Quality assurance in veterinary diagnostic laboratories

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Summary
The authors discuss the responsibility of veterinary diagnostic laboratories as suppliers of analytical data for tests on animals and animal products. The guarantee of the quality of analytical data is a basic quality requirement for veterinary certification. It is therefore important for the laboratory to adopt operational quality assurance standards which are recognised internationally. The management and quality assurance criteria contained in the International Standardisation Organisation/International Electrotechnical Commission Guide 25, or in directives or guidelines established by international organisations such as the Office International des Epizooties and the Codex Alimentarius of the Food and Agriculture Organisation, are reviewed. These documents provide procedures for adopting the principles of quality assurance in order to acquire the recognition of competence to execute the laboratory tests required for national and international veterinary certification.

Keywords
International organisations - Laboratory diagnosis - Quality assurance - Standards - Veterinary medicine.

Introduction
The free circulation of animals and animal products in international trade has its repercussions in the animal health field, and veterinary diagnostic laboratories have always played a significant role in this arena. Recent agreements for the Application of Sanitary and Phytosanitary Measures (SPS Agreement), the creation of the World Trade Organisation (WTO) and several resolutions of the International Committee and Regional Commissions of the Office International des Epizooties (OIE) (26, 28, 31, 34) testify to the major changes which have already taken place and, very likely, will take place in the future in international veterinary policy.

One of the most obvious changes is the demand for high-quality veterinary certification, which has arisen to ensure the best protection for the health of human and animal populations and to facilitate the development of trade in animals and their products.
of adoption of operational criteria by means of voluntary standards for quality assurance, which is recognised internationally as a method for satisfying the requirements for mutual recognition of quality in analytical veterinary laboratory diagnostic data, will also be reviewed.

Importance of quality assurance in veterinary diagnostic laboratories

Credibility of data

The foundation of any veterinary diagnostic laboratory is the quality of the products (test results and testing reagents) that they produce. National veterinary authorities rely on sound scientific and technical data to diagnose and recognise animal disease, regulate animal health monitoring activities, design science-based intervention programmes and produce credible data about health or disease status in countries or regions. The need to provide the most accurate and reliable diagnostic laboratory data is apparent, and a sound quality assurance programme provides the mechanism to ensure these outputs, as well as providing a mechanism to monitor the quality of laboratory results and services over time.

Customer expectations

In the current national and international climate, the expectation of quality is implicit in any service rendered. A solid quality assurance programme provides management, staff and customers with documentation and evidence that analytical processes and procedures are performed correctly and meet all applicable standards. A comprehensive quality assurance system is internationally recognised as a way to improve quality and increase customer satisfaction. Customers will recognise honest, proactive laboratories that produce excellent work and, over time, confidence in products and services will increase.

Mutual recognition of laboratories

There is an increasing demand for international recognition of testing results and internationally accepted criteria for generating animal health laboratory data. A lack of trust in the quality of laboratory data is a source of obstacles to international trade. To overcome this problem, a series of international agreements, such as the WTO Standards Codex, the OECD Codex on Good Laboratory Practice and European Union (EU) and European Fair Trade Association policies on laboratory testing and certification, have been formally adopted. All these agreements foresee the need for recognition of laboratory competence by an accreditation system capable of assuring the trustworthiness of data supplied, thereby avoiding unnecessary duplication of laboratory testing (14, 30, 32). Accreditation bodies, in their turn, should conform to the general operational requirements specified in international accreditation guidelines, such as International Organisation for Standardisation/International Electrotechnical Commission (ISO/IEC) Guide 58: 93 (23) or its EU equivalent (EN 45003) (5). Conformity with these requirements enables the accreditation body, whether public or private, to be recognised nationally or internationally as competent and trustworthy. As a consequence, laboratories accredited to international standards must be recognised as providing quality products and services internationally. This recognition promotes confidence and mutual acceptance of data and facilitates removal of non-tariff barriers to trade.

Harmonisation of standards

Harmonisation of standards has provided the foundation for international trade agreements and commitments. A well-known example is the Manual of standards for diagnostic tests and vaccines (hereafter referred to as the OIE Manual), published by the OIE Standards Commission, which is aimed at facilitating international trade in animals and animal products and contributing to the improvement of animal health services world-wide (29). Harmonisation of standards and procedures has facilitated co-operation and exchange of ideas and information between laboratories and has improved laboratory management and efficiency. Implementation of quality assurance programmes will further serve to improve activities in this area through the use of well-described and established protocols, harmonisation and standardisation of laboratory procedures and practices, and active results-monitoring processes. These activities will also aid in refining and improving the testing and production processes, minimising errors and resolving problems. In the long term, costs will decrease, waste will be reduced and products and services will improve as laboratories become more efficient.

Veterinary laboratories and globalisation of the market

Quality products and services provided by veterinary diagnostic laboratories are examples of how the application of management and quality assurance criteria influence and affect recent developments in the international trade arena and the requirements of the free market. In some cases, compliance with international quality standards is imposed by national laws; in other cases, by trading partners. In fact, the quality of analytical data supplied can decisively influence the decisions relating to human and animal populations protection and animal product safety, at either national or international levels. An example of how international standards and requirements have been applied to products and services of veterinary diagnostic laboratories can be seen in recent European legislation for official testing of food products in the EU. The EU, under Directive 93/99/EC (12), has decided that as from 1 November 1998, laboratories which perform testing relating to the official control of food products must:

- operate according to criteria specified in European Standard EN 45001 (equivalent to ISO/IEC Guide 25) and
- be evaluated according to EN 45002 by organisations recognised under the terms of EN 45003 (2, 3, 5).
To enhance further guarantees of test results quality, the directive stipulates that laboratories must (14):

- participate, independently of the requirements of the accreditation organisation, in proficiency testing
- ensure, as far as possible, that testing methods used are validated by means of an inter-laboratory circuit in accordance with ISO 5725: 1986 (17).

Directives 93/43 and 93/99 introduce into the EU food safety legislation the concepts of producer responsibility, controls by the producer and quality of analytical data (11, 12). Producers are advised to adopt Standard ISO 9000, while laboratories that conduct official testing are required to adopt Standard EN 45000 (11).

Producers, whether they have adopted ISO 9000 or not, are obliged to identify and to keep under control the major risk points in the food production process (i.e., adopt a hazard analysis and critical control point system) and maintain records of all verification activity and corrective actions adopted. The laboratory must keep records of the efficacy of testing and/or of corrective measures adopted. Thus, in the context of official testing, the concepts of responsibility of the producer (in this case, analytical data) and control by the producer are introduced.

For better protection of consumers, the EU requires that food products be certified by a third party. The third party shall verify and assure compliance by the producer to all the food hygiene requirements stipulated in the legislation. For food products of animal origin in particular, the legislation stipulates that national Veterinary Services must provide the third-party certification. As part of the official control system, veterinary laboratories (whether public or private) provide this third-party evaluation of the producers through their analytical data. In fact, analytical data objectively demonstrate whether the production process is under control or not.

The EU defines the organisation criteria for operating and the necessary requirements for demonstrating and recognising laboratory competence in Directive 93/99/EEC. In the EU, compliance with the quality system implemented according to Standard EN 45001 becomes a rule and further guarantees test results relating to food control.

**Free trade in animals and animal products**

The SPS Agreement of the WTO states that Member Countries have the right to adopt measures to protect the health and life of human beings, animals and plants. Any safeguard measure shall be based upon specific risk analysis, and shall be both justified and documented on a scientific basis (34). To avoid arbitrary and unjustified barriers to international trade and to assure the harmonious development and adoption of sanitary measures, it is necessary to adopt the international standards, guidelines and recommendations laid down by international organisations.

The new basic rules for free trade in animals and their products are clear and simple. Countries wishing to trade their own animals and products must be able to prove on a valid scientific basis that the import of these animals and products will not increase health risks to the human or animal population of the importing country, compared to the situation which existed prior to the importation. The basis for authorising the international movement of animals and animal health products is certification to a particular standard through the issuance of veterinary certificates. The reciprocal trust in international veterinary certificates between countries is essential for the free trade of animals and animal products. Honesty, transparency and competence are the basic requirements to generate trust (10). Reciprocal recognition of the quality of veterinary certification is an essential component of international trade.

The production of a veterinary certificate for international trade in animals can be seen as a complex production process involving various customers and suppliers. The trustworthiness of this process, and its quality, depend therefore on the trustworthiness (and quality) of the organisations, productive processes and products of each intermediate supplier of products/services leading to certification (24). In the process of national and international veterinary certification, veterinary diagnostic laboratories are suppliers of test results and must provide scientifically valid documentation of the reliability of the analytical data provided. To this end they must both use internationally recognised methods and document their ability to keep the whole diagnostic process under control.

Laboratories supply Veterinary Services with all the analytical data useful for certification, including data for the following:

- evaluation of the health status of animal populations and food of animal origin
- identification of animal health problems
- performance of risk analysis and epidemiological surveillance
- qualification of animals for import/export movement.

Within national and international veterinary certification systems, veterinary laboratories provide factual data capable of documenting the efficacy of the preventive measures applied by the Veterinary Services to keep under control the health risks related to critical points. If veterinary laboratories can document that their analytical results are to be trusted, the safety of animals and animal products circulating internationally will be improved greatly.

**International quality standards**

Successful implementation of the SPS Agreement of the WTO depends primarily on the acceptance of common standards,
and standards published by the ISO have become recognised as the model for compliance in the field of animal health. The ISO, based in Geneva, was founded in 1946 to develop quality standards for member countries. The ISO 9000 family of quality standards were first issued in 1987 and have become the international benchmark for defining quality-run organisations. Compliance with ISO standards identifies to the world marketplace an organisation that adheres to recognisable standards of quality. Being accredited by the ISO declares to the global economic community that the organisation can be trusted to provide quality products and services (test results and reagents), because an objective third-party auditor has independently verified that the quality system upholds the standards recognised internationally.

Voluntary implementation of international standards

Voluntary standards, such as ISO 9000 (20) for companies and ISO/IEC Guide 25 for laboratories (22), provide a useful tool, made obligatory in the legislation of certain countries, for assuring and demonstrating conformity with the market demand. Such standards require establishment of a quality system that involves supervision and documentation of the entire production process and enables intervention, with appropriate measures, when the process falls below the specified results. ISO 9000 may also be used for developing and improving the quality system of a company by outlining management models capable of satisfying the expectations and the requirements of customers and other stakeholders. Through its application, an organisation is able to demonstrate to its customers and to all other stakeholders that their needs and expectations, such as contractual obligations, are being met by a company management system in which all technical, administrative and human factors that influence quality of the product/service, regardless of the product/service supplied, are under continuous supervision, with the aim to avert and prevent non-conformity.

Application of the standard is valuable for generating confidence in customer-supplier relationships because it provides assurance that the company management model is adequate for the particular product/service supplied (9).

Confidence is based on evaluation by the customer of the organisation, the product processes and the products provided by the supplier. The evaluation process may be either performed directly by the customer (second-party evaluation) or by an independent organisation (third-party evaluation): the latter usually has a representative role for a group of second parties. In other words, various customers of a sole supplier rely on the quality certification carried out by an accredited body to engender confidence in the supplier (9).

When the confidence extends to assurance of technical conformity with specific requirements, this assurance can be obtained by controls of the product and/or the process. The market requires that such controls be performed by an organisation/person accredited or formally recognised as competent in the execution of a specific activity.

Recognition of competence involves adoption of the operational criteria according to ISO/IEC Guide 25 for laboratories, ISO/IEC Guide 28 for product certification by organisations and ISO/IEC Guide 39 for inspection organisations (18, 21, 22). These Guides are equivalent to the European standards EN 45001, EN 45011 and EN 45004, respectively (1, 3, 6).

Voluntary standards and the testing laboratory

The need to use management tools and quality assurance for recognising the competence of testing laboratories was recognised universally in 1978 with publication of the first edition of ISO/IEC Guide 25, now in its third revision. Another revision is currently being drafted by representatives of laboratory organisations and accreditation bodies throughout the world, who intend to adopt the criteria of ISO 9000, which makes a clearer subdivision between quality system requirements and technical requirements (9).

The current ISO/IEC Guide 25 defines the minimum requirements for developing a quality system for laboratories. These, including the more specific arrangements for application to laboratories, are similar to the provisions of ISO 9000. In fact, laboratories conforming to ISO/IEC Guide 25 as suppliers of test results (or calibration) are recognised as conforming to the requirements of ISO 9000.

The main objectives of ISO/IEC Guide 25 are as follows:

- to guide laboratories in setting up and developing their own quality system
- to define the general requirements for demonstrating competence in the execution of specific tests (or calibrations)
- to provide an operational basis for the evaluation of technical competence by the accrediting bodies (9).

For testing laboratories to be formally recognised as competent in the execution of specific tests, they must observe the criteria laid down in the Guide. Laboratories must also demonstrate that they satisfy the requirements of the quality system, that personnel are technically competent in performing specific tests, that adequate structure, equipment and materials are available, and that the laboratory is capable of satisfying the expectations of its customers regarding the quality of its test results.
Application of the principles of quality assurance and management to veterinary diagnostic laboratories

Definition of quality assurance

Quality assurance is defined in ISO 8402 as: 'all the planned and systematic activities implemented within the quality system and demonstrated as needed, to provide adequate confidence that an entity will fulfil requirements for quality' (19).

For the veterinary diagnostic laboratory, this can be interpreted as: 'all the planned and systematic activities implemented within the quality system of the laboratory that provide confidence in the accuracy and reliability of the products and services of the laboratory'.

General principles

The ISO/IEC Guide 25 provides a general reference for the implementation of an adequate quality system for a veterinary laboratory. There are numerous publications giving detailed description of the procedure to be adopted by a laboratory in order to conform to the general criteria of the Guide. For certain fields of application, such as chemical and microbiological testing, specific guidelines exist (8, 15, 16, 25, 30).

A veterinary diagnostic laboratory wanting to proceed towards quality assurance must take a series of additional internal and external factors into account in addition to the requirements of ISO/IEC Guide 25. A quality system within a laboratory includes the application of quality principles to all areas of operation (management, administrative procedures, staff training, facilities and equipment operations, process control, testing and data reporting processes, etc.). Essential components for each of these areas include a systematic approach for management, documentation, application of quality control (QC) activities, ongoing evaluation, education and training, and independent review.

Management

A laboratory must possess a clearly defined organisational system and infrastructure, and sufficient management and technical personnel with proper authorities and resources to carry out their duties. This necessitates the implementation of a quality system capable of monitoring and operating in an integrated, efficacious and efficient manner the four variables involved in the analytical data production process: personnel, diagnostic methods, equipment and materials.

Documentation

Development of written protocols and procedures describing laboratory activities, policies and operational procedures provides the foundation for defining the quality assurance standards and subsequent measurement and monitoring. Documents should be written to include a high level of descriptive detail and must address initial quality, maintenance and monitoring of all key elements involved in operating the laboratory (personnel qualifications and development, facilities and equipment, sample acquisition and accountability, testing and production procedures, test acceptance criteria, reagents, reporting mechanisms, etc.). Policies and procedures for the identification, collection, maintenance and archiving of all records and documents should exist. A system of standardised documentation will improve traceability, defensibility, confidence and credibility of products.

Quality control

Included under the quality assurance umbrella are all the traditional QC components usually associated with laboratory testing activities. In the majority of cases, accepted laboratory QC practices are already in use and function as a critical component in determining the quality and validity of testing services. A comprehensive quality assurance programme improves and expands this area by standardising and formalising practices for all aspects of testing and production (test acceptance criteria, control of production parameters, application of statistical analyses, etc.).

Ongoing evaluation

Continuous improvement is an essential element of a quality assurance programme. This includes activities such as exchanges with other laboratories (of personnel, protocols, reagents, samples, supplies and ideas), continuing education, publications, proficiency check tests or other inter-laboratory comparisons, complaint resolution and internal and external audits. Ultimately, the results of these activities, along with feedback from customers, improve products and services.

Education and training

Education and training are strategic elements for the success of the entire programme. Personnel may have difficulty in understanding and accepting a quality system, particularly if they are not used to working continuously according to written instructions or operational manuals or regularly recording each operation. These difficulties should never be underestimated and should be acted upon. Training is of overall importance to make each individual aware of the fact that each operation performed will influence the quality of the test results of the whole laboratory and ability of the laboratory to provide proof of its quality performance. Recognition and assurance of the competence of a laboratory depend on the competence of the personnel performing the tests. It is, therefore, important to organise training and continuous education programmes in order to provide the support necessary to cope in a scientifically correct manner.
with introduction of new methods or new technology for each individual engaged in testing.

Independent review
For external recognition of the capabilities of a laboratory, it is necessary to ensure not only that quality procedures are in place but also that these procedures are regularly reviewed and their efficiency and effectiveness are monitored. Ultimately, recognition (accreditation) of a quality assurance programme by an independent third party is an internationally accepted approach for verifying successful application of quality systems in laboratories.

Additional considerations
In addition to the general principles described above regarding implementation of an ISO/IEC Guide 25-compliant quality assurance programme, there may be additional requirements that need to be considered. These requirements may be imposed by a variety of parties (national or international legislation, regional trade agreements, international organisations, etc.) and are usually aimed at providing further assurance in relation to the quality of analytical data or recognising the technical competence of a veterinary diagnostic laboratory. Some commonly considered supplementary requirements include participation in inter-laboratory testing and/or programmes for technical proficiency control, complex schemes for internal quality control for specific tests, validation of internationally recognised methods or selection of alternative validation methods according to sound technical principles. Specific examples are given below.

The Codex Alimentarius Commission
In developing criteria for evaluating the competence of testing laboratories involved in the import or export of food products, the Codex Alimentarius Commission (14) has agreed that laboratories involved in official testing for import or export shall adopt the following quality criteria:

- conformity with the general operational criteria of ISO/IEC Guide 25
- participation in schemes for proficiency testing, conforming to stated requirements (4)
- the use, if available, of analytical methods validated by established procedure (13)
- the use of specific procedure for internal quality control (7).

In the same document, the Codex Alimentarius Commission recognises that appropriate procedure is required for evaluating competence and that the evaluating organisation should conform to the general criteria for laboratory accreditation of the ISO/IEC Guide 58:93 (14).

The Office International des Epizooties
The International Committee of the OIE has approved, as a supplement to the "OIE Guidelines for the Evaluation of Veterinary Services" (27), a directive for the evaluation of laboratory quality in harmony with ISO/IEC Guide 25 (30) and the guideline for proficiency testing of laboratories (32). Testing methods are those described in the OIE Manual (29); however, alternative methods may be used, provided that they have been validated according to Chapter 1.3 of the Manual and approved by the Standards Commission in accordance with the procedure for evaluation and designation of methods (33).

Internal factors
Internal factors depend mainly on the objectives of the laboratory, its organisational complexity and the resources available. To adapt to organisational criteria based on quality management and assurance requires a clear formulation of the objectives to be achieved and strong financial and administrative support from the top management of the laboratory. It also requires the formulation of a working programme coherent with the existing organisation. This programme usually starts with an analysis and preliminary evaluation of current laboratory practices and existing procedures and should be developed into a quality system adapted to the specific need of the laboratory. Elements of the quality system need to be identified properly and in full, taking into account all laboratory activities, including administrative functions. The importance of various elements of the system varies from laboratory to laboratory and depends on the particular organisation of the laboratory, its size, its field of activity and the quality considered necessary for the measurement (16). It is essential that the procedure for planning and developing a laboratory quality system should deal coherently with the organisation which is already in existence and the actual quality requirements to be met. In this way, both the application of system rules and their maintenance and successive improvements will be greatly facilitated, regardless of the organisational complexity of the laboratory.

In any case, each veterinary diagnostic laboratory, while progressing towards quality, should be aware that reference models, information and indications derived from the literature must be revised and made coherent and applicable to its own organisational conditions. Although quality systems for each laboratory must be customised to fit individual needs, principal international standards and guidelines must be considered and complied with.

Quality assurance programme implementation
The first step to take in organising a laboratory according to the criteria of quality management and assurance is to draw up and distribute a document that establishes a 'quality policy' and defines strategic quality objectives. The document should be drawn up in accordance with reference standards and should be signed by the Director of the laboratory. The Director must define and formally allocate responsibility for co-ordination and maintenance of the quality system. The Director is also responsible for re-examining the quality
system periodically and redefining the quality objectives appropriate to meet laboratory needs.

Another preliminary task is to prepare the laboratory quality manual. The manual serves as the reference tool for implementing and updating the quality system and describes the general criteria for the management and maintenance of the quality system.

Procedures for applying the general criteria of and for maintaining the quality system should be described in detail in appended documents. These constitute the quality system procedures and can be either included in the Manual or kept separately. Examples of quality system procedures are those concerning the control and management of documents, management and manipulation of samples, management and use of reference materials and samples, conduct of audits, management of archives and information systems, education and training of personnel, control and accreditation of suppliers, maintenance of equipment, participation in inter-laboratory testing and proficiency testing, etc.

On the basis of criteria laid down in the quality manual and/or quality procedures, those responsible for the various testing activities should document the procedures for performing the functions of the laboratory. Technical methods must be among those listed in the OIE Manual (29), in the Codex Alimentarius or in other international standards. In the absence of internationally recognised technical methods, procedures must be validated according to methods described in the OIE Manual or prescribed by an international organisation such as the Codex Alimentarius Commission (13). Other aspects of laboratory management, procedure documentation, application of quality control activities, ongoing evaluation, education and training and independent review, should meet the criteria described in the section on 'General principles' above.

In relation to international veterinary certification, a fundamental task of veterinary diagnostic laboratories is to assure the quality of their test results. To do so they must be recognised as honest, independent and constantly competent.

Adoption and implementation of the principles of quality assurance contained in ISO/IEC Guide 25 provide a powerful tool for demonstrating the competence of the veterinary diagnostic laboratory. Application of quality assurance principles, therefore, has a strategic role in enhancing trust among national veterinary services officials and consequently in facilitating the international circulation of animals and animal products. Fulfilling quality assurance strategies will also offer opportunities to improve programme efficiency, allow better utilisation of resources, increase customer satisfaction and enhance laboratory credibility. By actively adopting and executing quality assurance programmes, the quality of veterinary diagnostic laboratory products and services will improve, credibility and visibility will be enhanced, transparency of regulatory decision processes will become more apparent and there will be improvements in the ability to meet national and regional commitments to the World Trade Organisation.

Conclusions

Veterinary diagnostic laboratories are suppliers of critical analytical data that are used in animal health control and monitoring programmes and national and international veterinary certification systems world-wide. The quality of international veterinary certification depends heavily on the ability of laboratories to provide reliable test results and on mutual recognition of this ability. The test results of diagnostic laboratories provide factual evidence of the efficacy of safeguard measures taken at each critical point in the animal health field and in the food production chain. They are, therefore, important tools for the control of the health of animals and the hygienic status of foods of animal origin.
L’assurance qualité dans les laboratoires vétérinaires de diagnostic

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Résumé

Mots-clés
Assurance qualité — Diagnostic de laboratoire — Médecine vétérinaire — Normes — Organisations internationales.

Garantía de calidad en laboratorios veterinarios de diagnóstico

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Resumen
Los autores examinan la responsabilidad que contrae un laboratorio veterinario de diagnóstico en tanto que suministrador de datos analíticos para pruebas sobre animales o productos de origen animal. Garantizar la calidad de esos datos constituye un requisito básico de calidad para la certificación veterinaria. Por este motivo, es importante para el laboratorio adoptar criterios internacionalmente reconocidos que garanticen la calidad de su funcionamiento. Los autores examinan los criterios de gestión y garantía de calidad que figuran en la Guía 25 de la Organización Internacional de Normalización y la Comisión Electrotécnica Internacional o bien en directivas o directrices elaboradas por organizaciones internacionales como la Oficina Internacional de Epizootias o el Códex Alimentarius de la Organización de las Naciones Unidas para la Agricultura y la Alimentación. Esos documentos describen procedimientos conducentes a la adopción de los principios de garantía de calidad que todo laboratorio debe observar antes de que se reconozcan sus competencias para realizar las pruebas de diagnóstico que exige la certificación veterinaria tanto nacional como internacional.

Palabras clave
Diagnóstico de laboratorio — Garantía de calidad — Medicina veterinaria — Normas —Organizaciones internacionales.
References


