLs that have established processes for data consolidation, review, and quality verification

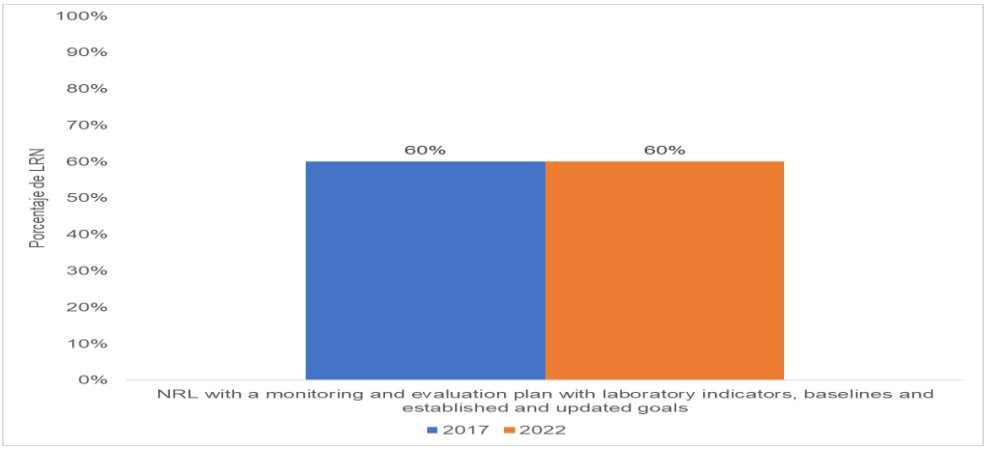


Source: Result of the survey applied to LSN and NRL in 2017 and 2022

An advance was identified in the number and percentage of NRL that have processes established in written documents or manuals for the consolidation, review and verification of the variables and data structures of the information reported by the NLN, going from 33% to 40%. %. In the same way, in the processes to evaluate the quality of the data in duplicity, invalid records, information inconsistency among others, it went from 33% to 40%.

Regarding the processes established to carry out the triangulation of the data, progress was made from 13% to 40% of the NRL, and in carrying out the triangulation of the data, it went from 33% to 20%.

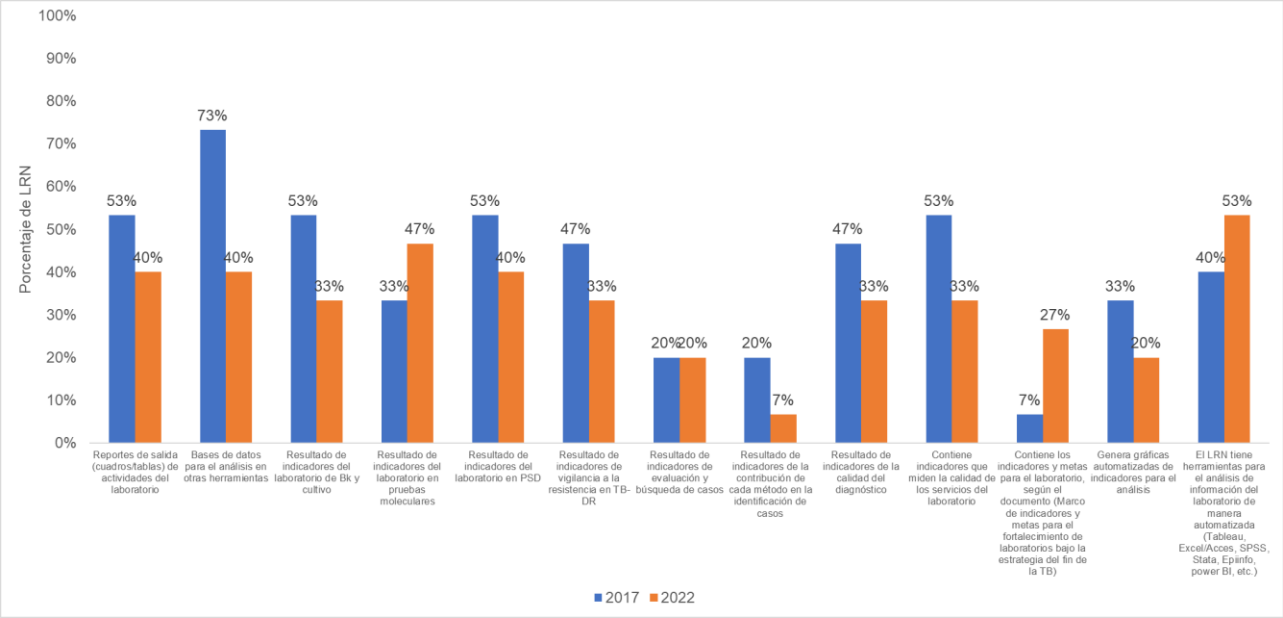
Graph 27. Percentage of NRLs with a monitoring and evaluation plan with laboratory indicators, baselines, and established and updated goals.



Source: Result of the survey applied to LSN and NRL in 2017 and 2022

The percentage of NRL with a monitoring and evaluation plan with laboratory indicators, baselines, and established and updated goals, remained at 60% between 2017 and 2022.

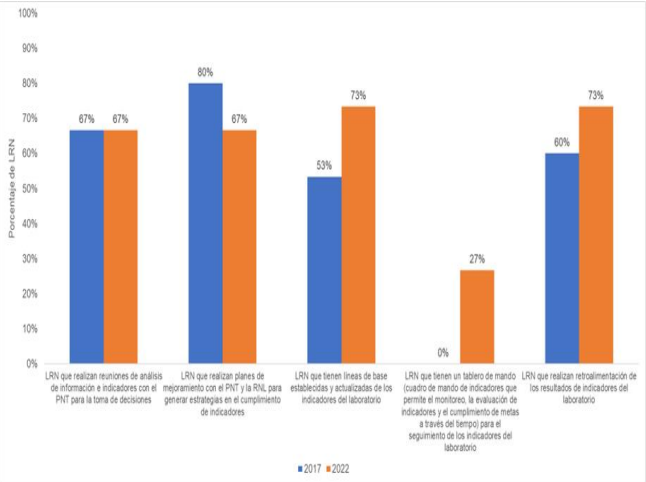
Graph 28. Comparison of the processes generated by the information system in the NRL, years 2017 - 2022

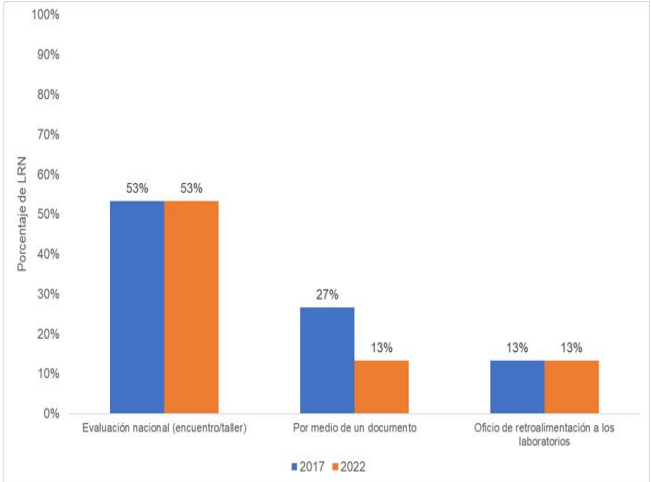


Source: Result of the survey applied to LSN and NRL in 2017 and 2022

According to the comparison, in nine processes the percentage of NRL in which the information system includes them decreases, while in three processes the percentage of NRL increases and in one it is maintained. It is important to take these processes into account in order to move towards strengthening information systems in the region.

Graph 29. Comparison of the monitoring and evaluation processes of NRL indicators and their feedback to the NLN, years 2017-2022



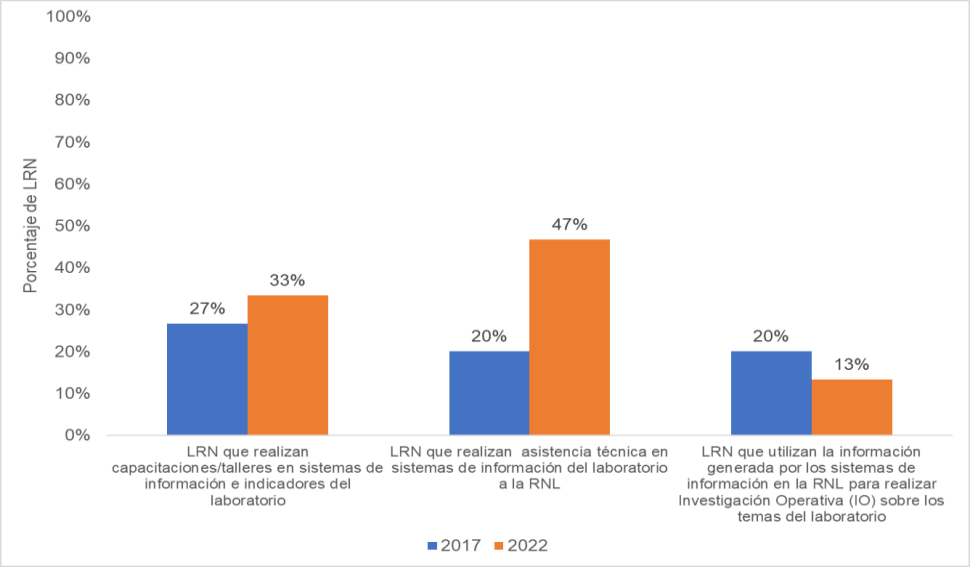


Source: Result of the survey applied to LSN and NRL in 2017 and 2022

Regarding the monitoring and evaluation processes of the NRLs, progress can be observed in three variables (base lines, indicator dashboards, and feedback on the results of the laboratory indicators). There is a setback in the improvement plans with the NTP and the NLN to generate strategies in compliance with the indicators, and the holding of NRL meetings with the NTP to analyze information and indicators for decision-making remains stable.

Feedback on the results of the NRL indicators is held annually in a meeting or workshop in 53% of the NRL in 2017 and 2022.

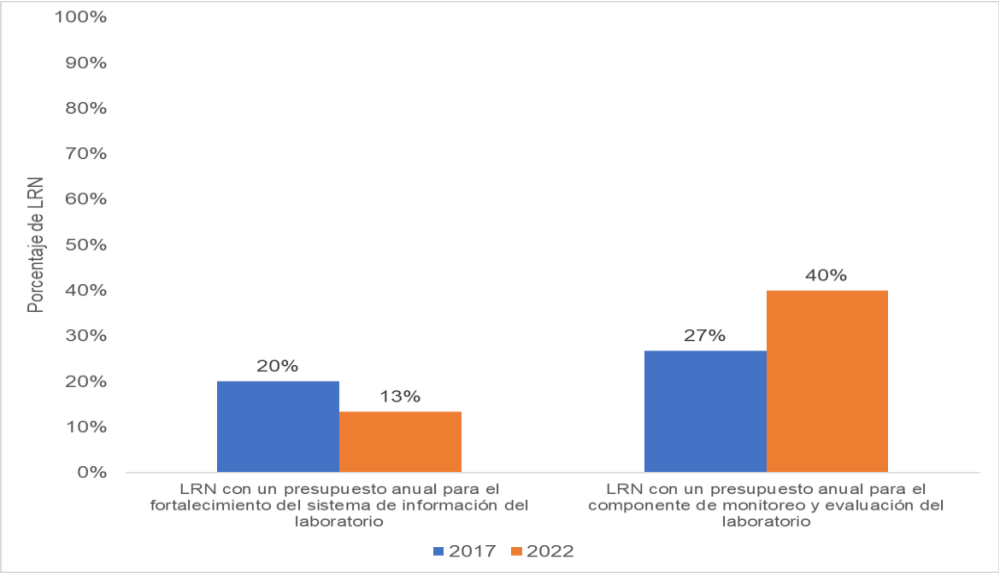
Graph 30. Comparison of variables included in knowledge management carried out by the NRL, years 2017 - 2022



Source: Result of the survey applied to LSN and NRL in 2017 and 2022

In knowledge management, progress was made in conducting training or workshops on information systems and indicators from NRL to NLN, going from 27% to 33%. However, this result remains low, considering the importance of strengthening the information system in the laboratories of the RNL. Technical assistance in information systems went from 20% to 47%, in the same way it is an important advance, but 100% of the NRL should carry out this permanent technical assistance to their NLN. In the development of operational investigations there is no progress in the number of NRL carrying out this activity permanently.

Graph 31. Percentage of NRL with annual budget for strengthening information systems and the monitoring and evaluation component of laboratory indicators, 2017, 2022



Source: Result of the survey applied to LSN and NRL in 2017 and 2022

The analysis of the budget destined for the strengthening of the information system and the monitoring and evaluation component of the laboratory was carried out. A decrease was found in the number of NRLs with an annual budget for strengthening the information system and an increase to 40% of the NRLs with a budget for the monitoring and evaluation component. This result is very low, considering the importance of the information system and the permanent monitoring and evaluation that must be carried out on the indicators of the NRL and its NLN.

10. Conclusions

- The information registered in the surveys by the LSN and NRL allowed updating the analysis of the information systems from the technological, management, status of implementation processes, availability, analysis and knowledge management, the budget for strengthening information systems, monitoring and evaluation of NRL indicators and their articulation with the NTP.

- 53% of the NRLs do not have their own information system that allows recording the information from the entry and recording of the TB sample data to the issuance of the results and their interoperability with the NTP.

- The NRL do not have an information system that allows supporting the management to be carried out with the NLN, such as the identification of gaps, technical assistance needs, information management, monitoring of indicators

to make decisions and generate information that is useful for conducting operational research in NRLs and NLNs.

- Internet connectivity in the NLN has increased in recent years, going from 18% to 44% coverage in the NLN, important if an information system for online data recording and reporting is planned.

- There is evidence of a high percentage of NLN laboratories that do not report information on TB bacteriology activities carried out in the NLN to the NRLs, which leads to having a significant bias in the calculation of indicators in countries where they do not This record is 100% fulfilled.

- The NRL do not have financial, human, and technological resources to strengthen the information system and the activities of monitoring and evaluation of indicators in the NLN and the articulation with the NTP.

- 29% of the NRL carried out training or workshops in information systems for the NLN.

- 41% of the NRL provided technical assistance to the NLN and 12% used the information generated by the information system to carry out operational research during the year 2022, these results are low considering the importance of information system management in the NLN.

- 29% of the NRLs have an interoperable system with the NTP, which contributes to clinical and epidemiological decision-making in real time, however, this percentage is low, considering the technological resources that exist to have this technology available. in the countries.

- In one of the 17 LRNs, information can be transferred between the information system of the PNT, the Ministry of Health (in other public health programs such as HIV, diabetes, mental health, vital statistics, among others), public health surveillance, and the RNL in an automated way.

- Although the project for the "Strengthening of the laboratory diagnosis of Tuberculosis in the region of the Americas" has provided tools and instruments that contribute to strengthening the quality of the data and the analysis of the information of the LRN indicators, only 7 LRN (under technical assistance) have adopted these tools, which would facilitate these processes at all levels of the data flow.

- The survey allowed a comparison of the study carried out in 2017 and the current measurement, identifying the progress in the variables analyzed in 15 NRL that participated in the first and second phase of the project

- Different advances have been made in the implementation of information systems for NRL and NLN, from paper records, Excel records and online/Web platforms. There are countries that have not advanced since the measurement carried out in 2017.

- Work continues with tools in Excel or Access that allow the collection of information, consolidation, filtering, and analysis of information. However, they are not as robust when there is a significant number of laboratories in the NLN or the information is required online or interoperable with the NTP, in addition to the reprocessing that is involved in the registration, consolidation, processing and feedback of data. the information generated to the NLN and the NTP.

- Strengthening from the generation of nominal records, system management, data quality auditing, interoperability between the NRL, NLN and NTP through the patient identification document and information analysis, entails to improve knowledge management and adequate decision-making for compliance with laboratory indicators and the tuberculosis program in the countries.

- A self-perception analysis and a SWOT analysis of the information system and the monitoring and evaluation process were carried out for each country, allowing the identification of the needs, weaknesses, opportunities, strengths, and threats that would have to be addressed to advance in the strengthening of each country.

- The results of this consultancy make it possible to identify the gaps and needs to be addressed in each country to strengthen the information systems of the NRL and NLN.

11. Recommendations

- Implement an information system according to the needs of the NRL, taking into account the human resource, the technological resource and the management that leads to the implementation of, ideally, an online system that allows interoperability between the NLN, the NRL , the health establishments, the NTP and other information systems of the Ministry of Health and that allow the

generation of the defined indicators, identify gaps in the fulfillment of the goals established by the laboratories of the NLN.

- It is important to continue advancing in the implementation of the information system in the NRLs that have started the implementation process. In NRLs that do not yet have an information system, it is important to manage the development and subsequent implementation of the system, from the reception of the samples to the issuance of the result.

- Strengthen the articulation and interoperability of information and processes between the NRL, the NLN, the TB programs and public health surveillance to generate greater knowledge of the gaps in the program and patient follow-up and strengthen the decision making by having access to information in a timely manner.

- Generate follow-up and feedback strategies for reports to increase the number of laboratories of the NLN that report laboratory activities (BK, culture, DST, molecular tests, etc.) at different stages of the information flow and from individual records. or databases.

- Generate coordination processes between the information system of the NRL, the NTP, and epidemiological surveillance in countries where these data sources have not yet been coordinated.

- Include and/or strengthen technical assistance in information, monitoring and evaluation systems and laboratory indicators carried out by the LSN to the NRL and, in turn, these to the NLN. This activity must be continuous to generate management capacity in information systems in laboratories, with commitments and improvement plans to positively impact implementation.

- Implement tools to strengthen data quality processes in NRLs and NLNs, which can be addressed with the tool provided by the project "Strengthening laboratory diagnosis of Tuberculosis in the Americas region."

- Carry out practical workshops on information systems, including topics that address the problem from the primary source of data, information processing, identification and analysis of gaps, M&E of indicators, decision-making to meet laboratory goals and the tuberculosis program based on advanced information analysis, and include the development of operational research with the information generated in the laboratory and the NTP.

- Strengthen the processes of generation, analysis, and dissemination of information through the tool for the analysis of the data delivered by the project "Strengthening of the laboratory diagnosis of Tuberculosis in the region of the Americas" that contributes to the generation of innovation in processes.

- Generate the interoperability of the GeneXpert equipment with the NRL, the NLN and the information system of the NTP, which facilitates the management of the information generated for decision-making.

- The regional tuberculosis program can consider a budget for strengthening the information system and the monitoring and evaluation processes in the NRL, based on the gaps found, the needs for technical assistance, workshops, and training to be carried out in the countries of the region.

12. Acknowledgment

We are grateful for the support received from the GTRL-TB and the people from the LSN and NRL who participated and registered the survey.

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14. Annexes

- Database of the survey registered by the NRL of the 17 countries
- Registered surveys
- Survey format in English and Spanish version