
**Biological evaluation of medical
devices — Guidance on the conduct
of biological evaluation within a risk
management process**

*Évaluation biologique des dispositifs médicaux — Directives relatives
à la conduite d'une évaluation biologique au sein d'un procédé de
management du risque*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 194, *Biological and clinical evaluation of medical devices*.

This second edition cancels and replaces the first edition (ISO/TR 15499:2012), which has been technically revised with the following major changes:

- definitions have been clarified;
- risk evaluation and risk control have been substantiated;
- compensation/adjustment of pH and osmolality has been substantiated.

Introduction

General

This document provides guidance on the conduct of biological evaluation of medical devices according to the requirements of ISO 10993-1. Although ISO 10993-1 provides a general framework for biological evaluation of medical devices, more detailed guidance can be helpful in the practical application of the standard. As a result, this document was developed to provide such guidance to users of ISO 10993-1. This guidance can be used to better understand the requirements of ISO 10993-1 and to illustrate some of the variety of methods and approaches available for meeting the requirements of ISO 10993-1.

Biological evaluation is a design verification activity which is set in the context of broader risk management processes. Therefore, this document includes guidance on the application of ISO 10993-1 in the context of risk management processes conducted according to the requirements of ISO 14971. This document describes concepts and methods that can be considered in establishing and maintaining a risk management process for biological evaluation as part of the overall evaluation and development of a medical device.

As scientific knowledge advances our understanding of the basic mechanisms of tissue responses, biological evaluation may be based upon review of relevant established scientific data and upon chemical analysis and *in vitro* and *in vivo* testing where these are required. ISO 10993-1 specifies a framework in which to plan a biological evaluation which minimizes the number and exposure of test animals by giving preference to chemical constituent testing and *in vitro* models in situations where these methods yield equally relevant information to that obtained from *in vivo* models. The selection of which approach(es) are applicable to a particular medical device will depend on the nature of the device, the extent of available relevant scientific data and upon risk assessment.

When judging the applicability of the guidance in this document, applicable regulatory requirements and regulatory guidance should be considered.

An organization can voluntarily incorporate guidance from this document, wholly or in part, into its risk management process.

Guidance contained in this document can be useful as background information for those representing risk management process assessors, conformity assessment bodies and regulatory enforcement bodies.

Relationship with other standards, guidance documents and regulatory requirements

The relationship between ISO 10993-1, this document and the standards for biological evaluation of medical devices and general risk management is summarized as follows:

- this document provides guidance on the application of ISO 10993-1;
- biological evaluation is a component of risk management and this document includes guidance on the application of ISO 14971 to the conduct of biological evaluation.

Biological evaluation of medical devices — Guidance on the conduct of biological evaluation within a risk management process

1 Scope

This document is applicable to the conduct of biological evaluation of medical devices according to the requirements of ISO 10993-1. It does not add to, or otherwise change, the requirements of ISO 10993-1. This document does not include requirements to be used as the basis of regulatory inspection or certification assessment activities.

This guidance is applicable to all biological evaluation of all types of medical devices including active, non-active, implantable and non-implantable medical devices.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10993-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

biocompatibility

ability of a medical device or material to perform with an appropriate host response in a specific application

3.2

biological risk

probability of harm to health occurring as a result of medical device or material interactions

3.3

biological safety

freedom from unacceptable biological risk

3.4

risk assessment

overall process comprising a risk analysis and a risk evaluation

[SOURCE: ISO/IEC Guide 51:2014, 3.11]

3.5

risk evaluation

process of comparing the estimated risk against given risk criteria to determine the acceptability of the risk

[SOURCE: ISO 14971:2007, 2.21]

3.6

risk management

systematic application of management policies, procedures and practices to the tasks of analysing, evaluating, controlling and monitoring risk

[SOURCE: ISO 14971:2007, 2.22]

3.7

toxicological hazard

potential for a compound or material to cause an adverse biological reaction, taking into account the nature of the reaction and the dose required to elicit it

3.8

toxicological risk

probability of a specified degree of an adverse reaction occurring in response to a specified level of exposure

3.9

risk analysis

systematic use of available information to identify hazards and to estimate the risk

[SOURCE: ISO 14971:2007, 2.17, modified]

4 Biological evaluation as a risk management practice

4.1 General

ISO 10993-1:2009, B.2.2.2 describes a continuous process by which a manufacturer can identify the biological hazards associated with medical devices, estimate and evaluate the risks, control these risks, and monitor the effectiveness of the control. Appropriate protection of the patient by weighing risks and benefits of medical devices is an essential element of this biological evaluation plan. Benefit to the patient from the use of medical devices entails the acceptance of potential risks. These risks will vary depending on the nature and intended use of the specific medical device. The level of risk which is acceptable for a specific device will depend upon the expected benefit provided by its use.

Consideration of biological risk is only one aspect of the risk assessment of a medical device, which should consider all aspects of risk. In some cases, it can be specifically necessary to consider the relative benefits of materials of different biological safety profiles in the context of some other characteristic. For example, it can be possible that the most biologically safe material available can have unacceptable mechanical strength, in which case, it would be necessary to consider if an alternate stronger material is of *acceptable* biological safety. It is fundamental to the conduct of biological evaluation that it be undertaken as part of the overall risk management process required in the design and development of the medical device.

Material selection and risk analysis are integral components of the design process for medical devices. The selection of materials plays a crucial role in evaluating the biological safety and, when approached in a systematic way, allows the collection of relevant data. In line with ISO 13485 and ISO 14971, criteria to define the acceptable biological risk should be established at the start of the design process. Because starting material, formulation and processing variations could impact final product biocompatibility, these considerations should also be incorporated into the risk assessment. The biological safety evaluation should be designed and performed to demonstrate the achievement of specified criteria for safety. This evaluation is a component of the risk management plan encompassing identification of all hazards and the estimation of associated risks. Adequate risk assessment requires characterization of toxicological hazards and exposures.

A major component in hazard identification is material characterization. The following steps can be identified:

- define and characterize each material, including suitable alternative materials;

- identify hazards in materials, additives, processing aids, etc.;
- identify the potential effect of downstream processing (e.g. chemical interactions between material components or final product sterilization) on chemicals present in final product;
- identify the chemicals that could be released during product use (e.g. intermediate or final degradation products from a degradable implant);
- estimate exposure (total or clinically available amounts);
- review toxicology and other biological safety data (published/available).

Information on biological safety to be reviewed can include:

- toxicology data on relevant component materials/compounds;
- information on prior use of relevant component materials/compounds;
- data from biological safety tests.

The risks posed by the identified hazards should then be evaluated. At this stage, it should be possible to determine whether there is an undue toxicological risk from the material.

If it can be concluded from existing data that risks are acceptable, then no additional toxicity testing is needed. Testing is also unwarranted if risks are found to be unacceptable. When existing data are insufficient, additional information should be obtained. The purpose of testing is to obtain additional data which can assist in reaching a conclusion. A rationale for testing should therefore be based on an analysis of the relevant risks which are indicated from the existing data.

The results of any tests should be assessed. Test reports should include descriptive evidence, an assessment of the findings and qualitative assessment of their acceptability.

The assessor should determine if the available information is sufficient to meet the purpose of the evaluation of biological safety and if so, document how the conclusion on safety was reached including the rationale for any decisions and the impact of test results and other information on the assessment.

The evaluation indicates the identity and significance of all relevant evidence and highlights the scientific basis of the overall conclusions in an accurate, clear and transparent manner. It is very important that the factors leading to the conclusion are fully discussed with succinct and accurate rationales for each judgment and identification and discussion of any uncertainties underlying each decision.

The components of risk management are summarized in [Figure 1](#) (taken from ISO 14971). The different elements of a biological evaluation process can be considered in terms of the elements of the overall risk management process.

In summary, biological evaluation should be seen as an element of risk management practice and therefore, the conduct of a biological evaluation of a medical device should aim to meet both the requirements of ISO 10993-1 and ISO 14971.

4.2 The biological evaluation plan

ISO 14971:2007, 3.4 requires that risk management activities be planned in advance. Since biological evaluation is a risk management activity, a Biological Evaluation Plan is required, and this forms part of the Risk Management Plan. It is emphasized that simply planning to conduct testing against all of the aspects of toxicology identified in ISO 10993-1:2009, Table A.1 does not meet the requirements of ISO 14971 or ISO 10993-1. The biological evaluation plan should be drawn up by a knowledgeable and experienced team and include as a minimum:

- arrangements for gathering of applicable information from the published literature (including information sources and search strategies), in-house and supplier data and other sources in order to conduct risk analysis;

- arrangements for conducting the evaluation, including the requirement for any specific technical competencies relevant to the specific device application;
- arrangements for review and approval of the plan as part of the overall design control process;
- arrangements for review of the final conclusions of the evaluation and the approval of any additional testing programme required;
- arrangements for the final review and approval of the outcomes of the biological risk assessment, including the risk control measures applied and the documentation of any residual risks and the disclosure of residual risks through means such as product labelling.

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