



Regulatory, quality and clinical affairs

NX-451 – What to know
when working with
medical devices

Session 10

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Clinical Research – Introduction

- Clinical research is a branch of Medical Science that studies people (patients or healthy volunteers) to better understand health and disease. It aims to improve the diagnosis, treatment, and prevention of medical conditions.
- It is performed by evaluating effectiveness and safety of therapeutic products such as drugs, medical devices, biologics, etc., by investigation of new surgical technics or by observation of specific clinical conditions.
- Clinical research contributes among other things to establish:
 - New techniques for screening and diagnosing a disease
 - New drug or device to market
 - New method for surgery
 - New approach for radiation therapy
 - New combination of standard treatments
 - New techniques such as gene therapy, genomic analysis, etc
- In the field of medical devices, it evaluates the relation between an exposition to a given treatment and its impact on the human being typically to demonstrate the reality of the clinical benefit.
- The ultimate goal of this research is to improve the Quality of Life

Clinical Research – Introduction

Definition:

*'Clinical research is a component of medical and health research intended to produce knowledge valuable for understanding human disease, preventing and treating illness, and promoting health. Clinical Research embraces a continuum of studies involving interactions with patients, diagnostic clinical materials or data, or populations in any of the following categories: (1) **disease mechanisms** (etiopathogenesis); (2) bi-directional integrative (**translational**) research; (3) **clinical knowledge, detection, diagnosis and natural history of disease**; (4) **therapeutic interventions including development and clinical trials of drugs, biologics, devices, and instruments**; (5) **prevention** (primary and secondary) and **health promotion**; (6) **behavioral research**; (7) **health services** research, including outcomes, and cost-effectiveness; (8) **epidemiology**; and (9) community-based and managed care-based trials.'*

Source: <https://www.ncbi.nlm.nih.gov/books/NBK220723/>

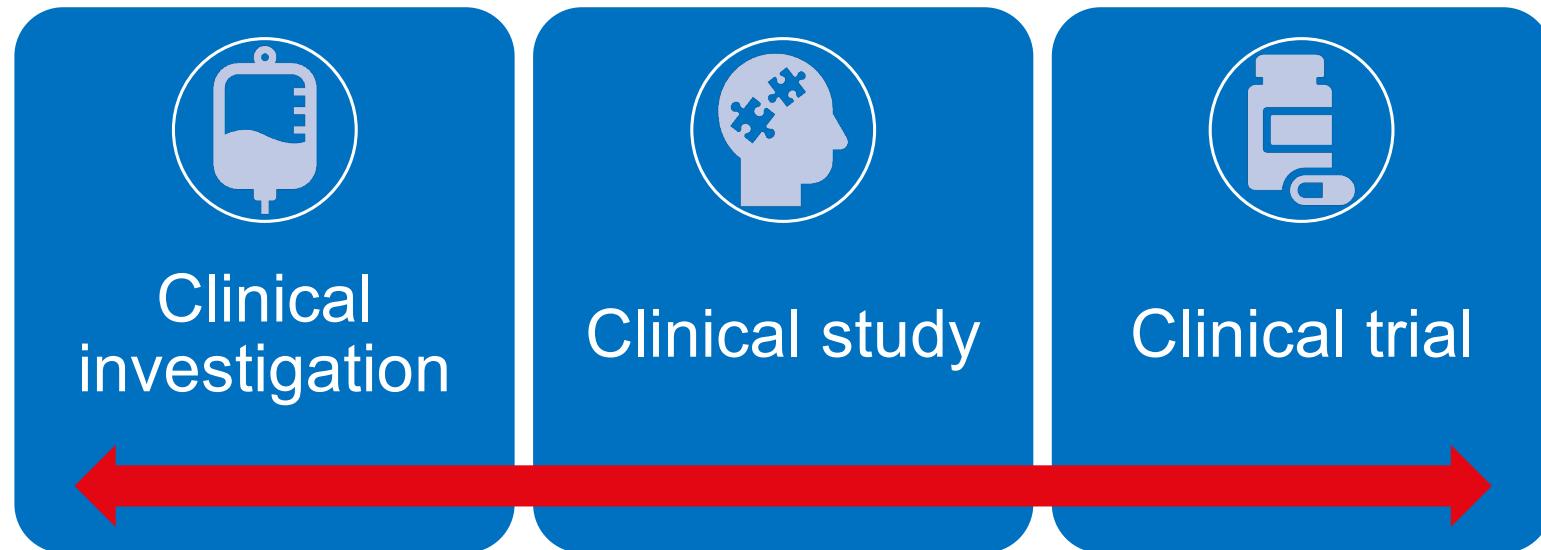
Simply speaking:

- Research on **human subjects** intended to collect new **medical knowledge**.
- It may be focused on evaluation of effectiveness (performance) and safety of therapeutic products such as drugs, medical devices, biologics etc.

Clinical Investigation – Introduction

MDR article 2(45) defines 'clinical investigation' as:

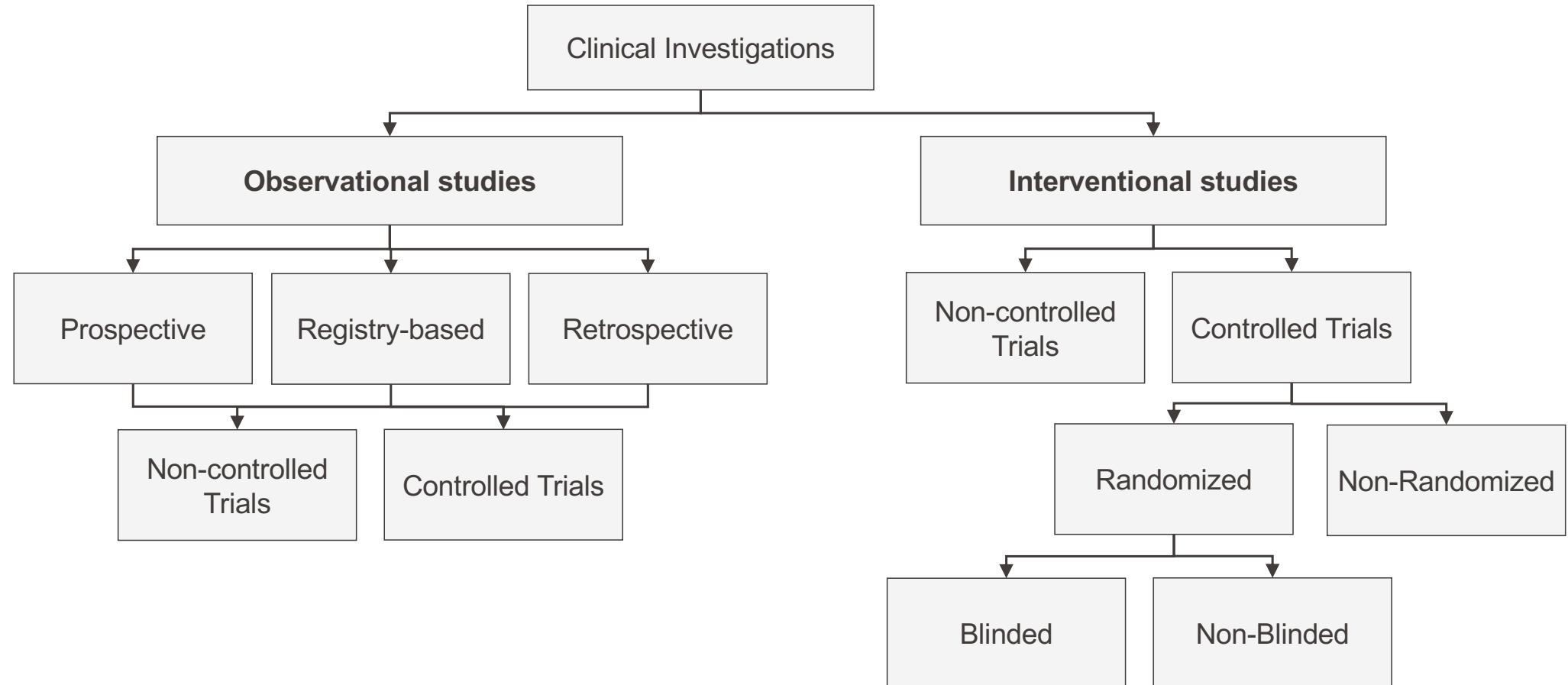
'any systematic investigation involving one or more human subjects, undertaken to assess the safety or performance of a device.'



- Pragmatically, a clinical study aims at collecting relevant data that will be used in the Clinical Evaluation to demonstrate the clinical benefit.
- Clinical research is different from clinical practice. In clinical practice established treatments are used, while in clinical research evidence is collected to establish a treatment.

Clinical Investigation – Definitions

Clinical Investigation is a form of research project that can be organized in mainly two ways:



Controlled Investigation

A controlled investigation compares the performance and safety of a medical device with a control group.

The control may be:

- A placebo device (e.g., a sham device with no therapeutic effect),
- An existing standard device,
- Or no intervention (depending on the study).

Purpose: To isolate the effect of the investigational device from other factors.

Example: Testing a new cardiac stent against an already-approved stent to see which performs better.

Randomized Investigation

A randomized trial randomly assigns participants to receive either:

- The investigational device, or
- A control (e.g., standard device, sham, or no device).

Purpose: To minimize selection bias and ensure comparable groups, especially important if outcomes may be influenced by patient or surgeon characteristics.

Example: Randomly assigning knee surgery patients to receive either a new prosthetic implant or the standard model.

Blinded Investigation

Blinding in device trials is more challenging than in drug trials due to the physical nature of devices, but it's still possible:

- Single-blind: The patient doesn't know which device was used.
- Double-blind: Both patient and clinician assessing the outcome don't know (though the surgeon may know during implantation).
- Sham procedures: Sometimes used to mimic device use without actual treatment (only if ethically justified).

Purpose: To prevent placebo effects or biased outcome assessment.

Example: In a trial of a neurostimulation device, the device is implanted in all patients, but only half receive active stimulation — and neither the patient nor outcome assessor knows which.

Historical control vs active control

- Historical control uses data from previously treated patients, not part of the current trial, to compare outcomes. They are retrospective, faster, and cheaper but prone to bias due to differences in time, setting, or patient population.
- Active control uses a current group of patients in the same study who receive an established, effective treatment. They are prospective and more scientifically rigorous but require more resources and ethical oversight.

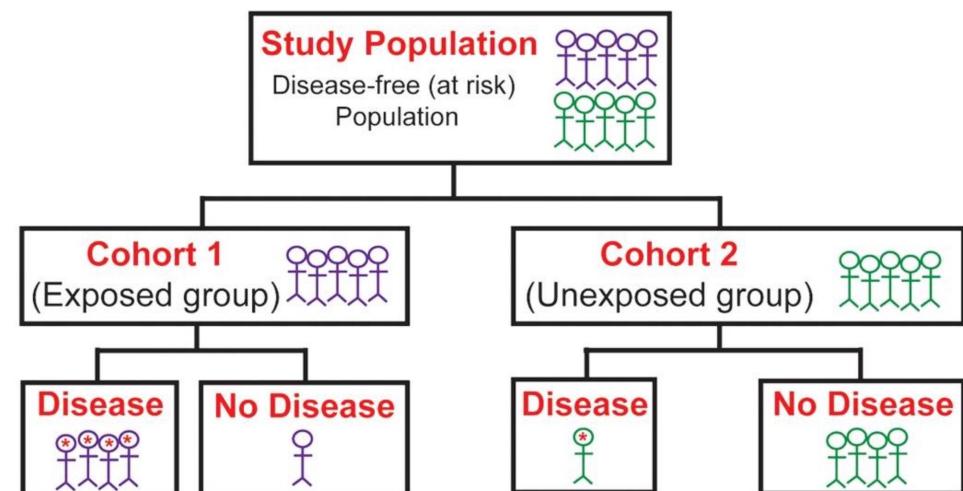
Clinical Investigation – Definitions

Observational studies

- Usually in observational studies, the investigator does not intervene on the patient or on the treatment.
- The main approach is to observe the relationship between an exposure to a treatment or a condition and its effects.
- In these studies, the goal is typically to compare two type of patients groups, one where the condition is already there (Case-control) or the exposition is planned (Cohort study) and a control group.

Common types of studies:

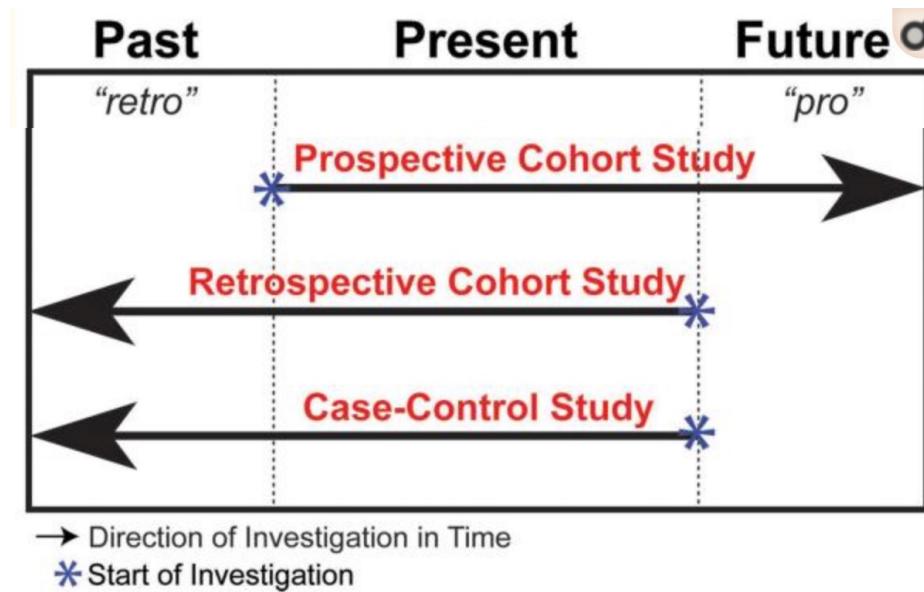
- Cohort studies: Follow a group over time to see how exposures (like smoking or using a medical device) affect outcomes.
- Case-control studies: Compare people with a condition (cases) to those without (controls) to find possible causes.
- Cross-sectional studies: Assess a population at a single point in time to measure prevalence or correlations.



Clinical Investigation – Definitions

Observational studies may be further divided in two types:

- Prospective studies - the investigator looks at the evolution of a situation by collecting data specifically to address the scientific question.
- Retrospective studies, the investigator assess existing data in order to identify if they contribute to respond to the scientific question.



Prospective Study example:

Study: A company develops a new implantable glucose sensor for diabetic patients.

Design: Investigator enroll 300 patients, implant the device, and follow them for 12 months to monitor device performance, accuracy, and complications.

Goal: To assess safety and effectiveness of the device as data is collected in real time.

Advantages

- High-quality data
- Clear time sequence, helping establish causality.
- Fewer missing data, better control on data
- Control over variables: Investigator can define protocols and follow-up.

Retrospective study example:

Study: Investigator wants to evaluate infection rates from a previously used orthopedic implant.

Design: They gather data from hospital records over the past 5 years, identifying patients who received the implant and analyzing infection rates and outcomes.

Goal: To identify patterns or risk factors using existing data.

Advantages

- Faster and less expensive
- Useful when studying uncommon complications or long-term device failures.
- Limited ethical risk to patients
- Helps identify trends or associations worth studying further.

Interventional studies

- Usually in interventional studies, the investigator will perform a specific (set of) intervention(s) on the patients.
- Typical example is the safety testing of a drugs, the efficacy testing of a new medical device, or testing of a new surgical approach.
- The study may be conducted with the use of a control group (i.e. comparing the relative performance of two devices) or without a control group (i.e. the endpoints of the study characterize already the success of the study).
- Assignment of patient to a defined group, in controlled study, may be random or non-random. Randomization is used to reduce the risk of bias linked to the possible selection of “good cases” in the study group.

Clinical Investigation – Definitions

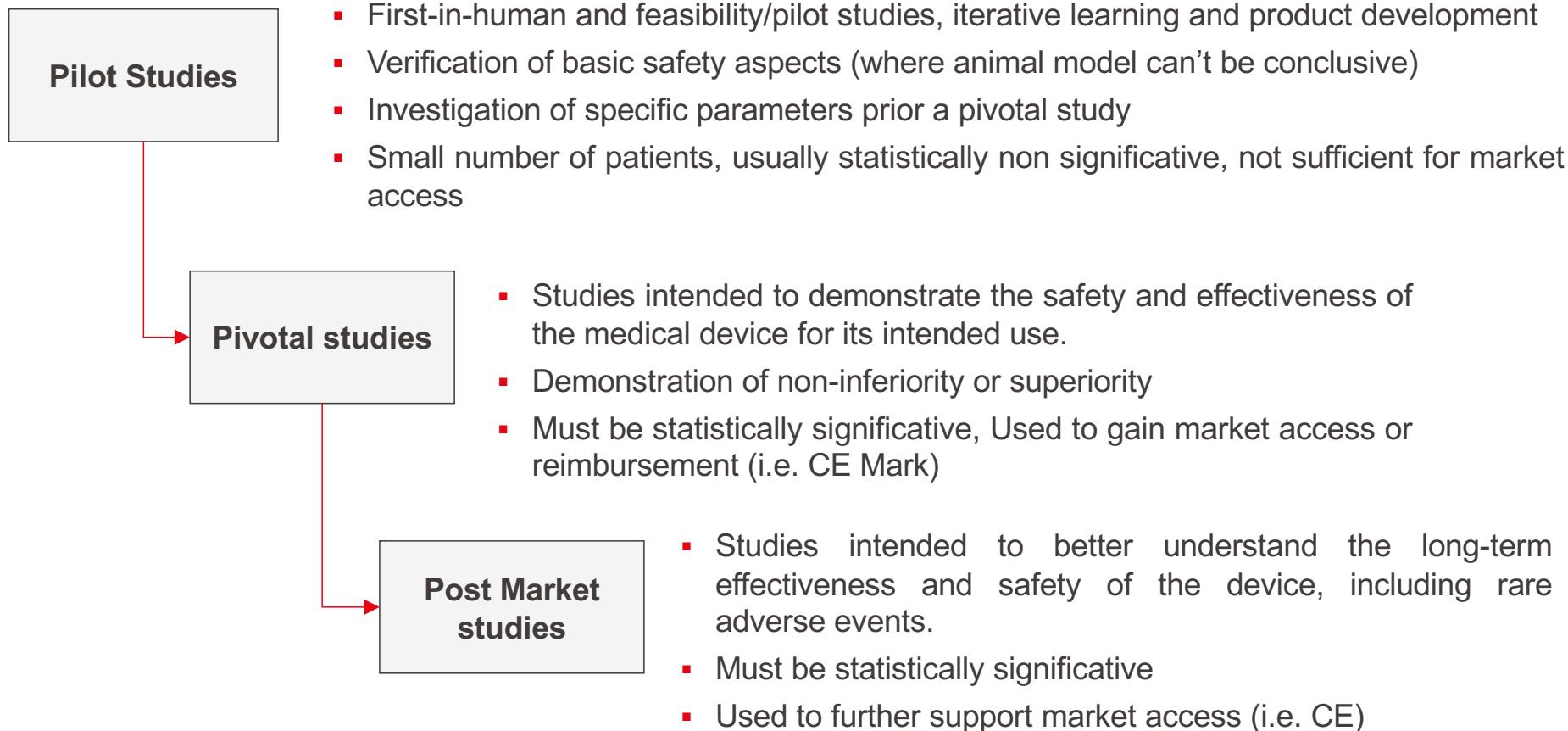
Research phases - Clinical trial phases are designed to step-by-step validate the safety, effectiveness, and long-term impact of a therapeutic product or medical device before it reaches patients."

Phase 0	Phase 1	Phase 2	Phase 3	Phase 4
<p>Pharmacodynamics and pharmacokinetics in humans</p> <p>10-15 patients</p> <p>Confirmation of interaction of the drug with the human body</p>	<p>Screening for safety</p> <p>20-80 patients</p> <p>Evaluation of safety, determination of safe dosage ranges, initial identification of side effects</p>	<p>Establishing the efficacy of the drug</p> <p>100-300 patients</p> <p>Determination of efficacy and further evaluation of safety</p> <p>Usually controlled study</p>	<p>Final confirmation of safety and efficacy</p> <p>1'000-3'000 patients</p> <p>Confirmation of efficacy, evaluation of effectiveness, monitoring of side effects, performance comparison</p>	<p>Safety studies during sales</p> <p>Postmarketing evaluation</p> <p>Further investigation of rare side-effects</p> <p>Further demonstration of risk benefit assessment</p>

Phase structure for drugs and biologics trials

Clinical Investigation – Definitions

With medical device investigation we usually don't use the notion of phase, but more the type of the investigation according to the development stage of the device.



Clinical Investigation – Historical context

Some refer to the first "clinical trial" in the Book of Daniel, chapter 1, verses 12 through 15, where a structured experiment was conducted with **two groups**: one that consumed "the King's meat" and one that did not, over a ten-day trial period.

Daniel 1:12-15 New International Version (NIV)

12 "Please test your servants for ten days: Give us nothing but vegetables to eat and water to drink. 13 Then compare our appearance with that of the young men who eat the royal food, and treat your servants in accordance with what you see."

14 So he agreed to this and tested them for ten days.

15 At the end of the ten days they looked healthier and better nourished than any of the young men who ate the royal food.

After 10 days of eating only vegetables and drinking water, Daniel and his three friends were:

- Healthier in appearance,
- Better nourished (literally: "fatter in flesh" in some translations),
- Stronger-looking than the other young men who ate the king's rich food.

⇒ It was demonstrated the intervention group (Daniel's diet) had superior health and cognitive outcomes. Compared to the control group

Clinical Investigation – Historical context

Early clinical trials were often flawed in terms of design and ethical considerations:

- In 1721, Lady Mary Wortley Montagu conducted an early form of smallpox inoculation on seven prisoners sentenced to death. The trial was deemed a success and helped pave the way for the eventual development of smallpox vaccination.
- In 1747, James Lind performed the first systematic clinical trial, investigating the effectiveness of vitamin C in treating scurvy. Lind divided 12 sailors with scurvy into six pairs and gave them different dietary treatments. His results demonstrated that a diet including citrus fruits was effective in treating scurvy.
- In 1796, the English physician Edward Jenner famously inoculated an eight-year-old child with pus from a cowpox lesion and then exposed her to smallpox. The child survived, providing the first experimental evidence for the principle of vaccination.
- In 1799, John Haygarth conducted a study on the use of Perkins tractors, metallic devices thought to “draw out” disease. Haygarth introduced the control group concept to demonstrate the placebo effect, highlighting the importance of having a control group to accurately assess the efficacy of treatments.

Clinical Investigation – Historical context

During the last century, modern clinical trials came into place to improve quality of the studies:

- 1920 - Birth of Randomization: Ronald Fisher introduced randomization as a way to eliminate bias in clinical trials, ensuring more reliable results.
- 1930 - MRC's Therapeutic Trials Committee: the British Medical Research Council established a committee to promote and support properly controlled clinical trials.
- 1946-1947 - First Randomized Trial: the first randomized controlled trial tested streptomycin for tuberculosis, marking the beginning of widespread RCT use.
- 1960s - Introduction of Ethical Standards: The Declaration of Helsinki (1964) set ethical guidelines for clinical trials, ensuring informed consent and participant safety.
- 1990s - Clinical Trials Registration: as a response to concerns about study transparency, the clinical trial registration process began, promoting public access to study data.
- 2010 - Good Clinical Practice (GCP) Guidelines: the GCP guidelines were further refined to ensure the ethics, quality, and reliability of clinical trials worldwide.
- Today - Advancements in Technology and Data - modern clinical trials leverage big data and AI to improve trial design, patient recruitment, and outcome analysis, making studies more efficient.

Clinical Investigation – Ethics in research

Unfortunately, the last century also showed the necessity of a strong ethical framework



1930-40s Nazi physicians experiments in concentration camps



1946 -1948 s Guatemala syphilis experiments - study the effects of penicillin



1940-70s Human radiation experiments - Manhattan Project, Plutonium Injection Experiments, Green Run, etc.



1950s Vipeholm experiments (carbohydrates and oral cavities)



1980s: Willowbrook case (hepatitis)



1960s: Brooklyn Jewish Chronic Disease Hospital study (injections of cancerous cells to healthy patients)

If you need more examples to be convinced of the need for ethical rules, go and check :
https://en.wikipedia.org/wiki/Unethical_human_experimentation_in_the_United_States

Ethics in Research: A Mandatory Principle

Ethics in research is fundamental to ensuring the safety and well-being of study participants, as well as the integrity and reliability of the collected data. Overall ethics in research ensures that:

- Participants' rights and well-being are protected
- Scientific Integrity is maintained
- Public Trust and Credibility is assured
- Research Advancements are facilitated with reliable evidence
- Legal and regulatory compliance is ensured
- Long-term impact on society and public health is in focus

⇒ Ethics in research is the foundation that upholds the entire integrity of the scientific process. It plays a pivotal role in advancing knowledge while protecting both individuals and society.

⇒ Adhering to ethical principles not only leads to valid and impactful research but also fosters a culture of integrity, accountability, and respect in the scientific community.

Milestones in Ethics in Research

- The **Hippocratic Oath** (circa 400 BCE) - The Hippocratic Oath is one of the earliest foundations of medical ethics, with physicians pledging to uphold principles like confidentiality and the core guideline: "First, do no harm" (Primum non nocere).
- 1938 – The FDA enacted the **Food, Drug, and Cosmetic Act**, requiring drug manufacturers to prove safety before marketing products, following the dangerous effects of Dr. Bull's Cough Syrup (morphine and chloroform).
- 1947 – The **Nuremberg Code** was established after WWII to ensure informed consent and ethical treatment of human subjects in medical experiments, following the atrocities of Nazi experimentation.
 - ⇒ Birth of modern ethical research principles
- 1964 – The **Declaration of Helsinki** focused on human rights protection in medical research, emphasizing informed consent and ethical oversight, especially after the thalidomide tragedy (10,000 babies born with malformations).
- 1996 – The International Conference on Harmonisation (ICH) issued the GCP guidelines to ensure ethical conduct and reliable data in clinical trials, prioritizing patient safety. It led to the publication of the **ICH E6 Guideline for Good Clinical Practice**.
 - ⇒ Birth of the Good Clinical Practices (GCP)



1 December 2016
EMA/CHMP/ICH/135/1995
Committee for Human Medicinal Products

Guideline for good clinical practice E6(R2)

Step 5

Adopted by CHMP for release for consultation	23 July 2015
Start of public consultation	4 August 2015
End of consultation (deadline for comments)	3 February 2016
Final adoption by CHMP	15 December 2016
Date for coming into effect	14 June 2017



ICH = The International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use

The ICH E6(R2) Good Clinical Practice (GCP) guideline is the currently adopted version.

The ICH has been working on the revised version, E6(R3), since 2019. The principles and Annex 1 of E6(R3) were adopted on January 6, 2025, and will come into effect in the EU region on July 23, 2025.



EUROPEAN MEDICINES AGENCY
SCIENCE MEDICINES HEALTH

1 December 2016
EMA/CHMP/ICH/135/1995
Committee for Human Medicinal Products

Guideline for good clinical practice E6(R2)
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- International ethical and scientific quality standard for the design, conduct, performance, monitoring, auditing, recording, analyses and reporting of clinical trials.
- Provides assurance that the data and reported results are credible and accurate, and that the rights, integrity and confidentiality of trial subjects are respected and protected.
- In Europe it is enforced since 31st of January 2022 through the Clinical Trials Regulation EU No 536/2014 *
- In Switzerland it is enforced through the Human Research Act

*Note1: replacing EU Directive 2001/20/EC

*Note2 : EU 536/2016 applies to interventional trials



Good Clinical Practices – Core principles

The ICH E6 (R2) guideline outlines 13 core principles for the Good Clinical Practice (GCP), which serve as the ethical and scientific foundation for designing and conducting clinical trials involving human subjects. They operationalize the ethical standards of the Declaration of Helsinki:

1. Ethical Conduct

Clinical trials should be conducted in accordance with the ethical principles that have their origin in the Declaration of Helsinki, and that are consistent with GCP and the applicable regulatory requirement(s).

2. Risk-Benefit Assessment

Before a trial is initiated, foreseeable risks and inconveniences should be weighed against the anticipated benefit for the individual trial subject and society. A trial should be initiated and continued only if the anticipated benefits justify the risks.

3. Subject Rights, Safety, and Well-being

The rights, safety, and well-being of the trial subjects are the most important considerations and should prevail over interests of science and society.

4. Adequate Information and Consent

The available nonclinical and clinical information on an investigational product should be adequate to support the proposed clinical trial.

5. Scientific Soundness

Clinical trials should be scientifically sound, and described in a clear, detailed protocol.

6. Approval by Independent Ethics Committee (IEC)/IRB

A trial should be conducted in compliance with the protocol that has received prior institutional review board (IRB)/independent ethics committee (IEC) approval/favourable opinion.

7. Qualified Personnel

The medical care given to, and medical decisions made on behalf of, subjects should always be the responsibility of a qualified physician or, when appropriate, of a qualified dentist.

8. Qualified Trial Staff

Each individual involved in conducting a trial should be qualified by education, training, and experience to perform his or her respective task(s).

9. Proper Handling of Data and Procedures

Freely given informed consent should be obtained from every subject prior to clinical trial participation.

10. Quality Assurance

All clinical trial information should be recorded, handled, and stored in a way that allows its accurate reporting, interpretation and verification.

11. Accurate Recording and Reporting

The confidentiality of records that could identify subjects should be protected, respecting the privacy and confidentiality rules in accordance with the applicable regulatory requirement(s).

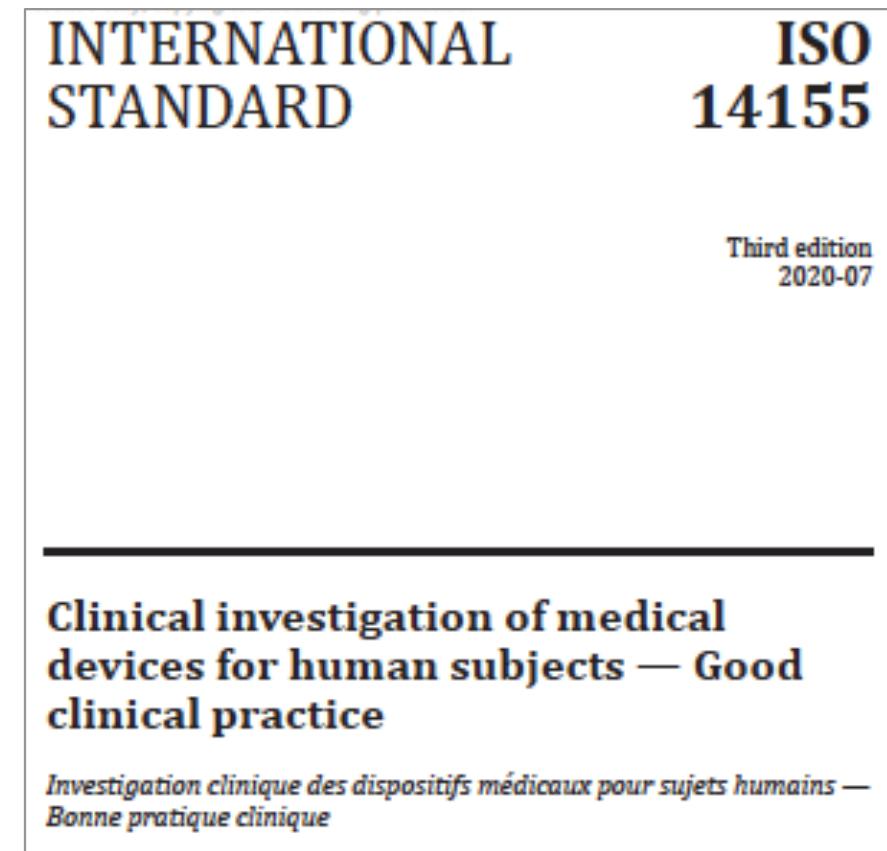
12. Confidentiality

Investigational products should be manufactured, handled, and stored in accordance with applicable good manufacturing practice (GMP). They should be used in accordance with the approved protocol.

13. Good Manufacturing Practice (GMP) Compliance

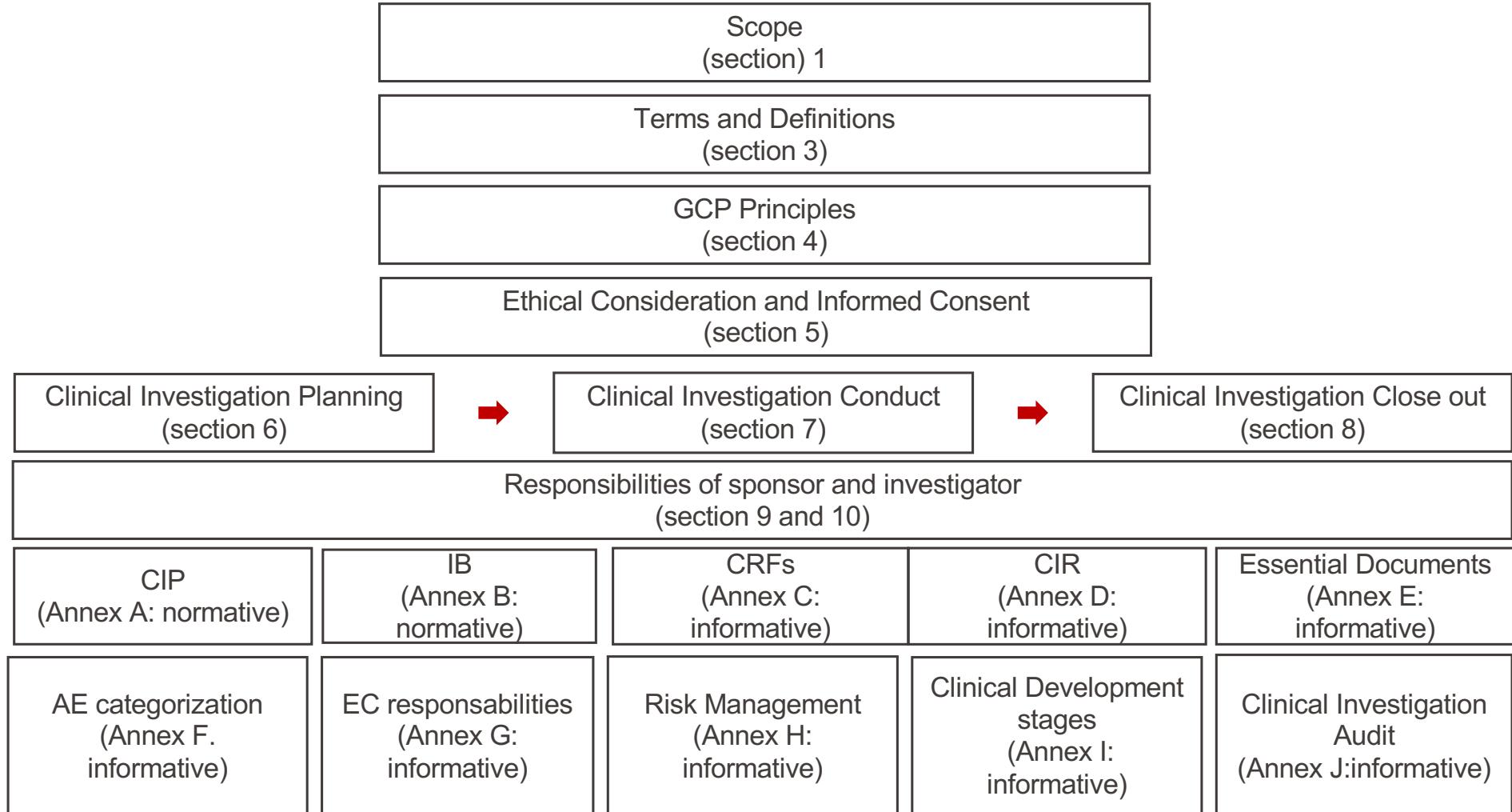
Systems with procedures that assure the quality of every aspect of the trial should be implemented.

Good Clinical Practices in medical devices investigations



- The latest version is from 2020
- ISO 14155 is specifically used for medical devices clinical investigation
- ISO 14155 is not applicable to IVD, instead the ISO 20916 applies
- ISO 14155 integrates all principles of ICH-GCP E6
- The use of the standard is directly reference in MDR EU 2017/745 (in the Whereas)
 - (64) The rules on clinical investigations should be in line with well-established international guidance in this field, such as the international standard ISO 14155:2011 on good clinical practice for clinical investigations of medical devices for human subjects (...)

Clinical Investigation – ISO 14155 Structure



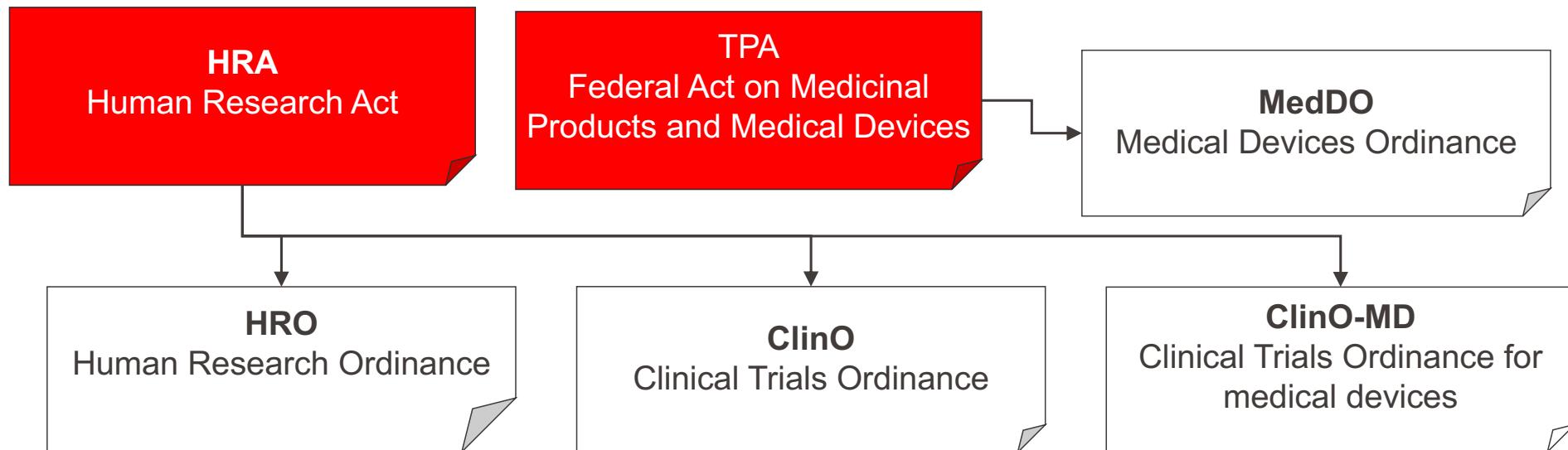
ICH E6 Guideline for Good Clinical Practices and ISO 14155 share the same purpose and principles but have differences:

Differences in terminology (non exhaustive):

- Medicinal product / drug / substance → Medical device
- Investigational product → Investigational medical device
- AE, SAE, SADR (serious adverse drug reaction) → AE, SAE, SADE (serious adverse device effect), Device deficiency, malfunction

Similarities:

- Focus on designing, conducting, recording and reporting results from clinical trials/investigations designed to assess the safety and efficacy/performance of therapeutic products
- Sponsor and investigator responsibilities
- Review by an independent EC is required
- Content of clinical investigation plan/study protocol
- Registration of the study in EU database (EU portal vs EUDAMED)
- Public disclosure of results
- Protection of personal data (GDPR 2016/679)



HRO applies to research on:

- IVF embryos in accordance with the Stem Cell Research Act;
- anonymised biological material;
- anonymously collected or anonymised health-related data.

⇒ applies ONLY for research projects

ClinO applies to research on:

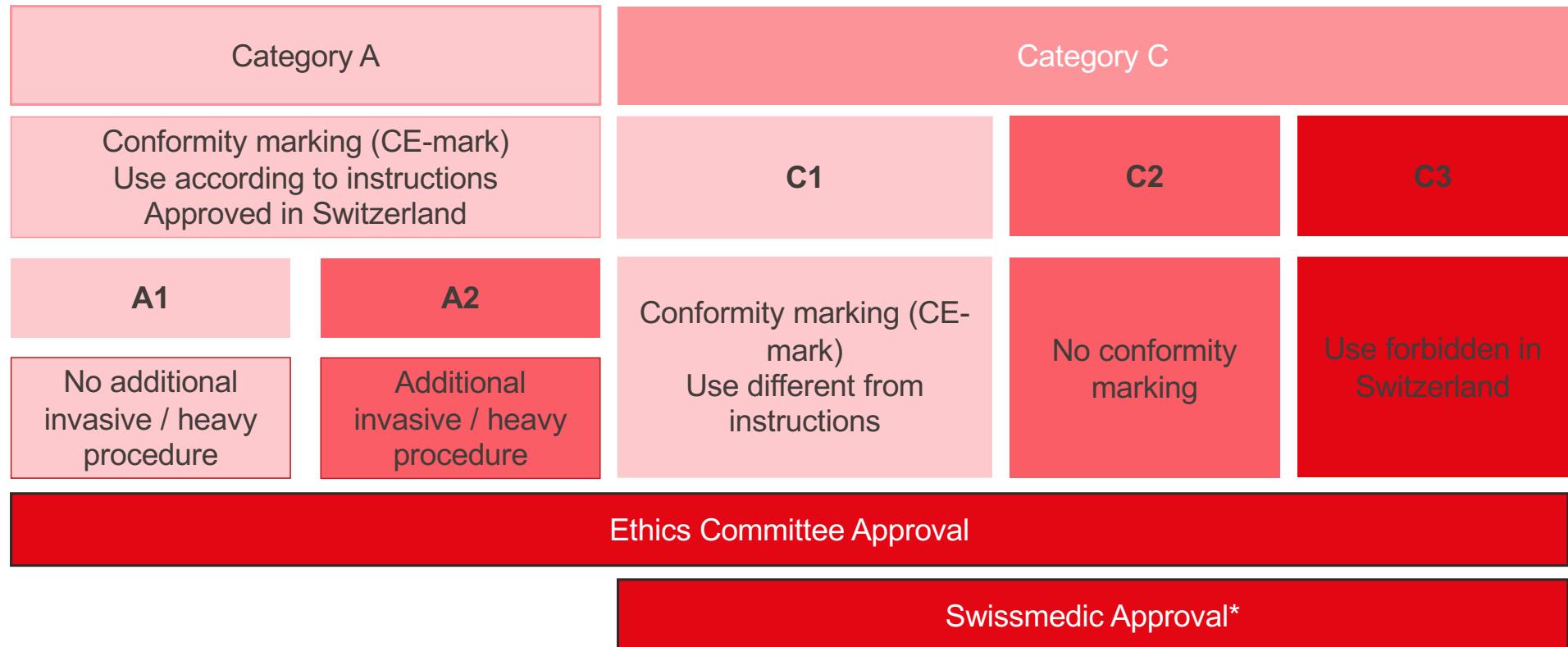
- Clinical trials involving drugs and biologics
- Investigations involving therapeutic products under the Therapeutic Products Act (TPA)

ClinO-MD applies to research on:

- Clinical investigations of medical devices, including implantable and high-risk devices



Categorisation of clinical investigations (Art 6 ClinO-MD)



Clinical Investigation – Legal basis in Europe



Clinical trials - Regulation
EU No 536/2014

Specific to pharmaceutical drugs or biological products

General Data Protection Regulation
EU No 2016/697

Applies to both types of studies

Medical Device Regulation
EU No 2017/745

Specific to Medical devices

The ICH E6(R2) Good Clinical Practice (GCP)

Clinical investigation of medical devices for human subjects — Good clinical practice





MDR Articles applicables to clinical investigation

MDR Art	Description
62-81	<p>General requirements regarding clinical investigations conducted to demonstrate conformity of devices</p> <ul style="list-style-type: none">- approval from CA- approval from EC- GCP principles- medical device confirms with GSPRs- according to requirements of Annex XV , Art 62-81
74(1)	PMCF investigation according to IFU, involve additional invasive or burdensome procedures , the sponsor shall notify the Member States concerned at least 30 days prior to its commencement by means of the electronic system
82	<p>Clinical investigation shall comply with the provisions of Article 62 (2) and (3), points (b), (c), (d), (f), (h), and (l) of Article 62(4) and Article 62(6)</p> <p>Member State shall define any additional requirements for such investigations, as appropriate for each Member State concerned</p>
Annex XV	General requirements on the conduct of a clinical investigation

Clinical investigation and evaluation

Reference	Title	Publication
MDCG 2024-10	Guidance on the publication of the clinical investigation reports and their summaries in the absence of EUDAMED	November 2024
MDCG 2024-11	Clinical evaluation of orphan medical devices	June 2024
MDCG 2024-12	Guidance on the Investigator's Brochure content Appendix A of the MDCG 2024-5	April 2024
MDCG 2024-13	Guidance on content of the Clinical Investigation Plan for clinical investigations of medical devices Clinical Investigation Plan Synopsis Template	March 2024
MDCG 2024-14	Guidance on exemptions from the requirement to perform clinical investigations pursuant to Article 6(1)(e) MDR and on sufficient levels of 'access' to data needed to justify claims of equivalence	March 2024
2023/C 03/06	Commission Guidance on the content and structure of the summary of the clinical investigation report	May 2023
MDCG 2021-25	Substantial modification of clinical investigation under Medical Device Regulation	December 2021
MDCG 2021-26	Instructions for generating CIV-ID for MDR Clinical Investigations	July 2021
MDCG 2021-27	Clinical investigation application/notification documents	May 2021
MDCG 2021-28	Regulation (EU) 2017/745 – Questions & Answers regarding clinical investigation	December 2023
MDCG 2020-10 – Word version	Clinical evaluation assessment report template	July 2020
MDCG 2020-10/1 rev1	Guidance on safety reporting in clinical investigations Appendix: Clinical investigation summary safety report form	October 2022
MDCG 2020-10/2 rev1		October 2022
MDCG 2020-8	Guidance on PMCF evaluation report template	April 2020
MDCG 2020-7	Guidance on PMCF plan template	April 2020
MDCG 2020-6	Guidance on sufficient clinical evidence for legacy devices Background note on the relationship between MDCG 2020-6 and MEDDEV 2.7/1 rev.4 on clinical evaluation	April 2020
MDCG 2020-5	Guidance on clinical evaluation – Equivalence	April 2020
MDCG 2019-9 – rev1	Summary of safety and clinical performance	March 2022

The European Union has published numerous guidance on clinical investigation under the form of MDCG Guidance

- Guidance on the publication of the clinical investigation reports and their summaries in the absence of EUDAMED
- Guidance on the Investigator's Brochure content
- Guidance on content of the Clinical Investigation Plan for clinical investigations of medical devices
- Commission Guidance on the content and structure of the summary of the clinical investigation report
- Substantial modification of clinical investigation under Medical Device Regulation
- Clinical investigation application/notification documents
- ...

