

QUALITY IN LABORATORY MEDICINE AND ISO 15189 ACCREDITATION

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ABSTRACT: Quality assurance in medical laboratories is vital for ensuring patient safety and enhancing healthcare outcomes. Over the years, laboratory professionals have implemented various quality assurance tools to evaluate and monitor performance, including internal quality control procedures, external quality assessment/proficiency testing programs, use of quality indicators, and implementation of accreditation and certification processes.

Accreditation according to the International Standard ISO 15189 marked a significant milestone by focusing on quality and competence criteria specific to medical laboratories. The peculiarity of ISO 15189 lies in its comprehensive framework, which integrates management principles, technical specifications, and clinical approaches. It emphasizes professional competence, ethical conduct, and collaboration with healthcare stakeholders; its structure aligns with other international standards, enhancing clarity and manageability.

ISO 15189 accreditation empowers laboratory specialists to play a crucial role in diagnostic and therapeutic pathways. The introduction of point-of-care testing requirements in the 2022 edition underscores the importance of governance by qualified laboratory professionals to ensure the training and competency development of non-laboratory personnel. Although ISO 15189 accreditation is internationally recognized and is mandatory for medical laboratories in many countries, efforts should be made to ensure wider adoption of this process to harmonize laboratory practices at the highest level of quality and gain confidence in laboratory performance.

KEYWORDS: Accreditation, Quality assurance, ISO 15189, Patient safety.

INTRODUCTION

Over the years, the term “quality” in medicine has become widespread, and its significance remains paramount. The concept of quality has become synonymous with ensuring patient safety, thus indicating change in healthcare paradigms. In recent years, there has been increased attention toward quality in medicine, particularly in clinical laboratories, and the use of quality assurance tools has evolved significantly over the past decades.

Plebani¹ eloquently illustrated in his work how quality has evolved alongside the transformation of clinical laboratories over the past seven decades. Laboratory professionals faced important challenges, navigating through rapid technological advancements and scientific progress; they emerged as key players in managing new approaches to diagnosis and therapy. Once performed manually in small laboratories, laboratory testing has evolved into highly automated systems capable of performing millions of tests annually. The first efforts focused predominantly on enhancing automation and standardizing examination procedures, leading to a remarkable reduction in analytical errors over time. Laboratory professionals have become increasingly aware of the importance of ensuring the reliability of laboratory results in the patient management setting. Thus, they have identified further quality assurance tools to verify the level of performance reliability and monitor it over time.

Early quality assurance systems introduced into medical laboratory practice, such as internal quality control (IQC) procedures based on the statistical analysis proposed by Levey and Jennings² and inter-laboratory comparison programs proposed by Belk and Sunderman³, laid the basis for modern quality assessment frameworks.

For many years, the quality assurance tools used in medical laboratories have included IQC to monitor the stability of analytical procedures and the participation in external quality assessment/proficiency testing (EQA/PT) programs to keep control of the accuracy of results.

The use of IQC is well-known due to the availability of numerous national and international guidelines and recommendations describing the correct procedures to be implemented^{4,5}. Similarly, quality specifications for effective participation in EQA/PT have been established⁶⁻¹².

The availability of recognized documents issued by authoritative bodies and expert working groups depends on the extensive use of these tools in medical laboratories over the years. In fact, daily use has revealed the critical issues and, consequently, the need to structure and harmonize practices through the establishment of reliable quality specifications reported in approved documents.

However, when laboratory professionals realized that the examination process is not limited to the purely analytical phase but also encompasses all activities preceding it (beginning with the formulation of the request) and those following it (ending with the correct interpretation of the laboratory report), they understood that further assurance tools were needed.

Indeed, the concept of the “brain-to-brain loop,” associated with laboratory processes, was introduced by Lundberg¹³ in 1981 when he expanded and defined all activities within the laboratory process under the responsibility of laboratory professionals. However, it was only after several years (around 1997) that laboratory professionals fully realized the importance of this concept and the need for comprehensive quality evaluation systems to monitor all stages of the total testing process (TTP). This awareness among laboratory professionals was also achieved thanks to the studies conducted by Plebani and Carraro¹⁴⁻¹⁷, which brought to light the types and origins of errors associated with all TTP activities, revealing that a significant number of errors occur in the pre-analytical and post-analytical phases. This highlighted the importance of implementing systems to mitigate errors, especially in the extra-analytical phases; therefore, additional quality assurance systems were implemented in association with IQC procedures and EQA/PT. These include the use of quality indicators, implementation of accreditation procedures, and risk management protocols, all of which aim to enhance overall laboratory quality and patient safety. The use of quality indicators to monitor undesirable events occurring in TTP activities is not yet widespread, despite its importance and the usefulness of the data in risk analysis procedures¹⁸⁻²⁰. However, as laboratory medicine is continuously evolving and transforming, it will be necessary to carefully and continuously analyze the context to identify what new quality assurance tools may be required. It is enough to consider the widespread use of big data, artificial intelligence, increasingly sophisticated computing tools, and telecommunication interconnection. All these important opportunities for medical laboratories, stemming from advances in the healthcare context, may necessitate implementing new control tools to ensure proper management of their use and positive findings.

Importantly, the effectiveness of these tools depends on the awareness level achieved by laboratory professionals regarding their importance and correct and suitable use in the context of the mission of laboratory medicine. If the medical laboratories want to play a role in modern healthcare, they must:

- ensure the quality of laboratory tests (irrespective of where they are performed) in both central laboratories and decentralized testing areas (e.g., areas where point-of-care testing [POCT], is used);
- improve the quality of services by assuring quality in all phases of the TTP (pre-, intra-, post-analytical), providing accurate results and effective information, clinically adequate turnaround times, effective communications with clinicians, and patient-centered services, etc.;
- improve medical outcomes through efforts to evaluate and continuously improve the interpretation and utilization of laboratory data for the management of patient care;
- undertake joint laboratory/clinical research projects;
- review the quality assurance tools in use, adapting them to the needs emerging from the continuously evolving and transforming context, and identifying additional quality assurance tools.

In the current context, laboratory professionals need to demonstrate conformity to high-quality performance standards. On the other hand, the introduction of the European Regulation *In vitro* Diagnostic Devices 2017/746 has brought attention to ISO 15189 accreditation. A wide discussion is now underway regarding ISO 15189 accreditation and the difficulties of its application.

This work aims to highlight the peculiarities of ISO 15189 accreditation and the advantages linked to its implementation.

ISO 15189 ACCREDITATION

The latest edition of the international standard ISO 15189, released in 2022, titled “Medical Laboratories - Requirements for quality and competence”, establishes criteria for quality and competence and is specifically designed to ensure a high standard of quality in laboratory testing and to promote confidence in the results and information produced by medical laboratories^{21,22}.

It represents an important tool for laboratory professionals to achieve and maintain performance at excellence levels. The standard recognizes the fundamental role of medical laboratories in patient care. Compliance with its requirements enables laboratories to meet the needs of patients and healthcare providers, align criteria and procedures with the best available practices, and achieve excellent performance. Therefore, ISO 15189 accreditation is an adequate tool to demonstrate the laboratory’s competence to its users, institutions, and accreditation bodies.

Accreditation provides numerous benefits concerning:

- *Patients*: ensuring that the laboratory assesses the suitability of results and verifies the value and relevance of tests in relation to patient clinical management;
- *Healthcare authorities*: meeting the needs for improving the quality of care by offering efficiency and productivity;
- *Medical laboratories*: providing evidence of compliance with best practices, authoritative attestation of professional competence, and motivating laboratory staff whose professional skills are recognized²³.

ISO 15189:2022 *per se* is not a mandatory standard; however, a survey conducted by the European Federation of Clinical Chemistry and Laboratory Medicine on the accreditation process in European countries shows that some countries, such as France, Hungary, and Lithuania, decided to integrate this standard as a mandatory requirement for all fields of laboratory medicine. Other countries require it for partial medical fields, like Belgium for molecular biology tests, Ireland for immunohematology and blood transfusion, Germany for newborn screening, the Czech Republic and Serbia for genetics, and Greece for private laboratories providing healthcare services²⁴.

Peculiarity of ISO 15189

ISO 15189:2022 is an internationally recognized quality standard aimed specifically at clinical laboratories to ensure reliable laboratory information through a well-structured quality system that conforms with high-quality specifications and maintains high professional competence. It can be applied to all recognized disciplines in laboratory medicine, and compliance can be certified by the national authoritative body through an evaluation process. Moreover, the fourth edition of the standard ISO 15189 specifies quality and competence requirements for POCT. The peculiarity of this standard is the inseparable association between the management-organizational and the clinical approaches and the promotion of the use of important tools to monitor performance quality. ISO 15189 provides a comprehensive framework that promotes professional excellence and patient-centered care. It entails not only technical skills but also a commitment to ethical conduct. A distinguishing feature of ISO 15189 accreditation is its emphasis on professional competence within the context of medical laboratory practice. The role of laboratory medicine is well-specified in the introduction of standards emphasizing that medical laboratories are essential for patient care and, therefore, must be available to meet the needs of all patients and the clinical personnel responsible for patient care. The application of ISO 15189 accreditation facilitates cooperation between medical laboratories and other healthcare services, assists in the exchange of information, and harmonizes methods and procedures. The requirements encompass all phases of the TTP^{13,17}, focusing on the management of the entire system by highly competent professionals. Key aspects of professional competence highlighted by ISO 15189 include consultation on test requests, collaboration with clinicians and healthcare stakeholders, guidance in interpreting results, and adherence to ethical standards that prioritize the health status of patients.

Structure of the International Standard ISO 15189

Figure 1 provides a schematic representation of the alignment of ISO 15189:2022 requirements with other international standards.

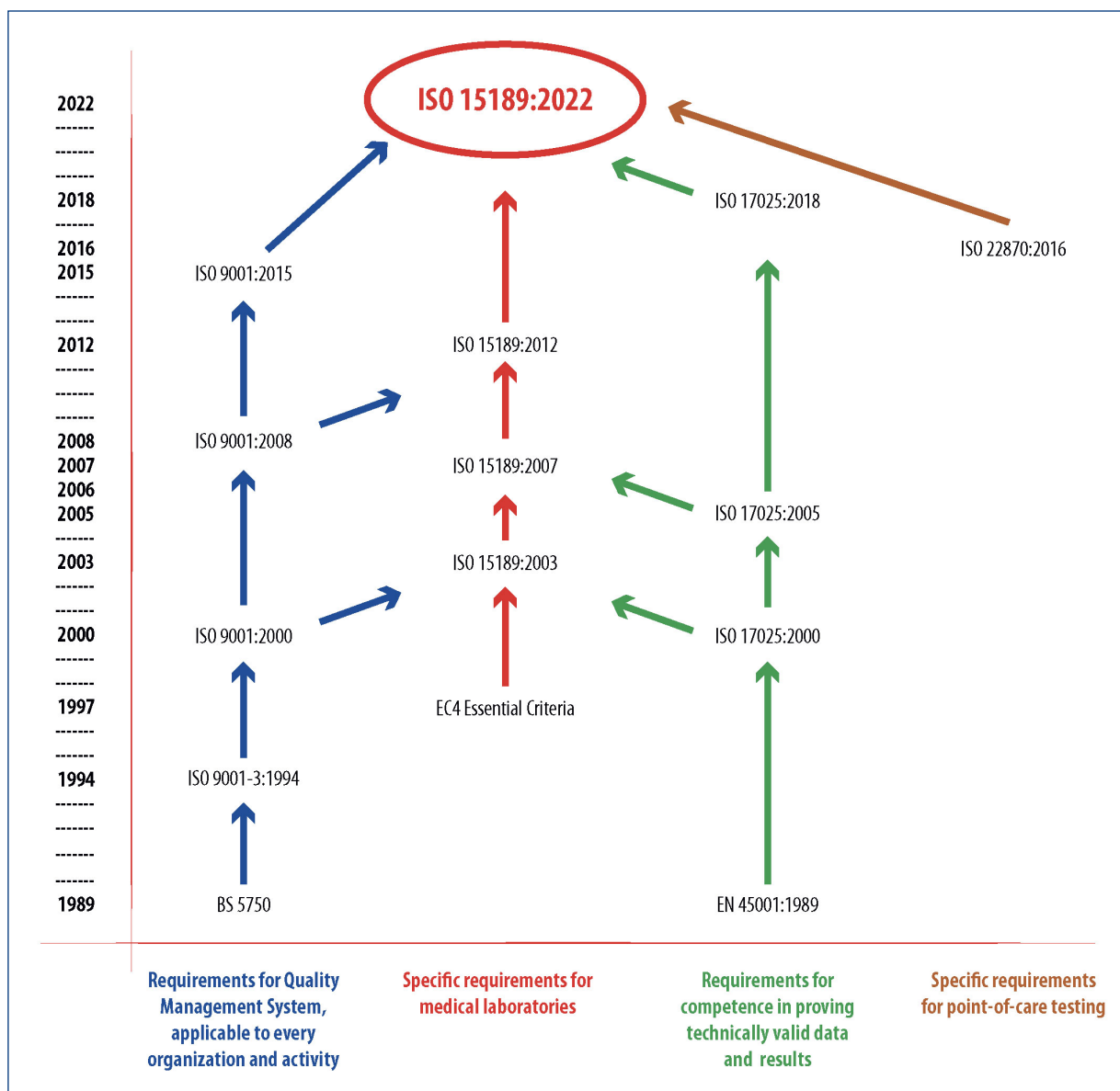


Figure 1. Alignment of ISO 15189:2022 requirements with other international standards.

The first edition of ISO 15189 was issued in 2003, followed by the second, third, and fourth editions in 2007, 2012, and 2022, respectively.

The setting of the standard refers to other standards issued by the International Organization for Standardization (ISO), in particular to the:

- ISO 9001 for the requirements of quality management system²⁵;
- ISO 17025 for the requirements of competence in providing technically valid data and results²⁶;
- Essential criteria issued by the European Communities Confederation of Clinical Chemistry (EC4) reporting specific requirements for medical laboratories^{27,28};
- ISO 22870 for specific requirements of POCT²⁹.

ISO 15189 applies specifically to medical laboratories; therefore, it differs from ISO 9001, which establishes criteria for a quality management system in any type of organization, and ISO 17025, which establishes general requirements for the competence of testing and calibration laboratories (chemical, physical, microbiological, food, environmental, etc.; not medical labs).

Importantly, compliance with ISO 15189 requirements ensures the laboratory meets ISO 9001 requirements; conversely, compliance with ISO 9001 requirements does not demonstrate competence in performing laboratory testing. Based on this consideration, laboratories that are certified ISO 9001 have a quality management system that complies with the requirements of ISO 15189 regarding management systems. If they intend to undertake ISO 15189 accreditation, they must implement criteria and procedures to demonstrate technical competence in ensuring the appropriate management of the TTP (pre-, intra-, and post-analytical phases) to provide accurate results and effective clinical information. Organizing requirements into thematically structured paragraphs and sub-paragraphs enhances clarity, consistency, and manageability and facilitates the implementation of a solid quality management system (Table 1).

Table 1. Paragraphs and sub-paragraphs of ISO 15189:2022 that report normative requirements.

Paragraphs	Sub-paragraphs
4. General requirements	4.1 Impartiality 4.2 Confidentiality
5. Structural and governance requirements	5.1 Legal entity 5.2 Laboratory Director 5.3 Laboratory activities 5.4 Structure and authority 5.5 Objectives and policies 5.5 Risk Management
6. Resource requirements	6.1 General 6.2 Personnel 6.3 Facilities and environmental conditions 6.4 Equipment 6.5 Equipment calibration and metrological traceability 6.6 Reagent and consumables 6.7 Service agreements 6.8 Externally provided products and services
7. Process requirements	7.1 General 7.2 Pre-examination processes 7.3 Examination processes 7.4 Post-examination processes 7.5 Nonconforming work 7.6 Control data and information management 7.7 Complaints 7.8 Continuity and emergency preparedness planning
8. Management system requirements	8.1 General requirements 8.2 Management system documentation 8.3 Control of management system documents 8.4 Control of records 8.5 Actions to address risks and opportunities for improvement 8.6 Improvement 8.7 Nonconformities and corrective actions 8.8 Evaluations 8.9 Management reviews
Annex A (normative) Additional requirements for point-of-care testing (POCT)	A.1 General A.2 Governance A.3 Quality assurance program A.4 Training program

The last edition includes numerous references to other international standards to ensure that a practice complies with the recommendations available. Specifically:

- Risk management requirements are aligned with the principles of ISO 22367³⁰;
- Laboratory safety requirements are aligned with the principles of ISO 15190³¹;
- Collection and transport requirements are aligned with ISO 20658³².

Moreover, the standard indicates the following documents in relation to:

- Bio risk management, ISO 35001³³;
- Management of reference material producers, ISO 17034³⁴;
- Certified reference material, ISO 15194³⁵;
- Metrological traceability of measurands, ISO 17511³⁶;
- Samples from particular sources and for specific analytes, ISO 20186 (all parts), ISO 20166 (all parts), ISO 20184 (all parts), ISO 23118, and ISO 4307³⁷⁻⁴¹;
- Evaluation of measurement uncertainty, ISO/TS 20914⁴²;
- Preservation of confidentiality, integrity, and availability of information, ISO 27001⁴³;
- Auditing management system, ISO 19011⁴⁴;
- Guidance for supervisors and operators of POCT equipment and non-laboratory supported services, ISO 22583⁴⁵.

The documents mentioned above are intended to provide guidance and suggestions to professionals for defining criteria and procedures to be implemented within their organizations. However, this does not exempt them from verifying other useful documents.

Advantages

Laboratory specialists are increasingly involved in defining diagnostic and therapeutic pathways aimed at managing patients to achieve the best possible outcomes. ISO 15189 accreditation empowers them to undertake this role effectively. Indeed, it promotes excellence in practice and recognition of high competence in accordance with internationally recognized requirements.

The achievement of accreditation reinforces the credibility of the results released by the laboratory and contrasts the concept of presumption of conformity (from self-referentiality to attestation by an authoritative body). It is a process that involves all laboratory professionals within their roles and responsibilities, including commitment and awareness. The entire organization emerges strengthened; this encourages the comparison and exchange of information, and activities are managed according to the risk assessment model. In addition, accreditation is carried out on a non-profit basis, outside the mechanisms of competition, so as to guarantee independence and impartiality, always under the supervision of the competent authority.

Accreditation in compliance with the requirements of ISO 15189 involves many advantages. Some examples are given in Table 2. The introduction of POCT requirements is an added value in a context where the use of POCT is becoming increasingly widespread, and the need for governance by qualified laboratories is imperative. Indeed, regarding the competence of POCT operators, laboratory staff have a key role in ensuring appropriate training and skill development of the non-laboratory personnel. In detail:

- staff training and competency are particularly relevant in POCT, as a large number of operators use the analyzers in various clinical settings;
- training planning must be rapid and flexible to ensure that only qualified personnel use the analyzers (particularly when staff turnover is high);
- the effectiveness and competency of personnel training should be checked periodically.

From theory to practice

The implementation of the accreditation process must focus on creating added value for the entire organization by establishing a management system to continuously improve service quality. This is only possible with the total involvement of all laboratory staff, including all professional figures, roles, and responsibilities. The first step is a complete understanding of ISO 15189 requirements through specific training involving all laboratory staff. Thus, each laboratory staff member becomes able to assess the gap between the procedures performed and those required by the standard.

Table 2. Peculiarity of ISO 15189 accreditation and advantages derived.

ISO 15189 Accreditation	
Peculiarity	Advantages
It is based on a comparative logic between homogeneous structures, typical of benchmark systems (accreditation of excellence).	Criteria and procedures are continuously updated and referred to the excellent state of the art.
It requires compliance based on best practices that change continuously according to the context and technological advances, methodological innovations, and scientific knowledge.	Increasing professional skills is continuously stimulated based on the latest knowledge and best practices.
It aims to support an incremental improvement in the quality of assistance by highlighting the quality of professional services.	The interdisciplinary and interprofessional approach is promoted and supported to provide an increasingly effective service for the patient.
It requires traceability (who does what and how) for all activities.	The system is designed to prevent the occurrence of undeliverable events. Responsibility is based on the process design, and the operator is exempt from specific responsibilities.
It requires a structured management of competencies to allow a clear identification of the following: <ul style="list-style-type: none"> • Skills needed • Skills Available • Competencies to be developed • Assessment and monitoring of competencies performed 	The qualification of personnel competencies supports more effective use of laboratory information in patient management.
It is an international standard recognized worldwide.	Mutual recognition, at national and international levels, of the quality level achieved by medical laboratories is possible because the accreditation is based on the same requirements and is verified by internationally appointed accreditation bodies ⁴⁶ .
It describes the requirements that facilitate compliance with European Regulation 746/2017 on <i>in vitro</i> diagnostic medical devices concerning the laboratory development tests ⁴⁷ .	Possibility to use laboratory development tests in compliance with the laws ⁴⁸ .

Forming working groups to study specific topics helps identify optimal solutions to fill the gap and achieve compliance through active brainstorming. Searching for reference documents (recommendations and guidelines) related to the topics under review is important to define criteria and procedures aligned with best laboratory practices.

This process of researching and studying reference documents enables increased knowledge. The identification of solutions to achieve conformity to the requirements, tailored to the different peculiarities of operational flows and testing, enhances staff competence.

Although the guidelines and recommendations are internationally recognized and suggest the criteria and procedures to be implemented to meet the requirements of the standard, they are often complex and not easy to implement, especially in relation to some test typologies. Furthermore, a problem stems from the increased workload required for their implementation and the associated costs. Promoting the introduction of ISO 15189 accreditation requires a pragmatic approach based on using data already available in the laboratory, balancing technological capabilities, risk, and time and personnel constraints.

In defining criteria and procedures and confirming the performance achieved during the verification, it is important to ensure the *intended use* of the tests, i.e. their clinical application (screening, diagnosis, prognosis, monitoring) for which the measurement procedure was designed. Clinical risk assessment is another essential element that helps identify the best solutions.

The accreditation visit is greatly valued because it is conducted using a peer-review approach and carried out by experienced laboratory professionals specializing in specific areas.

Therefore, laboratory professionals must seize this opportunity for professional growth, which also involves discussions with experienced colleagues on topics relevant to various diagnostic areas. Engaging in discussions on how to implement best laboratory practices and how to monitor them to maintain an excellent level of performance is the best strategy for adding value to the entire laboratory process and ensuring the reliability of the information provided.

ISO 15189 accreditation among Italian newborn screening laboratories

The adoption of ISO 15189 accreditation among Italian Newborn Screening (NBS) laboratories is varied, with many labs still operating under national or regional standards that may not align with ISO 15189. There are significant regional disparities in the quality and competence of NBS laboratories due to decentralized healthcare administration and varying access to resources. Moreover, resource constraints, training gaps, and the complexity of implementing comprehensive quality management systems pose significant challenges to achieving ISO 15189 accreditation.

Wider adoption of ISO 15189 can enhance their quality and performance, aligning with international standards and improving practice harmonization and overall healthcare outcomes.

CONCLUSIONS

In conclusion, the evolution of quality in medical laboratories reflects a continuous journey toward ensuring better outcomes for patients. The qualified competence of professionals is a crucial and strategic aspect of guaranteeing effective laboratory information that meets evolving clinical needs. ISO 15189 accreditation provides confidence in the adequacy of performance and the high level of competence of professionals. Laboratory professionals have become fully aware of the importance of accreditation; therefore, it is an important process to pursue, and efforts are needed for all medical laboratories to achieve this objective.

Quality assurance tools are numerous, and despite the proven effectiveness of the systems currently used to monitor and improve performance, new challenges always arise. For example, as the recent pandemic context has shown, quality assurance procedures were essential during the pandemic to determine operational flows to ensure excellent quality while having to provide timely information for large numbers of patients. Laboratories validated and verified analytical procedures implemented in-house or introduced to the market in record time. IQC procedures and EQA/PT programs were implemented to ensure the analytical accuracy of results in accordance with ISO 15189. Not only that, but the high competence of laboratory professionals was also required to collaborate with clinical professionals for proper interpretation of results, for epidemiological assessments and immune status studies, and even more so for vaccine dissemination. Laboratories accredited to ISO 15189 were facilitated because the processes and procedures for verifying and validating examination methods were already identified and structured, and the quality assurance tools conformed to excellent quality specifications.

Certainly, maintaining and continuing to improve existing tools and systems by integrating and adapting them to the evolving context in which laboratory medicine operates is crucial. The road to the future is long and challenging, and the laboratory's effort is to navigate it by involving all stakeholders in the discipline and increasingly demonstrating the value of laboratory medicine through excellent performance.

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