Brazilian laboratory indicators program

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Abstract

Background: This paper describes the evolution, structure, operation and some outcomes of the Brazilian Laboratory Indicators Program created by the Brazilian Society of Clinical Pathology/Laboratory Medicine (Sociedade Brasileira de Patologia Clínica/Medicina Laboratorial, or SBPC/ML), in partnership with ControlLab, a Brazilian Company that provides services for proficiency testing, internal control, calibration, and training indicators for clinical laboratories.
Methods: This web-based program is confidential for all participants. It contains 61 indicators categorized into three groups. Program operation and data analysis methods are described and indicators are reported in box plot format, with grouping varying in accordance with the profiles of the participating laboratories. Three indicators were selected as examples of program effectiveness in 2011: hemolysis, blood re-collection and productivity.
Results: Participants profile, examples of three indicators for the year 2011 (hemolysis, blood re-collection and productivity) and exploratory research conducted in 2012 on the implementation of the program are presented. Data related to laboratories participating in the program from 2006 to 2011 were collected and graphically represented.
Conclusions: The Brazilian Laboratory Indicators Program brings important benefits for participants, contributing to the improvement of existing health systems in Brazil.

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Introduction

Clinical laboratories play an essential role in healthcare management. Information from laboratory tests contributes to more than 70% of medical decisions (1). They are involved in admission of patients to healthcare facilities, diagnosis and prognosis of diseases, selection of effective therapies and monitoring and evaluation of treatment and outcome criteria. Clinical laboratories also contribute to determination of risk factors and biological states, evaluation of immunization status and health promotion initiatives (2).

Clinical laboratories must be prepared to overcome difficulties, take advantage of opportunities to increase effectiveness, improve quality and supply of value added services and implement cost improvements (2). Some studies have proposed a minimum number of quantitative indicators that can be used to define quality and outlined the main characteristics of effective clinical laboratory functioning (3–6).

Clinical laboratories were among the first organizations to assess quality in the healthcare sector (7). Programs have been in place in Brazilian clinical laboratories to analyze laboratory processes since 1975. In 1995, Brazilian clinical laboratories implemented quality assessment systems, culminating with the launching of specific accreditation programs for the sector in 1998. The Clinical Laboratories Accreditation Program (PALC) of the Brazilian Society of Clinical Pathology/Laboratory Medicine (Sociedade Brasileira de Patologia Clínica/Medicina Laboratorial, or SBPC/ML), currently based on the essential requirements of the European Communities Confederation of Clinical Chemistry (8) and the International Standard (ISO) 15189:2007 (9), is the largest of these programs in Brazil, with approximately 100 accredited laboratories.

Some reports on experiences with laboratory key performance indicators and benchmarking have been published in recent years. In 2006, Plebani described an Italian investigation of markers of effectiveness of laboratory services using data from five Italian laboratories. That study concluded that the observations and proposals made on the basis of early and later experiences have allowed a performance comparison of not only workload and efficiency indicators but also of the quality and efficacy of the entire testing process (10).

Two Spanish groups published evaluations of laboratory performance – the first over a period of 7 years (11) and the second over 4 years (12). The same group evaluated their work according to certain quality indicators in an extra-analytical

process (13). In the UK, Barth performed a survey of members of the Association for Clinical Biochemistry to study current practice according to clinical quality indicators in laboratory medicine (14). The result was published as an opinion paper regarding key performance indicators in laboratories (15).

In 2011, Sciacovelli described preliminary data from an International Federation of Clinical Chemistry Working Group on Laboratory Errors and Patient Safety and concluded the following (5):

"Model of Quality Indicators managed as an External Quality Assurance Program can serve as a tool to monitor and control the pre-, intra- and post-analytical activities. It might also allow clinical laboratories to identify risks that lead to errors resulting in patient harm: identification and design of practices that eliminate medical errors; the sharing of information and education of clinical and laboratory teams on practices that reduce or prevent errors; the monitoring and evaluation of improvement activities."

In Brazil, the first efforts toward benchmarking in clinical laboratories can be found in the work of a group of hospital laboratories in 2004 (16). In 2005, this group of PALC-accredited clinical laboratories demonstrated that indicators of process performance are an inherent part of management and continuous improvement. SBPC/ML was challenged to produce not only a consensus on effective indicators but also a practical system for monitoring individual laboratory performance. Inherent in this development is the need for comparison between clinical laboratories in a competitive market. Therefore, similar to the case in other sectors of the economy and in other countries, the tool known as benchmarking now also applies to the clinical laboratories sector. This tool, if used effectively, fosters continuous improvement.

As a result of these challenges, the Laboratory Indicator Program (LIP) was introduced, which was the result of a partnership between ControlLab and the SBPC/ML. Its objectives are to provide a basis for continuous improvement of laboratory processes, and to increase productivity, effectiveness and patient safety. In this paper, LIP program operation and data analysis are described. Data related to the participation of laboratories in the program from 2006 to 2011 were collected and are graphically represented in the following sections. Three indicators were selected as examples of program data: hemolysis, blood re-collection and productivity. Statistical summaries, graphics and a sample individual data summary of indicators obtained in 2011 are presented here. The results of exploratory research performed by ControlLab–SBPC/ML in 2012 on the implementation of the program are also presented

Materials and methods

Program operation

When registering with LIP, each laboratory receives a password to access the online system. Numerical identification of each participant is exclusive and non-transferable, and guarantees confidentiality and access to the site's data and reports. The LIP is web-based

and allows the user to send data, access information, consult reports, access documents, manage and delegate tasks and track deadlines. Each laboratory assigns an administrator to LIP who manages its relationship with ControlLab and SBPC/ML and ensures continuous participation in LIP. The administrator is in charge of the veracity of data provided. The administrator analyses reports and uses their results to improve laboratory processes. A confidentiality agreement prevents the disclosure of individual data about participating laboratories to outside parties.

Initially, each laboratory must provide profile data. These data include information about annual revenue, number of tests reported per month, the nature of the data (public, private or beneficent), location (independent clinic, hospital, university or blood bank), target sector of society (public and/or private network, emergency services, non-hospitalized and/or hospitalized individuals), achievements (certifications, accreditations and awards), level of automation of operational routines and main specialty areas offered. This information needs to be updated annually.

The program consists of numerous indicators, which are consolidated and continuously followed by users and periodically reported in the program. Currently, the program consists of 61 indicators categorized into three groups: demographic indicators, which are used to evaluate the market position of a laboratory and inform strategic decision-making; process performance indicators, which aid in monitoring the effectiveness of the operational processes in a laboratory, comprising the pre-, intra- and post-analytical phases; and resource management indicators, which allow the laboratory to verify data as to costs, productivity and training (Table 1).

Laboratories participating in LIP may also opt to initially use certain indicators intermittently when less frequent monitoring is required. Exploratory research can identify characteristics of the process related to a specific indicator. Laboratories have complete access to all indicators. Data are provided for the indicators in their respective areas of interest.

LIP cycles comprise three phases: data collection, data analysis and issuing of reports. Each phase is repeated every 3 months (in January, April, July and October of each year; Figure 1).

An advisory group is responsible for the technical analysis, evaluation and answering of questions and comments from the participants and defining improvements, suggested by the participants, which may be implemented in the program. This group does not have access to the identity of individual participants.

Users have access to an Excel® spreadsheet for calculation of each indicator and avoidance of incorrect or unexpected data. The description for each indicator includes a pre-established definition, the calculation criteria with associated numerical fields and an option to record periodicity (monthly, bi-annual, etc.), as exemplified at Table 2. Data supplied by the laboratories must strictly follow the description of each indicator in order to prevent gross errors, miscalculations or other problems that could result in erroneous data or invalid comparisons. Each laboratory receives a report one month after the data are received by ControlLab.

Data analysis, statistical analysis and results report

Statistical analysis consists of comparison with previous data, use of statistical methods and technical analysis. Once the data are received, tracking is performed to identify and exclude inconsistencies or miscalculations. The results of this tracking are presented in the laboratory reports for verification and correction in the following round.

Exclusion criteria differ for each indicator. Admissible results are defined on the basis of the results from previous rounds. We calculate the interquartile deviation of previous rounds and get a zone of five

Table 1   Laboratory quality continuous indicators.

Laboratory quality continuous indicators: demographic data	
Periodicity	Indicator
Annual	Percentage of inpatients (hospitalized patients)
Annual	Percentage of outpatients (non-hospitalized patients)
Annual	Percentage of external patients (home care and executive)
Annual	Percentage of patients with sample collection in the laboratory
Annual	Percentage of patients with sample collection by third party
Annual	Percentage of patients with sample collection by franchise
Annual	Average number of tests performed per patient
Annual	Average number of tests performed per private patient
Annual	Average number of tests performed per health plan patient
Annual	Average number of tests performed per patient from Public Health System
Annual	Percentage of outsourced tests
Annual	Average revenue per patient (Brazilian currency)
Annual	Percentage of tests performed in private patients
Annual	Percentage of tests performed in health plan patients
Annual	Percentage of tests performed in Public Health System patients
Annual	Percentage of other tests (different from the three classes above)

Laboratory quality continuous indicators: resource management	
Periodicity	Indicator
Annual	Percentage of billing spent with payroll (new)
Annual	Percentage of expense with physical area and resources
Annual	Percentage of expense with equipment
Annual	Percentage of expense with materials
Annual	Percentage of expense with personnel
Annual	Percentage of expense with specialized services
Annual	Percentage of expense with transportation
Annual	Percentage of secondary expenses (complementary operations not related to the operational aspect)
Monthly	Occupational accidents per million hours worked
Monthly	Percentage of amount rejection by all the health plans
Quarterly	Percentage of amount rejection by each health plan
Annual	Number of laboratory information system downtime episodes
Annual	Downtime of the laboratory information system
Monthly	Absenteeism rate – hours not worked per million hours anticipated
Monthly	Hours worked per employee
Annual	Percentage of general turnover
Annual	Percentage of turnover of reception desk personnel
Monthly	Average number of tests per employee
Monthly	Average number of tests per employee from technical area
Monthly	Average number of tests per employee from anatomical pathology and cytopathology areas
Monthly	Average number of tests per employee from billing
Monthly	Average number of tests per employee from reception
Monthly	Average number of tests per employee from reception desk

(Table 1 continued)

Laboratory quality continuous indicators: resource management	
Periodicity	Indicator
Monthly	Average number of tests per employee responsible for sample collection in the laboratory
Monthly	Average number of tests per employee responsible for sample collection in franchise
Bi-annual	Training hours per employee
Bi-annual	Percentage of hours in internal training

Laboratory quality continuous indicators: processes performance	
Periodicity	Indicator
Monthly	Accidents with sharp material per million of patient's sample collection
Monthly	Coagulated blood samples per million of samples collected
Monthly	Hemolysed blood samples per million of samples collected
Monthly	Blood culture contamination per million of blood samples collected
Monthly	Urine culture contamination per million of urine samples collected
Annual	Percentage of reports delivered by email
Annual	Percentage of reports delivered by website
Annual	Percentage of reports delivered at the patient's home
Annual	Percentage of reports delivered to the patient in the laboratory
Annual	Percentage of reports delivered by phone or fax
Monthly	Late reports per million of patients attended
Monthly	Rectified reports per million patients attended
Monthly	Failure to communicate critical results per million of what should have been communicated
Monthly	General re-collection per million of patients
Monthly	Re-collection for inappropriate material per million of patients
Monthly	Re-collection for confirmation per million of patients
Monthly	Re-collection for accident per million of patients
Monthly	Re-collection for other reasons per million of patients

to seven interquartile deviations, for technical analysis and definition of acceptable results.

Some indicators require full verification because they are related to other indicators, as in the case of percentage of hospitalized, ambulatory (non-hospitalized) and external patients, the total sum of which must be 100%. This is also true for re-collection indicators, the final total of which must be equal to the total sum of the different causes (accident, inappropriate material, confirmation and other reasons). Results in which the total sum does not equal 100% are excluded.

Various factors that may influence the data are selected according to the time of the year and laboratory profile characteristics, such as number and type of tests performed and public attendance figures. Regression tree and repeated measures analysis techniques (SPSS 15.0®) are then used in the analysis. Relevant groupings and aggregated monthly results are defined. Graphic representation of the results in box plot form is available only for groups that have demonstrated heterogeneity. The box plot graphically represents the indicators as follows:

- Minimum value: lesser value of the data distribution;
- First quartile: value corresponding to 25% of the data;
- Median: value corresponding to 50% of the organized data;
- Third quartile: value corresponding to 75% of the data;
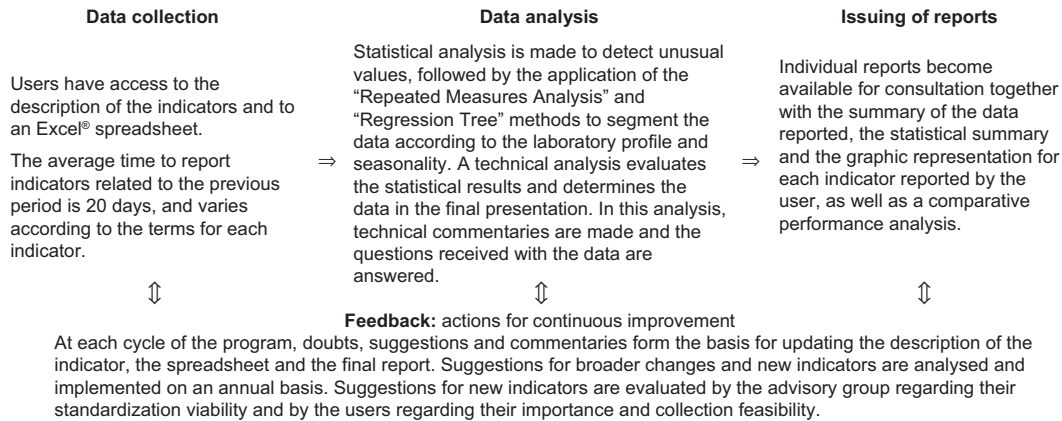- Maximum value: greater value of the data distribution.

Data collection		Data analysis		Issuing of reports
Users have access to the description of the indicators and to an Excel® spreadsheet. The average time to report indicators related to the previous period is 20 days, and varies according to the terms for each indicator.	⇒	Statistical analysis is made to detect unusual values, followed by the application of the "Repeated Measures Analysis" and "Regression Tree" methods to segment the data according to the laboratory profile and seasonality. A technical analysis evaluates the statistical results and determines the data in the final presentation. In this analysis, technical commentaries are made and the questions received with the data are answered.	⇒	Individual reports become available for consultation together with the summary of the data reported, the statistical summary and the graphic representation for each indicator reported by the user, as well as a comparative performance analysis.
⇕		⇕		⇕

Feedback: actions for continuous improvement

At each cycle of the program, doubts, suggestions and commentaries form the basis for updating the description of the indicator, the spreadsheet and the final report. Suggestions for broader changes and new indicators are analysed and implemented on an annual basis. Suggestions for new indicators are evaluated by the advisory group regarding their standardization viability and by the users regarding their importance and collection feasibility.

Figure 1 The four phases of the LIP cycles: data collection, data analysis, issuing of reports and feedback.

Whenever the indicator is related to the failure of processes, it is calculated in sigma defect metrics (defects per million opportunities), results are converted to sigma levels and relative positions are calculated to help laboratories in the comparative evaluation of their performance. For these indicators, the same value unity is used at the numerator and denominator, if it is possible, considering the value of an expression expressed in terms of some standardized measure, usually based on the quantity of the variable studied. As examples, indicators of coagulated blood samples, hemolysed blood sample, blood culture contamination and urine culture contamination use the same value unity (samples) at the numerator and denominator. However, some indicators use different value unities, as an example of blood re-collection, due to the impact of the re-collection to the patient and not per sample.

The relative position of each laboratory is obtained, with the organization of the results in the ascending order, and the data are divided into five quintiles. The first quintile represents the results for the best performance for that indicator and the fifth quintile represents the poorest outcomes.

Annual indicators forum

A meeting is held annually at the Congress of the Brazilian Society of Laboratory Medicine and Clinical Pathology to discuss the laboratory indicators programme. The one-day meeting brings together up to 120 laboratory professionals, including program users and others interested in the topic. A central theme is set and experiences with the chosen indicators discussed. Laboratories with good performance for a given indicator present their experiences and describe practices adopted to achieve this goal. Details related to each indicator and useful means of monitoring processes are discussed. International practices, data from the literature and results of previously conducted exploratory research enrich the discussion.

Results

Participant profiles

LIP began operating in 2006 with 151 registrations. Currently 164 Brazilian laboratories are registered as participants. The number of participants increased from 2006 to 2009 and slightly decreased from 2009 to 2011. However, the number of continuous participants, from 2009 to 2011 remains the same. Overall continuous active participation is 50–70% (Table 3).

In 2011, LIP participation of laboratories in the five Brazilian regions was as follows: 60% in the Southeast region, 23% in the North-Eastern region, 7% in the South region and 10% in the North and Central-Western regions. Most participating laboratories were private (81%) and independent (61% not linked to hospitals). In terms of certification, 38% were certified by PALC and the SBPC/ML, 45% were certified by ISO 9000 and 20% were certified by the National Accreditation Organization. Most laboratories served non-hospitalized individuals (99%), and 58% served the hospital network. The private network included 88% of the laboratories, while 46% of laboratories served the public network. For these indicators, laboratories were allowed to choose more than one alternative, and the sum may be higher than 100% (Table 4).

Indicators

As previously mentioned, three indicators were selected as examples of program effectiveness for the year 2011: hemolysis, blood re-collection and productivity. The results for these three indicators obtained in 2011 are presented in Figures 2–4.

The results of productivity are an example in which the statistical analysis identified heterogeneity of segmented data and were represented in two graphs, depending on the volume of tests performed monthly (laboratories up to and above 125,000 tests per month).

Table 5 presents an example of the report received by each participant, where the results reported are converted to sigma, and classified to the relative position, which allows the immediate location of the laboratory compared to the performance of other participants.

Exploratory research about the implementation of LIP

A query about the implementation of the program was carried out in 2011 in the form of a survey answered by 83 users. The results are shown in Table 6. Of the 83

Table 2   Indicators description.

Indicator	Hemolyzed samples
Description	Hemolyzed samples collected per million of samples collected in the month
Restriction	Consider all samples with some degree of hemolysis, independently of the method used to detect it (visual inspection, scale to compare or serum index measured) if it generates re-collection or not, and if the hemolysis is detected in all tubes collected or not. Do not report the indicator if does not follow this recommendation
Formula	$\dfrac{\text{Total of hemolyzed samples} \times 1{,}000{,}000}{\text{Total of blood samples collected}}$
Periodicity	Monthly calculated and quarterly reported
Unity	Hemolyzed samples/millions of samples
Format	##

Indicator	Productivity
Description	Number of tests performed per employees at the technical area in the month
Formula	$\dfrac{\text{Total tests performed}}{\text{Number of employees at technical area}}$
Periodicity	Monthly calculated and semiannual reported
Unity	Tests/employee
Format	###
Comments	Include every test performed and the employees of all technical areas. Do not include employees working in reception, administrative and maintenance activities. For the 'Number of employees', consider the full-time activity. For example, a professional who devotes only part-time activity should be counted as 0.5 employees.

Indicator	Re-collection
Description	Re-collection of samples per million patients attended in the month.
Formula	$\dfrac{\text{Total patients with re-collection of samples by class} \times 1{,}000{,}000}{\text{Total of patients attended}}$
Periodicity	Monthly calculated and quarterly reported
Unity	Re-collection/millions of patients
Format	##, ###
Comments	To report this indicator, the laboratory must inform the re-collection rates in each class: • General re-collection: need of re-collection of biological samples of patients, due to inappropriate materials, accidents with samples, confirmation of results and for other reasons, compared to the total number of patients attended in the period. • Re-collection for inappropriate materials: re-collection of biological samples of patients caused by inappropriate materials, against the total number of patients attended. Inappropriate materials should be considered in following situations: container/preservative wrong, insufficient material, transported improperly, not seeded, collected in inade-quate time with lipemia, clotted, deteriorated, with hemolysis, or others that impede its realization. • Re-collection for result confirmation: re-collection of biological samples of patients for confirmation of results against the total number of patients attended, due to divergence of the previous result, result inconsistent with clinical information, questioning of the result by the physician or patient, etc. • Re-collection for accident sample: re-collection of biological samples of patients caused by accident of the previous sample (loss, spill, break, etc.) against the total number of patients attended. • Re-collection for other reasons: re-collection of biological samples of patients compared to the total number of patients seen. Consider other reasons for the re-collection that cannot be classified as re-collection for inappropriate material, for accident sample or for result confirmation, such as error in the registration, test not performed, not collected sample, sample unmarked, sample not delivered to the sector, etc. • The sum of re-collection for inappropriate material, for result confirmation, for accident sample and for other reasons must be equal to the general re-collection figure.

Table 3   Participation profile.

Year	2006	2007	2008	2009	2010	2011
Registered	151	186	187	202	180	164
Active participants	105	89	111	118	102	91
Continuous participants	54	47	37	53	54	53
Participants with minimum involvement	51	42	74	65	48	38
% active participation	70%	48%	59%	58%	57%	55%

responses, 40 were from laboratories with continuous participation, 21 from laboratories with minimal participation and 22 from laboratories that were enrolled in the program but were unable to implement it at the time. Of this last group, the answers to only two questions (1.3 and 4.2) were considered.

For laboratories that do participate, LIP has proved successful. In total, 91% of participants reported using the indicators as a strategic or complementary tool to improve

Table 4 Participant profile.

Number of tests realized monthly			Laboratory status	
Up to 3000 tests/month	3%		Independent	61%
3001–12,500 tests/month	0%		Based in a blood bank	4%
12,501–25,000 tests/month	12%		Based in a hospital	33%
25,001–50,000 tests/month	13%		Based in a university hospital	6%
50,001–125,000 tests/month	43%		Based in a university, out of hospital	0%
125,001–250,000 tests/month	19%		Proper healthy plan operator	6%
More than 250,000 tests/month	10%			
			Attended public	
Nature			Outpatients (non-hospitalized patients)	99%
Beneficent	6%		Inpatients (hospitalized patients)	58%
Mixed economy	6%		Inpatients (hospitalized patients):	65%
Private	81%		UTI/emergency	
Public	7%		Blood bank patients	10%
			No answer	0%
Brazilian region			Attended networks	
Central-West	6%		Private	88%
North-East	23%		Public	46%
North	4%		No answer	0%
South-East	60%			
South	7%		Recognitions obtained by the laboratory	
			Certification ISO Series 9000	45%
Localization			Accreditation LAP (CAP)	3%
Capital city	49%		Accreditation DICQ (SBAC)	7%
Interior city	51%		Accreditation ONA	20%
			Accreditation PALC (SBPC/ML)	38%
			Other certifications/awards	36%
			No certifications/awards	12%

performance, and 80% reported that LIP has effectively helped to define strategies and actions for improvement in their organizations.

Based on the responses to this survey, some improvements were implemented and indicators modified in terms of periodicity and organization. Availability of the Excel® spread sheet was increased, sporadic indicators were included, exploratory research was implemented and behavioral studies were initiated.

Annual indicators forum

Table 7 describes the results of the annual forum, in number of participants, satisfaction with the event (based on content applicability, attendance expectations and exchange of knowledge), and intention to attend the forum in the next year.

Discussion

Benchmarking is among the many tools that help organizations survive in a competitive scenario. It is a widely known and useful practice, already tested in the laboratory sector in several parts of the world (17). For laboratories to participate in a program such as LIP, the indicators need to be measured, results rigorously analyzed and performance must be broadly disseminated. The responsibility for implementing continual improvement rests with the participating laboratory, but in

a competitive environment better performance results from benchmarking against peers (18).

In Brazil, some characters of the sector, such as the small size of the laboratories, the use of home-developed laboratories informatics systems and the shortage of laboratorial staff, make the collection of data and the participation at benchmarking programs difficult. These difficulties are reflected in the low participation rate of Brazilian laboratories in programs of this nature when compared to the number of clinical laboratories operating in the country (almost 17,000) according to the Healthy Establishments National Census in 2011 (19). However, the value of this initiative is demonstrated by the immediate registration of 150 laboratories in LIP and the attendance of professionals at the Annual Indicators Forum held by SBPC/ML–ControlLab.

The reduction of the number of participants, active participants and participants with minimum involvement, with the maintenance of the number of continuous participants and percentage of active participation presented at Table 2, may demonstrated the level of difficult to laboratories obtain the data related to the indicators.

Behavioral studies can be performed on the basis of exploratory research. Such indicators are useful for clarifying results, comparing data, analyzing aspects of processes related to performance, identifying probable causes of poor performance, detecting excellence and suggesting methods of improvement.

One of the key factors critical to the success of LIP is the standardization of indicators to ensure that all data entered
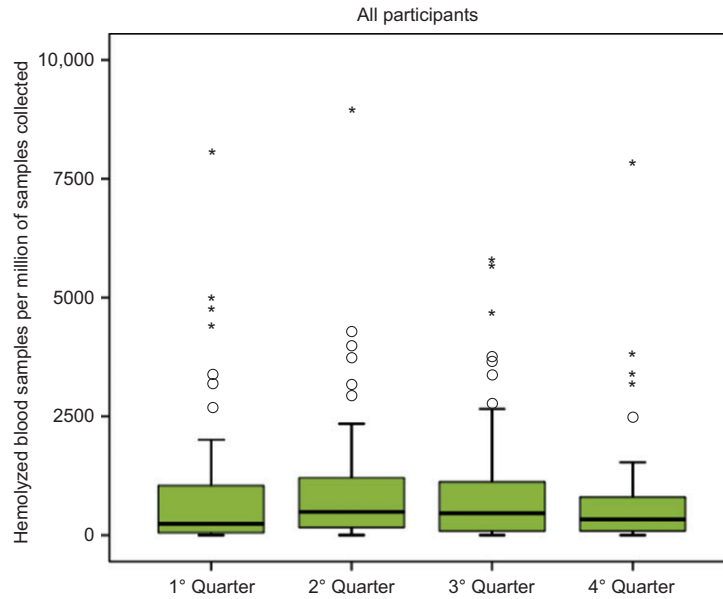
ANNUAL STATISTICAL SUMMARY (HEMOLYZED BLOOD SAMPLES PER MILLION OF SAMPLES COLLECTED)

Indicator	Segmentation	Period	n	Minimum	1st Quartile	Median	3rd Quartile	Maximum
Hemolysis	All	1st Quarter	52	0.00	48.83	237.17	1039.83	8065.00
of samples	Participants	2nd Quarter	54	0.00	159.67	486.17	1206.33	8969.67
		3rd Quarter	53	0.00	85.00	458.33	1116.67	5735.33
		4th Quarter	46	0.00	86.67	329.33	796.00	7886.33

ANNUAL STATISTICAL SUMMARY – SIGMA LEVEL

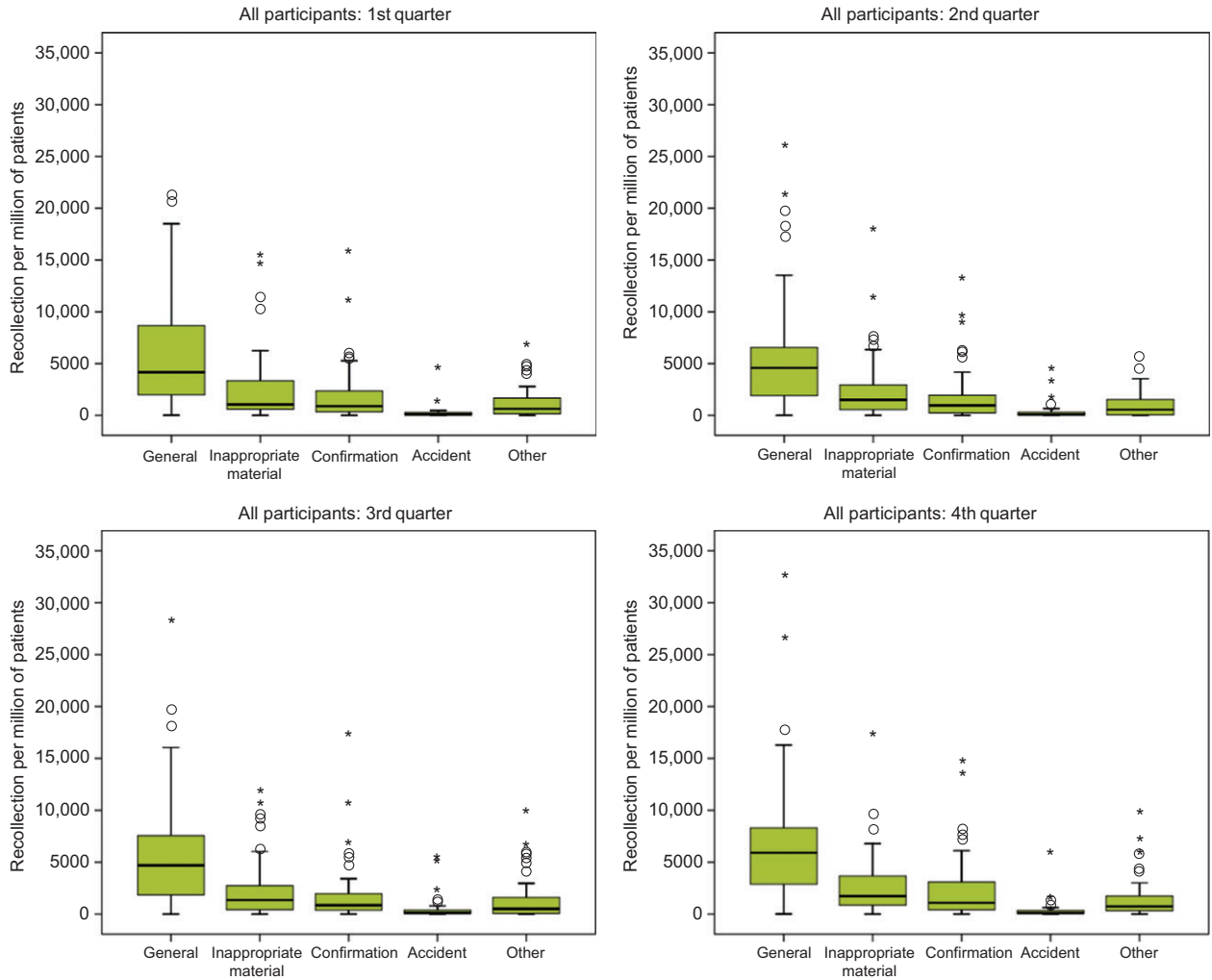| Indicator	Segmentation	Period	n	Maximum	3rd Quartile	Median	1st Quartile	Minimum
Hemolysis	All Participants	Jan	52	>7	5.9	5.0	4.6	4.0
of samples		Feb	52	>7	5.8	5.1	4.7	3.9
		Mar	52	>7	5.8	5.0	4.5	3.8
		Apr	53	>7	5.3	4.8	4.5	3.9
		May	53	>7	5.2	4.9	4.5	3.9
		Jun	54	>7	5.3	4.9	4.6	3.8
		Jul	53	>7	5.5	4.8	4.6	4.0
		Aug	53	>7	5.2	4.8	4.6	4.0
		Sept	53	>7	5.5	4.8	4.5	4.1
		Oct	46	>7	5.3	4.9	4.6	3.9
		Nov	46	>7	5.3	4.9	4.6	3.9
		Dec	46	>7	5.6	5.0	4.6	3.9

Figure 2 Process performance indicator: hemolysis of samples.
n: number of participating laboratories.

for each laboratory are comparable. To this end, different tools are used to assure the standardization of indicators, as individual reports sent to each laboratory provide complete descriptions of the indicators, an Excel® spread sheet with warnings about incorrect or unexpected data, exclusion criteria, admissible results and verification methods applied during statistical analysis. These actions help laboratories to understand the indicators clearly, collect the required data and make any necessary changes or calculations.

The use of sigma metrics (defects per million opportunities) for indicators related to process success or failure facilitates performance comparison and standardizes the basis for comparison of different laboratory processes. In addition,

sigma metrics more accurately represent measures that could be mistakenly considered lower if a percentage index were used. Laboratories thus avoid the false sense of security about their performance that may occur if quality indicators presented low variance percentages (20), especially considering the large volume of tests performed by laboratories and their potential impact on clients. The presentation of laboratory results in the form of sigma level and information about the relative positions of laboratories assist LIP users in planning strategy against market realities and defining goals more consistent with national practice.

The levels of active and minimal participation in LIP demonstrate that not all registered laboratories are completely

ANNUAL STATISTICAL SUMMARY (RECOLLECTION PER MILLION OF PATIENTS)

Indicator	Segmentation	Period	n	Minimum	1st Quartile	Median	3rd Quartile	Maximum
General Re-collection	All participants	1st Quarter	62	17.00	1977.50	4154.58	8664.00	21320.33
Re-collection for inappropriate material	All participants	1st Quarter	59	0.00	582.17	1051.00	3325.83	15410.33
Re-collection for confirmation	All participants	1st Quarter	58	0.00	348.00	885.67	2342.33	15838.00
Re-collection for accident	All participants	1st Quarter	56	0.00	0.50	118.67	284.00	4571.33
Other Re-collections	All participants	1st Quarter	59	0.00	154.00	625.00	1662.17	6816.00
General Re-collection	All participants	2nd Quarter	55	0.00	1894.33	4575.00	6548.67	26050.00
Re-collection for inappropriate material	All participants	2nd Quarter	55	0.00	547.67	1503.00	2933.00	17941.00
Re-collection for confirmation	All participants	2nd Quarter	55	0.00	238.67	965.83	1946.67	13267.67
Re-collection for accident	All participants	2nd Quarter	55	0.00	2.00	105.67	295.33	4586.67
Other Re-collections	All participants	2nd Quarter	55	0.00	40.33	553.58	1533.50	5643.00
General Re-collection	All participants	3rd Quarter	63	2.00	1856.50	4692.67	7553.83	28445.00
Re-collection for inappropriate material	All participants	3rd Quarter	60	0.00	427.67	1353.17	2741.83	11932.67
Re-collection for confirmation	All participants	3rd Quarter	60	0.00	369.00	852.50	1969.33	17330.67
Re-collection for accident	All participants	3rd Quarter	58	0.00	21.33	126.00	377.67	5352.67
Other re-collections	All participants	3rd Quarter	59	0.00	55.00	501.67	1610.00	9978.33
General Re-collection	All participants	4th Quarter	55	15.67	2867.17	5913.00	8307.83	32764.67
Re-collection for inappropriate material	All participants	4th Quarter	52	5.33	849.75	1730.17	3677.00	17486.00
Re-collection for confirmation	All participants	4th Quarter	52	0.00	400.83	1090.00	3081.50	14747.00
Re-collection for accident	All participants	4th Quarter	51	0.00	22.17	119.00	347.67	5861.33
Other Re-collections	All participants	4th Quarter	52	0.00	318.42	740.50	1727.67	9781.00

Figure 3 Process Performance Indicator: Re-collection.
n: number of participating laboratories.
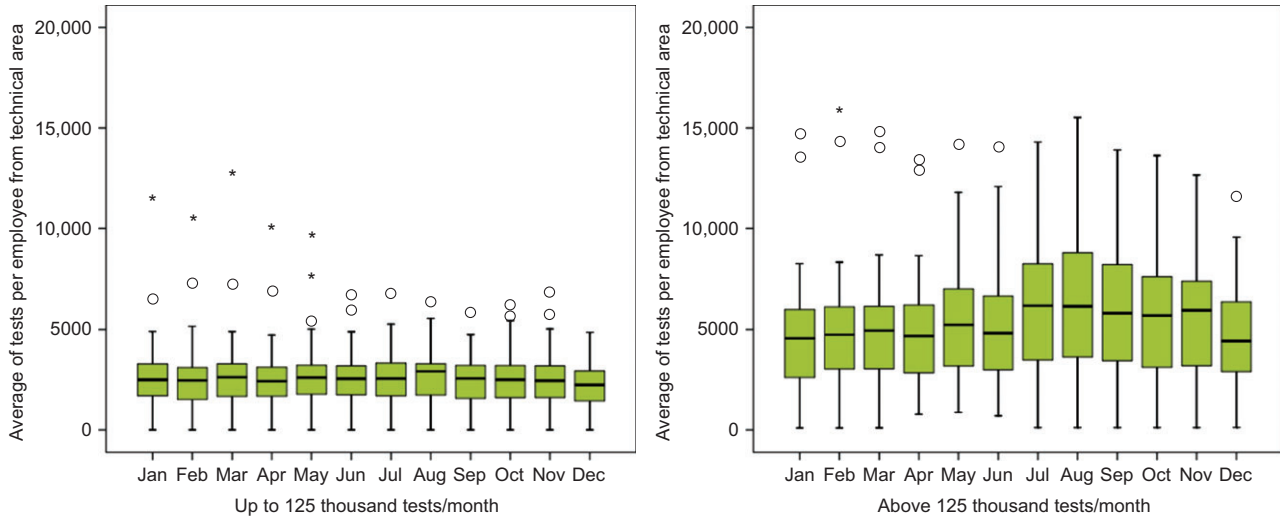
ANNUAL STATISTICAL SUMMARY (AVERAGE OF TESTS PER EMPLOYEE FROM TECHNICAL AREA)

Indicator	Segmentation	Period	n	Minimum	1st Quartile	Median	3rd Quartile	Maximum
Technical personnel productivity	Up to 125 thousand tests/month	Jan	41	3.14	1706.00	2499.00	3284.00	11515.00
		Feb	41	3.21	1513.00	2465.00	3106.00	10560.00
		Mar	41	3.15	1679.00	2627.00	3286.00	12763.00
		Apr	42	3.39	1681.00	2427.00	3122.00	10077.00
		May	42	3.97	1780.00	2611.00	3217.00	9681.00
		Jun	42	3.81	1751.00	2554.00	3186.00	6685.00
		Jul	35	4.09	1702.00	2560.00	3324.00	6800.00
		Aug	35	4.11	1736.00	2914.00	3296.00	6356.00
		Sept	35	3.92	1578.50	2563.00	3215.50	5842.00
		Oct	37	3.68	1616.00	2506.00	3209.00	6188.00
		Nov	37	3.68	1623.00	2451.00	3190.00	6835.00
		Dec	37	3.09	1437.00	2243.00	2937.00	4861.00
Technical personnel productivity	Above 125 thousand tests/month	Jan	16	94.00	2613.00	4558.00	5989.00	14735.00
		Feb	16	99.00	3025.50	4744.50	6128.00	15900.00
		Mar	16	100.00	3041.50	4950.50	6152.00	14838.00
		Apr	16	784.00	2845.00	4680.00	6218.50	13437.00
		May	16	867.00	3178.50	5233.50	7012.00	14236.00
		Jun	16	704.00	2994.00	4821.50	6665.00	14094.00
		Jul	16	113.00	3469.50	6180.00	8262.00	14297.00
		Aug	16	115.00	3621.00	6153.00	8808.50	15516.00
		Sept	16	118.00	3441.50	5812.00	8230.00	13907.00
		Oct	18	117.00	3112.00	5695.50	7626.00	13632.00
		Nov	18	116.00	3196.00	5953.00	7397.00	12651.00
		Dec	18	124.00	2906.00	4414.50	6376.00	11593.00

Figure 4 Resources Management Indicator: Productivity of Technical Personnel.
n: number of participating laboratories.

prepared to make the changes necessary for improvement, but joining the program is the first step in an effort to improve their processes and businesses. The results of the exploratory research about the implementation of LIP demonstrate that users of the program have experienced real benefit in becoming more efficient and competitive in their organizations.

However, many internal barriers remain to be overcome by participating laboratories. These barriers include implementing automated data collection, accessing raw data necessary to calculate the indicators, obtaining effective participation of different laboratory departments in data collection,

understanding of graphs and tables offered in the program and finding time for the analysis of program and individual reports together with managers and directors.

The decision to organize an original Brazilian program was based on the fact that benchmarking initiatives already implemented in other countries were not fully applicable to the clinical laboratory sector in Brazil. Differences in healthcare systems, economic and legal realities, regulations and business environments also informed this decision. Although comparison of results obtained from laboratories in other countries with those obtained in Brazilian laboratories would

Table 5   Example of laboratorial individual data.

Indicator	Results			Sigma level			Relative position
	Oct 2011	Nov 2011	Dec 2011	Oct 2011	Nov 2011	Dec 2011	
Technical personnel productivity (average of tests per employee from technical area/σ)	3134	3099	2780	NA	NA	NA	2nd
Hemolysys of samples (hemolyzed blood samples per million samples collected σ)	166	276	474	5.09	4.95	4.81	3rd
General re-collection (recollection per million patients/σ)	5170	5872	6697	4.06	4.02	3.97	3rd
Re-collection for inappropriate material (recollection per million patients/σ)	680	1233	1276	4.70	4.53	4.52	2nd
Re-collection for confirmation (recollection per million patients/σ)	626	295	319	4.73	4.94	4.91	2nd
Re-collection for accident (recollection per million patients/σ)	27	107	159	5.54	5.20	5.10	3rd
Other re-collections (recollection per million patients/σ)	3836	4237	4943	4.17	4.13	4.08	5th

Table 6   Results of research on implementation of the Laboratory Indicators Program.

Frequency of participation	No participation	Minimal	Continuous	Total
n, %	22 (26%)	21 (25%)	40 (48%)	83
Data collection				
The indicators data collection is:				
• (Almost) completely manual	–	10%	8%	8%
• Partially automated	–	57%	63%	61%
• (Almost) completely automated	–	33%	30%	31%
Are the data collection and the calculation of indicators made according to the description provided in the program?				
• Yes, I read the document and follow its instructions	–	90%	98%	95%
• No, I didn't even know of this document	–	0%	3%	2%
• No, I never had time to read this document	–	0%	0%	0%
• No, the indicators are intuitive	–	0%	0%	0%
• Other	–	10%	0%	3%
Is there any difficulty or restriction related to data collection? Select only the more significant ones.				
• Some data are difficult to obtain, I do not have the means to track them	59%	76%	80%	73%
• The other teams are not able to help	18%	10%	13%	13%
• It is too laborious to raise the data and I don't have the time	27%	0%	0%	7%
• In some cases, we do not feel comfortable to report the data	9%	0%	3%	4%
• In some cases the data are considered as confidential	23%	24%	10%	17%
• We have no difficulties in collecting the data	5%	0%	10%	6%
• Other	23%	0%	5%	8%
The data collection is				
• (Almost) exclusively my responsibility and my team's responsibility	–	57%	45%	49%
• Shared with other teams/management areas	–	43%	55%	51%
Calculation of indicators				
Are the calculations of indicators made through the spreadsheet provided in the program?				
• Yes, I use the program spreadsheet to calculate the indicators	–	90%	88%	89%
• No, I use a spreadsheet that I (and my team) have created	–	10%	13%	11%
Analysis of reports				
Do you analyse the program reports in each quarter?				
• All were analysed	–	29%	68%	54%
• I have analysed them several times	–	19%	20%	20%
• I have analysed them 50% of the time	–	5%	8%	7%
• I have never analysed them	–	38%	3%	15%
• I have analysed them a few times	–	10%	3%	5%
Is there some difficulty or restriction for the analysis of the reports of the program? Select the most important.				
• There is no difficulty	–	29%	53%	44%
• Not always, I have time to analyse them	–	14%	3%	7%

(Table 6 continued)

Frequency of participation	No participation	Minimal	Continuous	Total
• I don't fully understand the graphics and data	–	62%	40%	48%
• I don't see much use for the data contained in the report	–	0%	3%	2%
• Other	–	0%	8%	5%
If you have already analysed any report, those analyses were made:				
• Only by me or my team (if you are from high management)	–	43%	23%	30%
• With high management	–	5%	23%	16%
• With high management and managers of the interested areas	–	43%	48%	46%
• With high management, managers and employees of interested areas	–	5%	10%	8%
The indicators are used by the laboratory:				
• As a strategic tool to verify the business and processes performance	–	29%	33%	31%
• As an operational tool for process control	–	67%	68%	67%
• They are not really used to track the performance	–	10%	5%	7%
• Other	–	5%	0%	2%
Experiences				
Has the indicators program already helped you define any strategic or improvement action?				
• No	–	38%	10%	20%
• Yes	–	62%	90%	80%
Does the laboratory have different indicators than the ones included in the program?				
• No	86%	67%	33%	75%
• Yes	14%	33%	68%	61%

Table 7 Annual Indicators Forum results.

Theme	2006	2007	2008	2009	2010	2011
	Indicators implementation	Customer services	Indicators practical application	Patient safety	People management	Pre-analytical management
Participants, n	70	100	130	109	111	82
LIP participants	100%[a]	66%	64%	75%	75%	80%
Overall satisfaction	89%	74%	94%	96%	98%	98%
Applicability	84%	66%	94%	99%	97%	84%
Attendance expectations	87%	64%	93%	96%	100%	94%
Exchange of knowledge	–	–	99%	96%	95%	91%
Intention to attend the next event	–	74%	95%	94%	94%	95%

[a]Exclusive for LIP participants.

be interesting and useful, these differences limit comparison. The Brazilian LIP allows comparison between laboratories operating in the same environment. International experiences were therefore used as a basis for description and selection of indicators for the program.

Conclusions

The implementation of LIP in Brazil by the SBPC/ML and ControlLab allowed the Brazilian clinical laboratory community to have access to a tool that may contribute to continuous improvement of the functioning of the laboratories. Laboratories can now consider their own characteristics in relation to those of the larger Brazilian laboratory environment. The future of LIP depends on the motivation and increased participation of the laboratories in Brazil. A critical mass of participants is required in order to extend the basis for comparison and constantly improve indicators and quality of the information obtained.

Conflict of interest statement

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