2ND IBCQ INTERNATIONAL BIOBANKING CONFERENCE

March 8-10, 2021
Virtual Conference

Biobanking for Precision Care - Lessons Learned from Global Crises

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Standardized Preanalytics: The Key for Reliable Diagnostics, Research and Biobanking

Dr. Uwe Oelmueller, SPIDIA4P Coordinator

www.spidia.eu

The SPIDIA4P project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 733112.

Disclosure of Conflict of Interest

Dr. Uwe Oelmueller

- Employed by QIAGEN GmbH, Hilden, Germany
- Management Committee Co-Chair of PreAnalytiX GmbH (QIAGEN/BD Company)

Introduction

- Dr. Uwe Oelmueller
- QIAGEN: Head of MDx Sample Technologies
- PreAnalytiX: Management Committee Co-Chair
- Coordinator of the EU FP7 Collaborative Grant Project SPIDIA (2008 – 2013)
- Coordinator of the EU Horizon 2020 Coordination and Support Action SPDIA4P (2017 – 2021)
- Working group convenor at the ISO/TC 212 (clinical Laboratory testing and in vitro diagnostic test systems) and at
- Working group convenor a the CEN/TC 140 (in vitro diagnostic medical devices)
- Hilden, Germany

Standardized Preanalytics: The Key for Reliable Diagnostics, Research and Biobanking

2nd IBCQ International Biobanking Conference March 9th 2021

Dr. Uwe Oelmueller, SPIDIA4P Coordinator

www.spidia.eu

New Technologies and Standards for Pre-analytical Workflows

SPIDIA – FP7 (2008 – 2013)

- ⇨ 16 Partners
- New technologies for sample collection, stabilization, processing, transport, storage (Blood, Tissues)
- 9 EU CEN Standards

SPIDIA4P – H2020 (2017 – 2021)

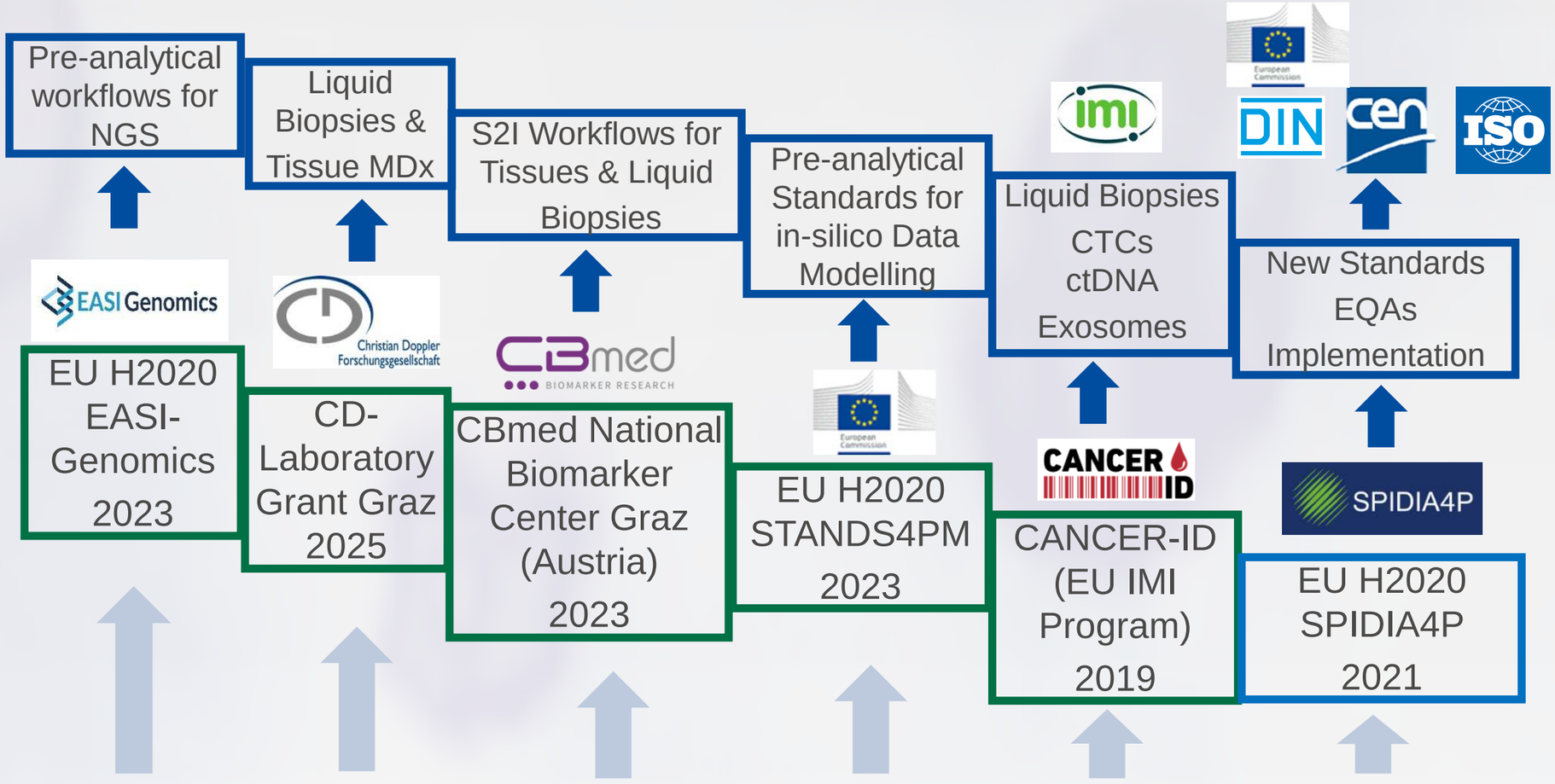
- ⇨ 19 Partners
- ⇨ 14 associated consortia & stakeholder organizations
- 13 additional new CEN & ISO Standards
- EQAs
- European and International implementation

www.spidia.eu ⇨ **Subscribe the Newsletter!**

The SPIDIA project has received funding under the Seventh Research Framework Program of the European Union, FP7-HEALTH-2007-1.2.5, under grant agreement no. 222916. The SPIDIA4P project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 733112.

Largest Consortia Network for Pre-analytics in Community

⇨ Tech Developments, Standards, EQAs, Implentation, Consulting, Education



SPIDIA

www.spidia.eu

Deficiencies in Routine Healthcare and Research demand for Improvements

- Diagnostic errors cause about 10% of all patient deaths and about 17% of adverse events

  Institute of Medicine (IOM) Report Sept. 2015

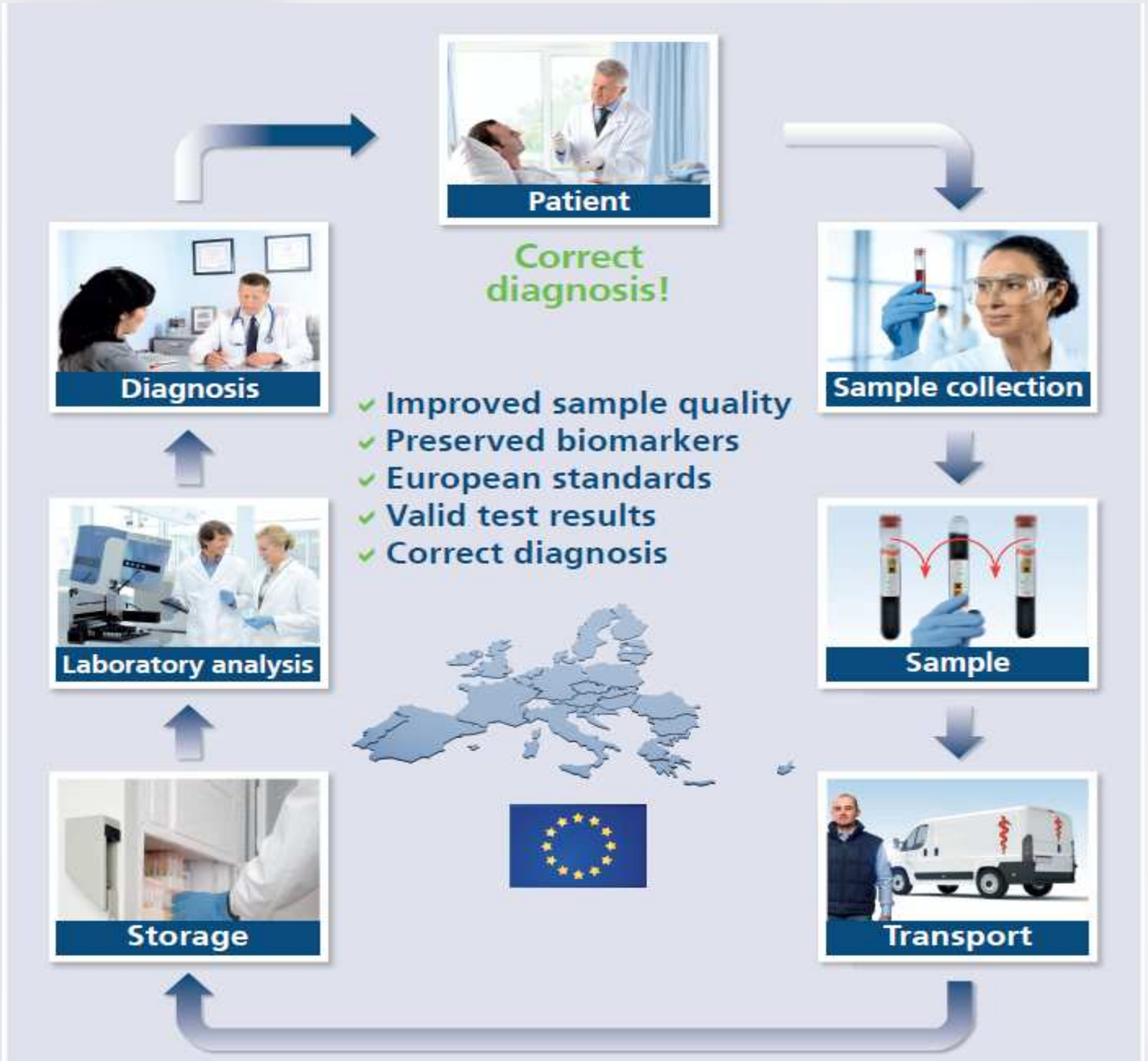
- Pre-analytical phase accounts for 46% to 68% of clinical laboratory errors

  Medical Laboratory Observer, May 2014

- Irreproducible preclinical research exceeds 50%, US $28B / year spent on preclinical research that is not reproducible - in the US

  Freedman LP, Cockburn IM, Simcoe TS (2015) PLoS Biol 13(6): e1002165.doi:10.1371/journal.pbio.1002165

An Analytical Test Result is the Result of an Entire Workflow

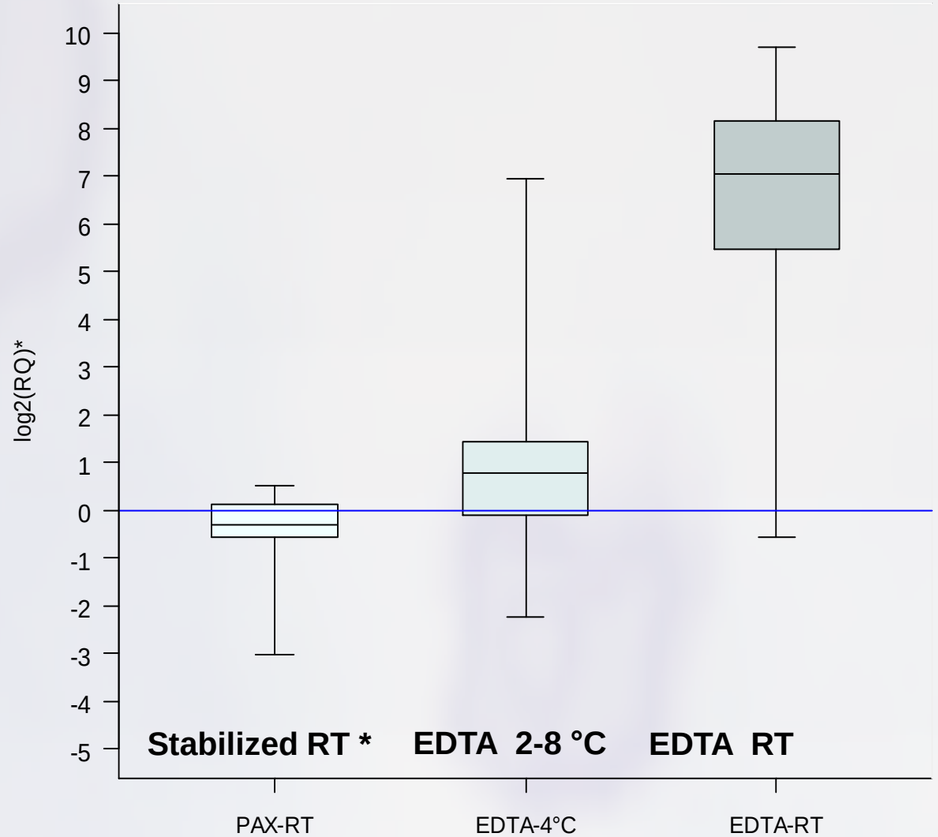


Specifying, developing and verifying preanalytical workflows is an essential part of analytical test development

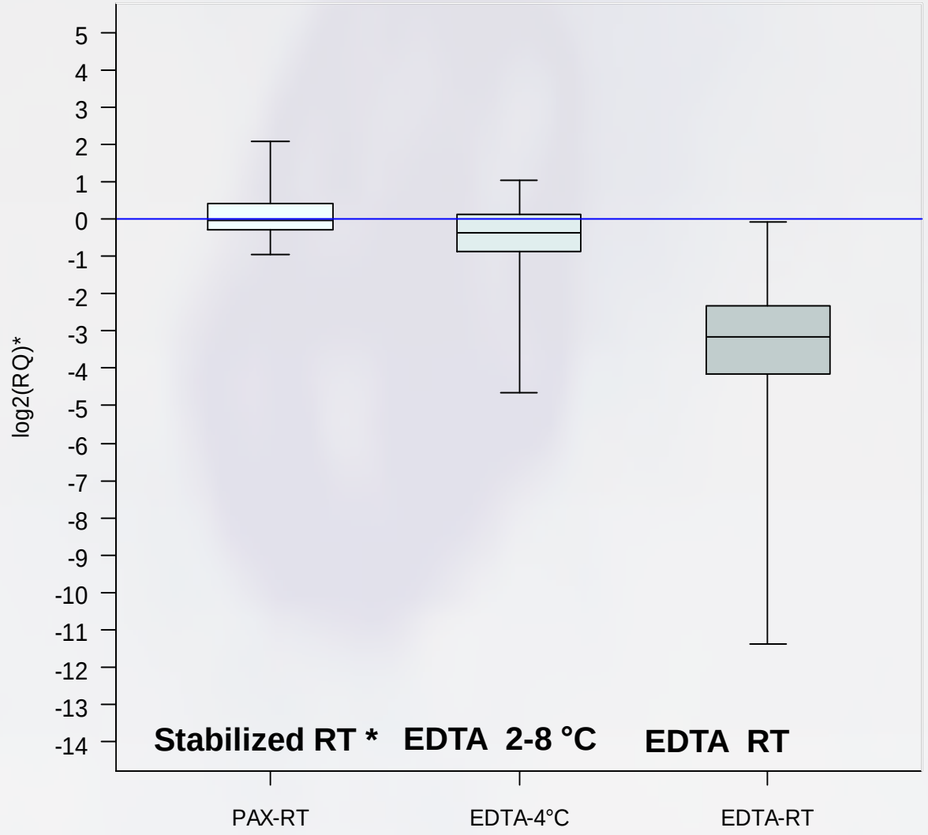
European Conference. Standards: Your Innovation Bridge. Brussels (2014). SPIDIA Booth.

SPIDIA Pan-European Research Ring Trial
Changes of Blood Cellular RNA Profile: 48 Hours After Collection

Up-regulated FOSB mRNA level



Down-regulated TNFRS mRNA level



* PAXgene Blood RNA Tube

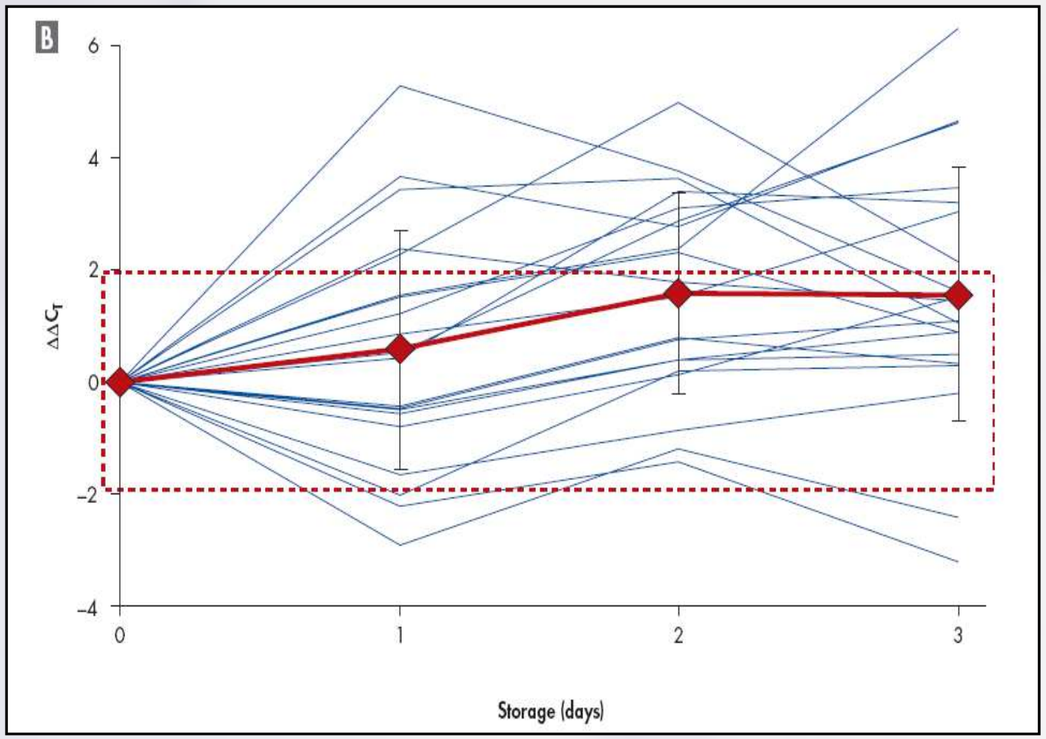
Malentacchi F et al. (2014). SPIDIA-RNA: Second External Quality Assessment for the Pre-Analytical Phase of Blood Samples Used for RNA Based Analyses. PLoS ONE 9(11): e112293.

Zhan H et al. (2014). Biomarkers for Monitoring Pre-Analytical Quality Variation of mRNA in Blood Samples. . PLoS ONE 9(11): e111644.

Blood RNA Quality Marker Discovery

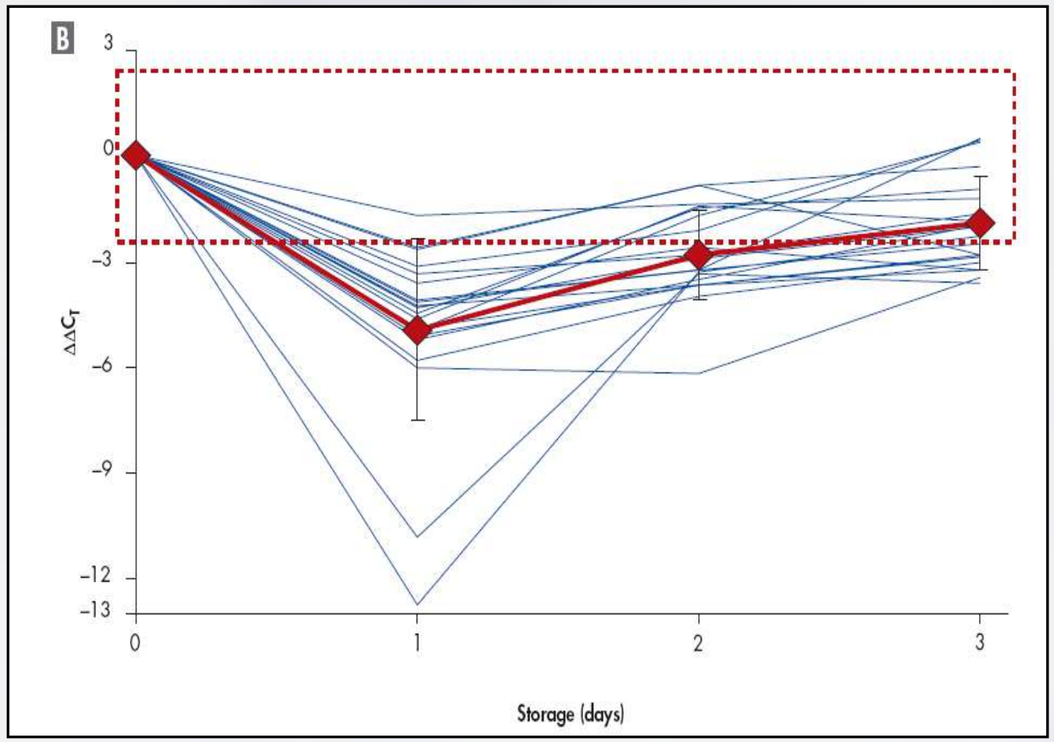
Challenge are Individual Sample Kinetics

Human EDTA Blood stored at Room Temperature over 3 days



IL-1β **mRNA**

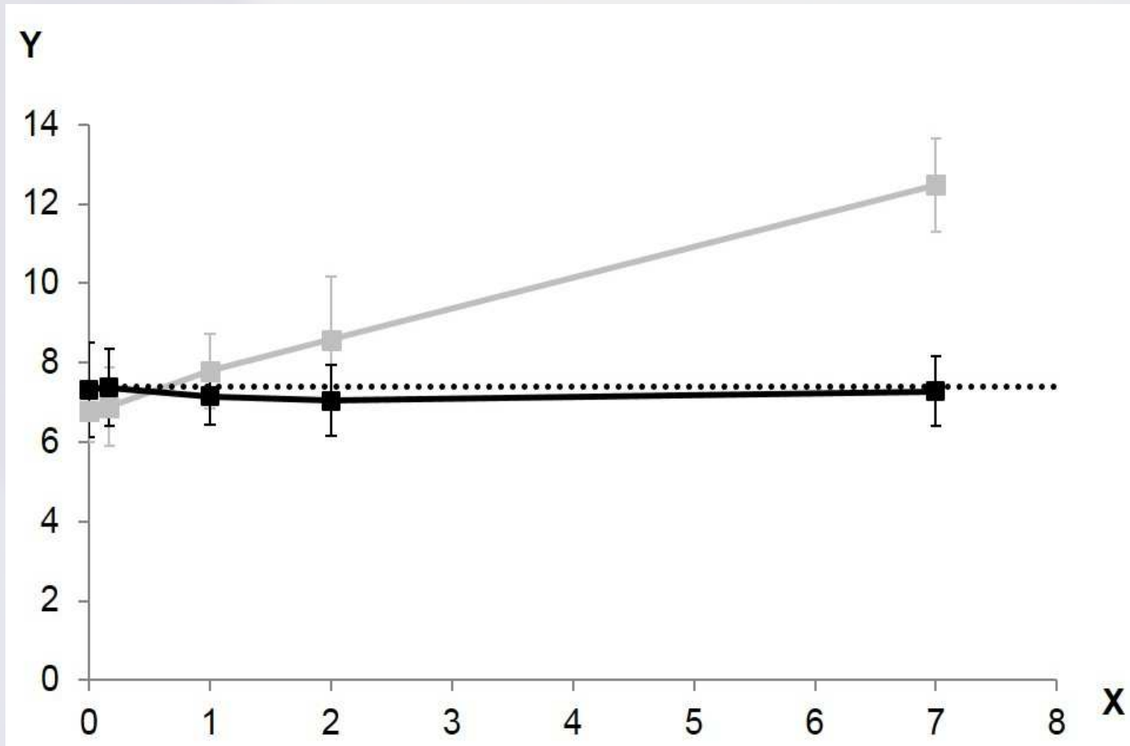
Guenther K. et al.. AMP Poster (2005)



c-fos mRNA

Guenther K. et al..CLI 5, 26-28 (2008)

Post Blood Collection ccfDNA Profile Changes - Impact on EGFR Test



X venous whole blood storage duration (in days) before plasma preparation

Y ΔCT = CT (mutant) - CT (wildtype control)

EDTA Blood

Stabilized Blood

···· Threshold (given by the examination provider)

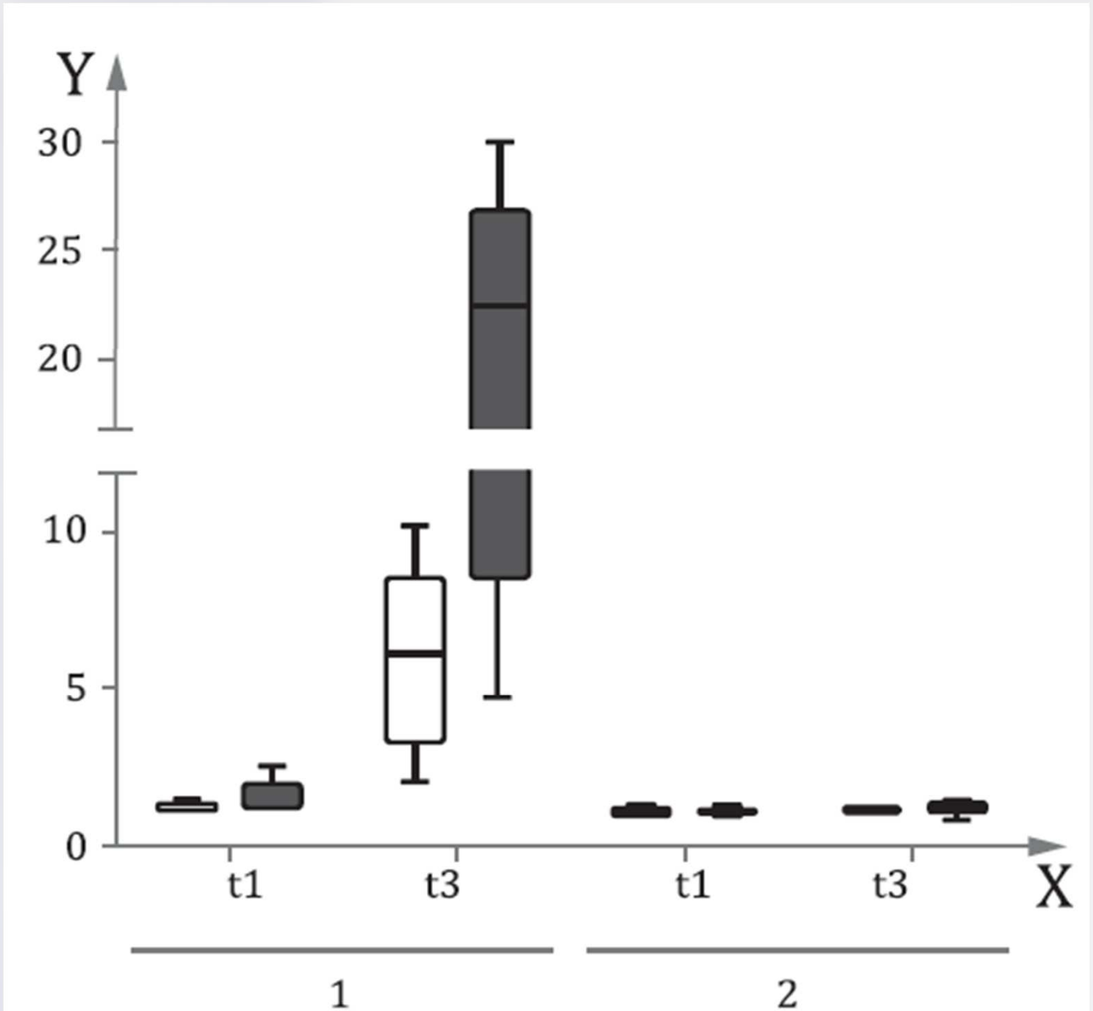
The average of 8 donors is shown

- Spiked restriction enzyme treated EGFR DNA with mutation T790M, equivalent to 200 copies
- ccfDNA tested with the commercially available EGFR Plasma PCR Kit (RUO)

Source:

ISO 20186-3:2019: Molecular in vitro diagnostic examinations — Specifications for pre- examination processes for venous whole blood — Part 3: Isolated circulating cell free DNA from plasma. Annex A.

Blood Specimen Storage – Post Collection Release of DNA Dilutes Original ccfDNA Profile



⇨ Apoptosis of white blood cells leads to increased DNA yield and dilution of the target ccfDNA

18S rDNA gene, 66 bp amplicon

18S rDNA gene, 500 bp amplicon

X whole blood storage duration at room temperature before plasma generation (t1,3,6: 1, 3, and 6 days)

Y ratio of 18S rDNA copy numbers determined in plasma after indicated blood storage durations versus immediately after blood collection (t0)

1: EDTA Blood

2: stabilized Blood: with ccfDNA profile stabilizer

ISO 20186-3:2019
Molecular in vitro diagnostic examinations — Specifications for pre-examination processes for venous whole blood — Part 3: Isolated circulating cell free DNA from plasma. Annex A.

Major Efforts for Improvements

- **Technologies**
- **International ISO & CEN Standards**
- **External Quality Assessment (EQA) Schemes**
- **Implementation -** healthcare, biobanking, research

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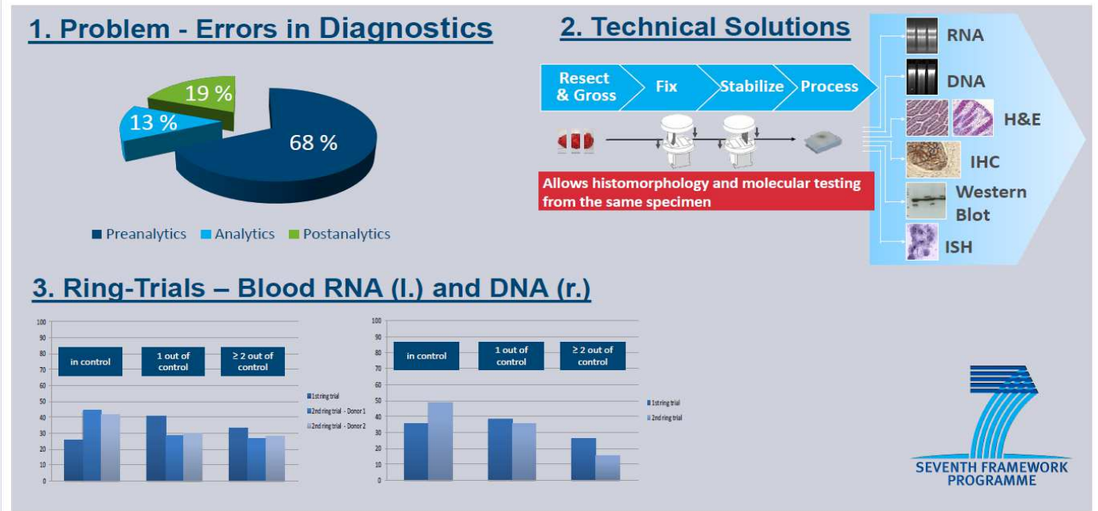
SPIDIA's Road to Standardization

under Vienna Agreement (1991)

- 2019 : 8 ISO/International Standards
- 2014: 8 new projects for ISO Standards approved in ISO/TC 212 „C*linical laboratory testing and in vitro diagnostic test systems*"

- 2015: 9 CEN Technical Specifications published
- 2013: 9 new projects approved in CEN/TC 140 *„In vitro diagnostic medical devices"*
- 2010: Start of standardization work



European Conference. Standards: Your Innovation Bridge. Brussels (2014). SPIDIA Booth.

Highly Consensus Driven Process for Developing Standards

CEN

- Recognized by the EU and the European Free Trade Association (EFTA) as being **responsible for developing standards at European level**
- Development of a European Standard (EN) or International Standard (ISO) is governed by the principles of **consensus, openness, transparency, national commitment** and **technical coherence**

CEN/TC 140 (Committee for in vitro diagnostic medical devices)

- **34 EU countries National Standards Bodies** ⇨ One European Standard replaces 34 national standards
- **11 Stakeholder organizations in liaison**

ISO/TC 212 (Committee for Clinical Laboratory Testing and in vitro Diagnostic Test Systems)

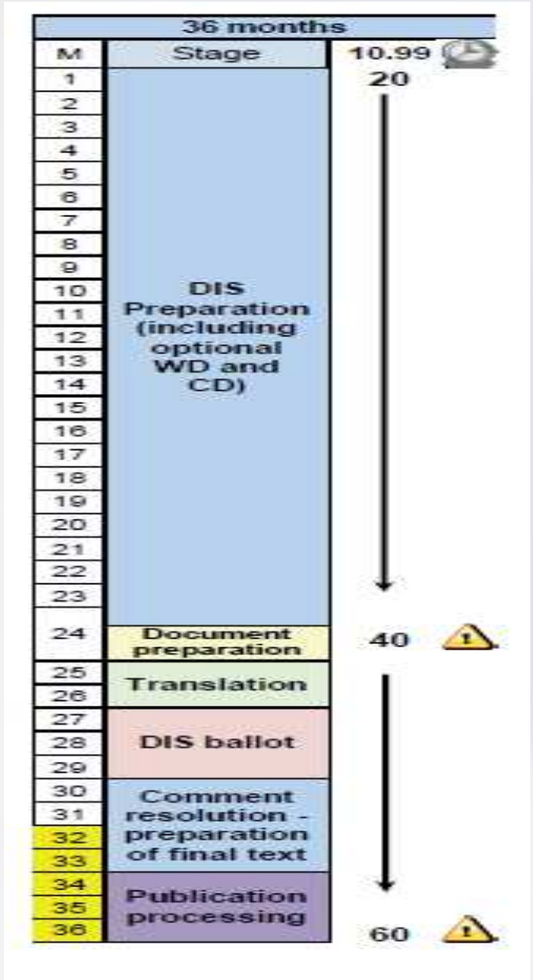
- **45 member countries, 23 observing members,**
- **23 organizations in liaison** (incl. WHO, OECD, IFCC, ILAC, European Commission . . .)

ISO Standard Development – Usually a 36 to 48 Months Period

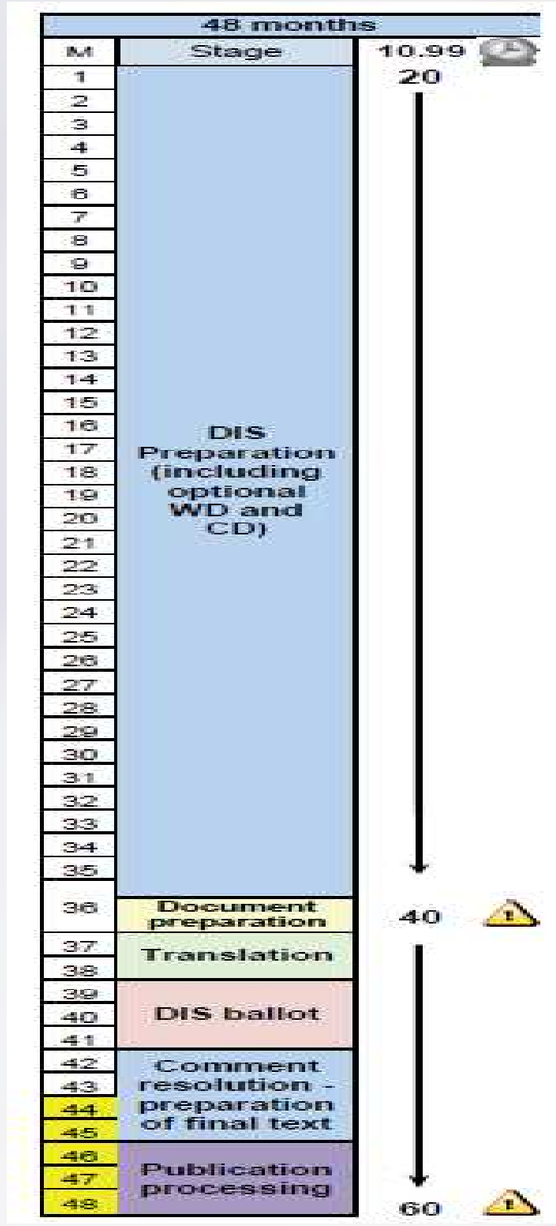
ISO/TC 212

- Technical Committee for Clinical Laboratory Testing and in vitro Diagnostic Test Systems
- 45 member countries, 23 observing members, 24 organizations in liaison (incl. WHO, OECD, IFCC, ILAC, European Commission . . .)

Source (March 2021): https://www.iso.org/committee/54916.html



Source: https://www.iso.org/files/live/sites/iso org/files/developing_standards/docs/ en/Target_date_planner_4_ISO_stan dards_development_tracks_2017.pdf



Twofold Role of Standardization

Traditional Role of Standards

- Source of technical know-how
- Trade facilitation and opening of markets
- Providing a scientific basis for legislation in the health, safety and environment sectors

Valued-added role for research and innovation

- Speeding up innovation by providing the requisite knowledge base (technology transfer)

➢ New ideas, technologies and products benefit from standardization to get into the marketplace and to be successful

Source: Gindele 2013
http://www.iso.org/iso/home/about/conformity-assessment.htm

22 CEN & ISO Standard Documents and EQAs by 2021

INTERNATIONAL STANDARD **ISO 20186-3**

First edition
2019-09

Molecular in vitro diagnostic examinations — Specifications for pre-examination processes for venous whole blood —

Part 3:

Isolated circulating cell free DNA from plasma

Analyses de diagnostic moléculaire in vitro — Spécifications relatives aux processus préanalytiques pour le sang total veineux —

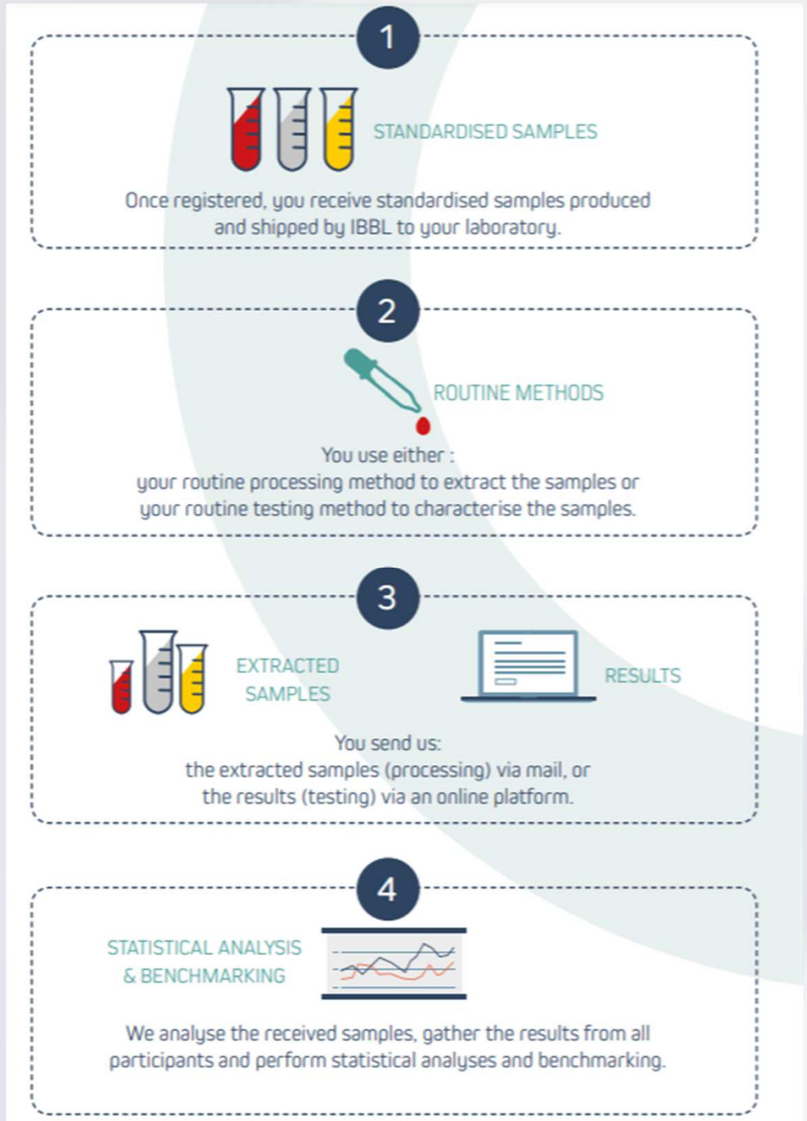
Partie 3: ADN libre circulant extrait du plasma

Reference number
ISO 20186-3:2019(E)

- Molecular in-vitro diagnostic examinations - Specifications for **pre-examination processes** for
  - **Blood** — Cellular RNA, gDNA, ccfDNA, ccfRNA
  - **Blood** – Exosomes, ccfRNA
  - **Blood Tumor Cells** – DNA, RNA, staining
  - **Tissue** (FFPE) — DNA, RNA, Proteins
  - **Tissue** (Frozen) – RNA, Proteins, DNA
  - **Tissue** (FFPE) – in situe staining
  - **Fine Needle Aspirates** – DNA, RNA, Proteins
  - **Saliva** – DNA
  - **Urine & Body Fluids** – cfDNA
  - **Metabolomics** – Urine, Serum, Plasma
  - **Microbiome** – Stool, Saliva etc.

published CEN published ISO in development

The External Quality Assurance (EQA) Program in SPIDIA4P



Implemented by Integrated Biobank of Luxembourg (IBBL) in annual PT Program

- DNA extraction from whole blood
- RNA extraction from whole blood
- DNA extraction from FFPE material
- RNA extraction from FFPE material
- Microbial DNA extraction from saliva
- Microbial DNA extraction from stool
- DNA extraction from frozen tissue
- Total RNA extraction from frozen tissue
- Cell-free DNA (cfDNA) extraction from whole blood
- Cell-free RNA (cfRNA) extraction from plasma
- Dual DNA/RNA Extraction from Frozen Tissue
- Circulating Tumor Cells (CTC) Detection and Isolation
- Viable PBMC isolation

Source: https://www.ibbl.lu/ibbl-bioservices/biospecimen-proficiency-testing

ISO 20186-3 – Pre-examination Processes for Blood ccfDNA

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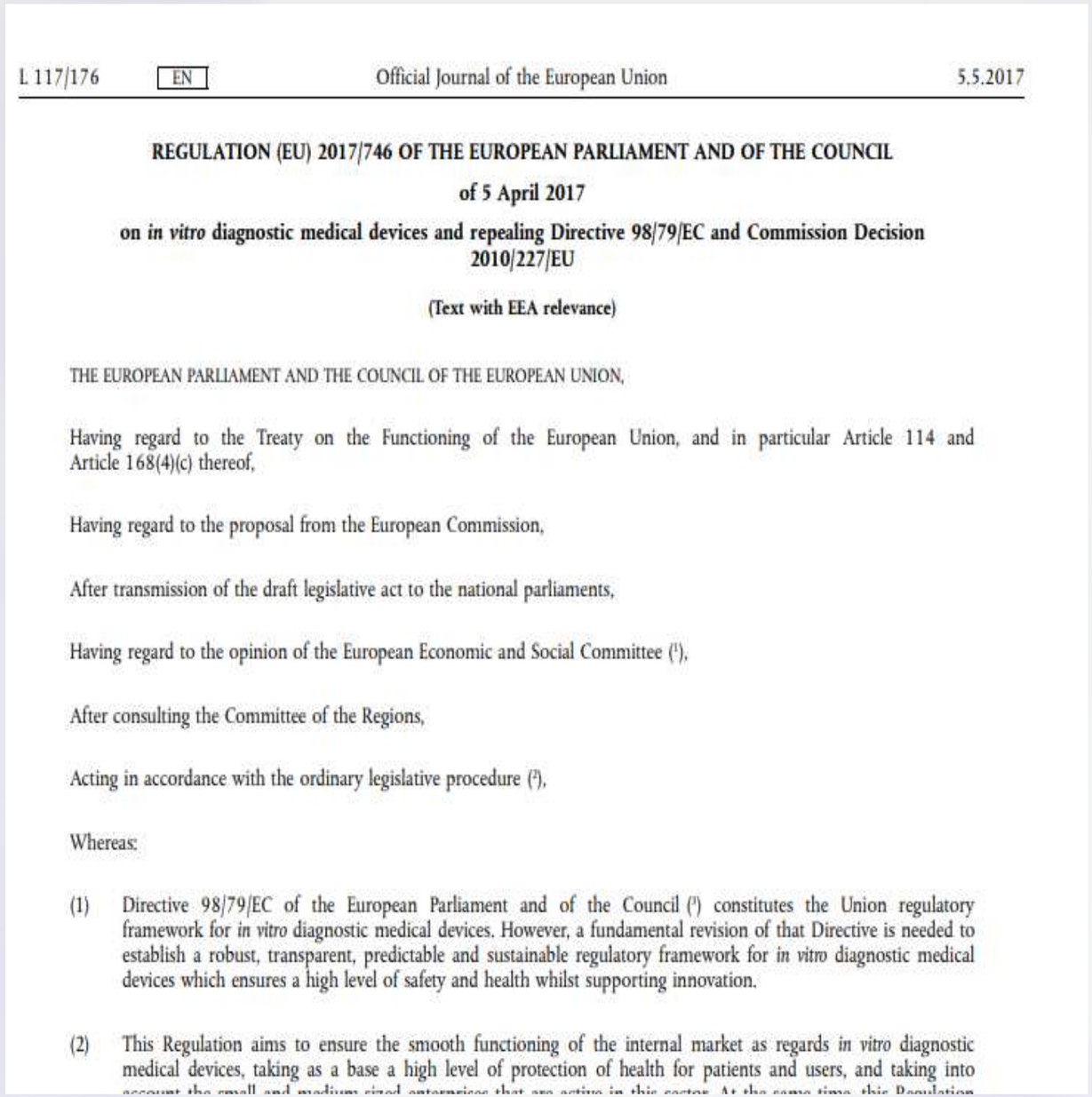
Example:

ISO 20186-3:2019 - Molecular in vitro diagnostic examinations — Specifications for pre-examination processes for venous whole blood — Part 3: Isolated circulating cell free DNA from plasma

Pre-analytical Workflow - Same Standards for all Segments

- **Biobanks**
  - Source for good quality samples ⇨ required for biomarker & analytical test development
- **Biomedical & Translational Research**
  - Academia
  - Pharma industry
  - Diagnostic Industry
- **Diagnostics**
  - High sample quality is the safe way
  - Analytical assay might tolerate lower quality or not ⇨ Verification studies

New EU In Vitro Diagnostic Medical Device Regulation (IVDR)



L 117/176 EN Official Journal of the European Union 5.5.2017

REGULATION (EU) 2017/746 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 5 April 2017

on *in vitro* diagnostic medical devices and repealing Directive 98/79/EC and Commission Decision 2010/227/EU

(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 114 and Article 168(4)(c) thereof,

Having regard to the proposal from the European Commission,

After transmission of the draft legislative act to the national parliaments,

Having regard to the opinion of the European Economic and Social Committee ([1]),

After consulting the Committee of the Regions,

Acting in accordance with the ordinary legislative procedure ([2]),

Whereas:

(1) Directive 98/79/EC of the European Parliament and of the Council ([3]) constitutes the Union regulatory framework for *in vitro* diagnostic medical devices. However, a fundamental revision of that Directive is needed to establish a robust, transparent, predictable and sustainable regulatory framework for *in vitro* diagnostic medical devices which ensures a high level of safety and health whilst supporting innovation.

(2) This Regulation aims to ensure the smooth functioning of the internal market as regards *in vitro* diagnostic medical devices, taking as a base a high level of protection of health for patients and users, and taking into account the small and medium sized enterprises that are active in this sector. At the same time, this Regulation

- entered into force on 26 May 2017
- will replace the EU's current Directive on in vitro diagnostic medical devices (98/79/EC)
- transition period until 26 May 2022

New In Vitro Diagnostic Regulations 2017 (IVDR)

- Pre-analytical workflow parameters in several sections

  - 6. PRODUCT VERIFICATION AND VALIDATION (Annex II)

    - 6.1. Information on analytical performance of the device
    - 6.1.1. Specimen type

      This Section shall describe the different specimen types that can be analysed, including their stability such as storage, where applicable specimen transport conditions and, with a view to time-critical analysis methods, information on the timeframe between taking the specimen and its analysis and storage conditions such as duration, temperature limits and freeze/thaw cycles

New In Vitro Diagnostic Regulations 2017 (IVDR)

- State-of-the-Art requested in various articles and annexes - *Example:*

  - ANNEX 1: GENERAL SAFETY AND PERFORMANCE REQUIREMENTS

    - CHAPTER I GENERAL REQUIREMENTS

      1. Devices shall achieve the performance intended by their manufacturer and shall be designed and manufactured in such a way that, during normal conditions of use, they are suitable for their intended purpose. They shall be safe and effective and shall not compromise the clinical condition or the safety of patients, or the safety and health of users. . . . . taking into account the generally acknowledged **state of the art.**

Role of Standards and Technologies

New EU IVDR – in-vitro Diagnostic Device Regulation 2017

Pre-analytical workflow parameters

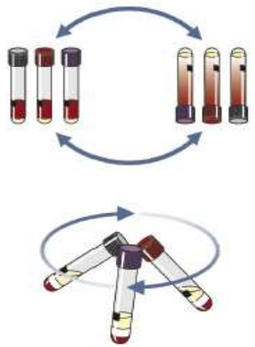
EN ISO & CEN Standards

SOPs

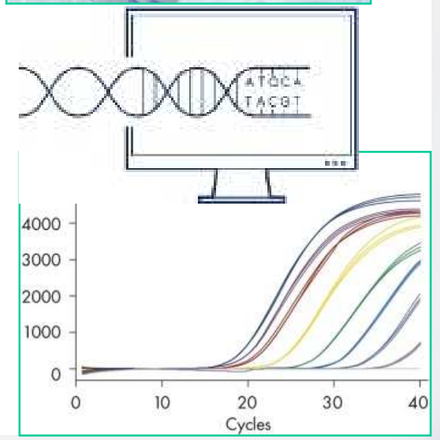
Technologies & Products

Pre-analytical Steps: Part of a Whole Diagnostic Test Workflow

Tube



Kit



Specimen Collection & Stabilization → **Storage Transport** → **Sample Processing** → **Analyte Isolation** → **Analytical Test** → **Data Analysis**

FDA approved PIK3CA RGQ PCR Assay: Preanalytical Workflow Parameters

- FDA approved in 2019: CDx test

➢ Preanalytical workflow parameters are specified and verified as part of the approved test

⇨ Example: Collection and storage duration in Instructions-For-Use (IFUs):

Whole peripheral venous blood collected in K_2EDTA blood collection tubes must be processed to obtain plasma within four hours of blood collection. Failure to do so may result in genomic DNA contamination of the sample. For further information on the isolation of plasma from

Product claims may differ from country to country based on regulations and approvals. Contact the company's country representative for further details.

➢ ISO 20186-1:2019 (*Molecular in vitro diagnostic examinations — Specifications for pre-examination processes for venous whole blood — Part 1: Isolated cellular RNA*) now also requires to specify the respective temperature

SPIDIA4P: Implementation including Training Programs

BBMRI.QM TRAINING & EDUCATION

on the ISO standards for

MOLECULAR IN VITRO DIAGNOSTIC EXAMINATIONS – SPECIFICATIONS FOR PRE-EXAMINATION PROCESSES FOR

Frozen tissue:

Isolated RNA, ISO 20184-1

Isolated proteins, ISO 20184-2

Formalin-fixed and paraffin-embedded tissue:

Isolated RNA, ISO 20166-1

Isolated proteins, ISO 20166-2

Isolated DNA, ISO 20166-3

Venous whole blood:

Isolated cellular RNA, ISO 20186-1

Isolated genomic DNA, ISO 20186-2

Isolated circulating cell free DNA from plasma, ISO 20186-3

The BBMRI.QM team provided in cooperation with the H2020 project SPIDIA4P GA 733112, an in-depth training on the pre-analytical standards relevant for biomedical research and biobanking.

This BBMRI.QM training & education programme was presented as a virtual training, split into 16 sessions in which the individual chapters of the standards were discussed. Renowned experts gave comprehensive presentations on requirements, definitions and practical applications.

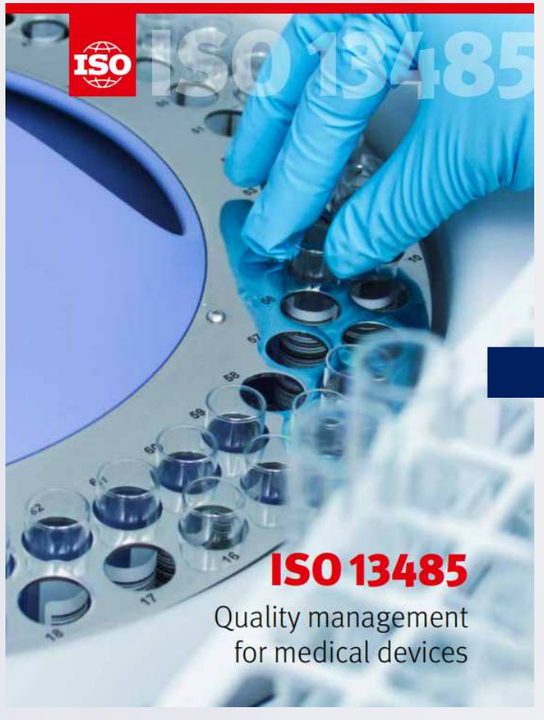
The webinars have been recorded and archived and can be accessed at any time for further study or for refreshing individual chapters.

How to register for this? More info below!

Source: https://www.bbmri-eric.eu/services/bbmri-qm-training-education/

Implementation of Preanalytical Standards

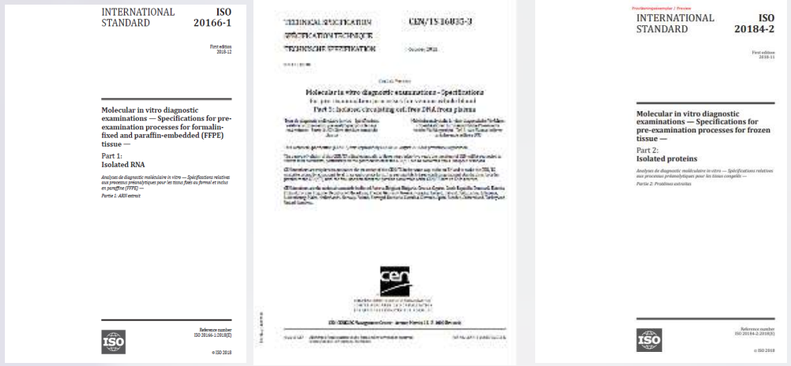
Example: SPIDIA4P industry partner

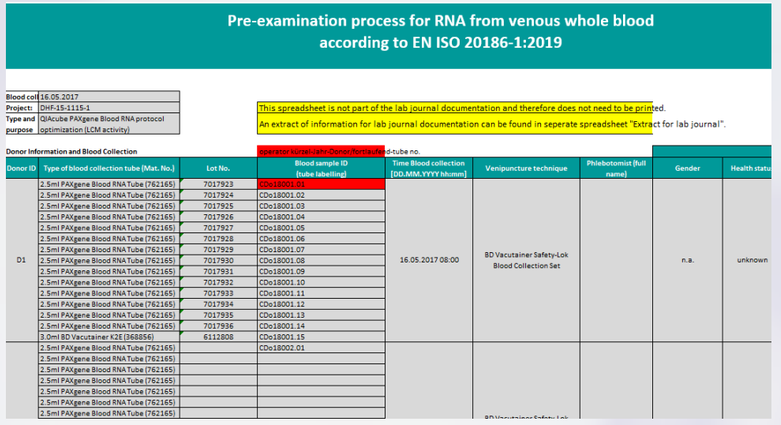


Certification according to ISO 13485

Company Quality Manual: Process Landscape

Product Development Process





Pre-examination process for RNA from venous whole blood according to EN ISO 20186-1:2019

Blood coll	16.05.2017
Project:	DHF-15-1115-1
Type and purpose	QIAcube PAXgene Blood RNA protocol optimization (LCM activity)

This spreadsheet is not part of the lab journal documentation and therefore does not need to be printed.
An extract of information for lab journal documentation can be found in seperate spreadsheet "Extract for lab journal".

Donor Information and Blood Collection — operator kürzel-Jahr-Donor/Kontrauflerd-tube no.

Donor ID	Type of blood collection tube (Mat. No.)	Lot No.	Blood sample ID (tube labelling)	Time Blood collection [DD.MM.YYYY hhmm]	Venipuncture technique	Phlebotomist (full name)	Gender	Health status
D1	2.5ml PAXgene Blood RNA Tube (762165)	7017923	CDo18001.01	16.05.2017 08:00	BD Vacutainer Safety-Lok Blood Collection Set		n.a.	unknown
	2.5ml PAXgene Blood RNA Tube (762165)	7017924	CDo18001.02					
	2.5ml PAXgene Blood RNA Tube (762165)	7017925	CDo18001.03					
	2.5ml PAXgene Blood RNA Tube (762165)	7017926	CDo18001.04					
	2.5ml PAXgene Blood RNA Tube (762165)	7017927	CDo18001.05					
	2.5ml PAXgene Blood RNA Tube (762165)	7017928	CDo18001.06					
	2.5ml PAXgene Blood RNA Tube (762165)	7017929	CDo18001.07					
	2.5ml PAXgene Blood RNA Tube (762165)	7017930	CDo18001.08					
	2.5ml PAXgene Blood RNA Tube (762165)	7017931	CDo18001.09					
	2.5ml PAXgene Blood RNA Tube (762165)	7017932	CDo18001.10					
	2.5ml PAXgene Blood RNA Tube (762165)	7017933	CDo18001.11					
	2.5ml PAXgene Blood RNA Tube (762165)	7017934	CDo18001.12					
	2.5ml PAXgene Blood RNA Tube (762165)	7017935	CDo18001.13					
	2.5ml PAXgene Blood RNA Tube (762165)	7017936	CDo18001.14					
	3.0ml BD Vacutainer K2E (368856)	6112808	CDo18001.15					
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Global Process SOPs incl. legal requirements

Technical SOPs for pre-analytical workflows based on ISO & CEN standards

SPIDIA4P

EU Parliament Event on March 5th 2019

BBMRI-ERIC®

TACKLING ISSUES ON IN VITRO DIAGNOSTICS FOR PERSONALISED MEDICINE, SPIDIA4P

SPIDIA4P: International Acknowledgements and Awards
Example: World Standards Day European Commission 2020

European Commission

VALORISATION POLICIES

MAKING RESEARCH RESULTS WORK FOR SOCIETY

FROM RESEARCH TO STANDARDS

WHY ARE STANDARDS IMPORTANT?

The European Green Deal and the New Industrial Strategy for Europe make clear that developing new standards will be essential to boost industry's competitiveness, build a sustainable future and shape a Europe fit for the digital age.

WHAT IS DONE AT EU LEVEL?

A standard is a document that sets the technical requirements of a product, service or process and its use. Standards are adopted by recognised standardisation bodies (such as ISO, CEN, CENELEC, ETSI, and many more). In these organisations, representatives from industry, research, governments and civil society, discuss and agree on what should be a standard. Once a standard is published, its use is normally voluntary but in some cases certain specific standards can be made mandatory by law.

The COVID-19 crisis has illustrated the crucial importance of standards as a mean to valorise knowledge. During the pandemic, there was a shortage of medical protective equipment, such as masks. Manufacturers adapted existing production lines to fabricate more of them. However, how could people be sure that these masks were safe and efficient against the virus? Thanks to standards!

Upon a request by the European Commission, European and national standardisation bodies made standards freely available to ensure the production of high quality protective masks to keep citizens safe against COVID-19.

In other words, standards form a common language that allows researchers, people, public institutions and industry to communicate, produce and commercialise products and services. This is especially important in the European single market.

HOW R&I CAN CONTRIBUTE TO STANDARDISATION AND VICE VERSA?

Standards are a crucial tool to valorise research results.

They help researchers bring their innovation to the market and spread technological advances by making their results transparent and ensuring high quality. Standards give confidence to consumers that an innovative technology is safe.

They codify the technology requirements and inform both manufacturers and consumers on what to expect.

They allow technologies and materials to be interoperable: since a standard provides details on the use and content of a technology or a material, it is much easier to know when and how it can be used in combination with other technologies.

R&I Framework programmes ensure that beneficiaries of EU funded research realise the potential of using standardisation.

STANDARDS = DRIVER FOR INNOVATION & MARKET GROWTH

Research and Innovation

SUCCESS STORIES

SPIDIA4P

How standardisation helps applying innovative research results to reduce the numbers of diagnostic errors in healthcare

Patient samples, such as blood samples, can significantly alter after collection from the body, e.g. during storage, transport and processing before a laboratory test is run (pre-analytical phase). This can lead to wrong diagnostic results. About 50% - 70% of clinical laboratory errors are caused by the pre-analytical phase. SPIDIA4P has 22 new pre-analytical ISO and European CEN standard documents to standardise the pre-analytical phase and hence reducing the errors.

"Standards ensuring good quality patient samples are key enablers for improving diagnostics, biobanking and biomedical research",
Dr. Uwe Oelmüller, coordinator of Spidia4P

https://www.spidia.eu/

HYDROGEN

How research results helped existing standards to adapt to new technologies

The EU's Energy Strategy encourages the use of hydrogen for transport, but impurities can damage or degrade fuel cells. New technically validated standards are vital for expansion of hydrogen supply infrastructure and improved quality and efficiency.

EURAMET's EMPIR HYDROGEN project advanced hydrogen purity specifications and related analytical techniques. Results of the project fed into the revision and development of four ISO standards.

"We worked closely with standardisation bodies and industry to ensure we met their needs and bridged the gap between research and validation."
Jacques Hameury, project coordinator of HYDROGEN

http://projects.lne.eu/jrp-hydrogen/

REACH2020

How research results help developing new standards for elderly people

REACH2020 objective is to turn clinical and care environments into personalised modular systems that encourage the elderly to become healthy via activity. Standardization activities within REACH are further used as an important instrument to use project results at national (DIN NA 023-00-07 AA), European (CWA 17502) and international (ISO/TC 314) standardization levels.

"Under COVID-19 long-term "social distancing", digital MedTech solutions for active aging and elderly rehabilitation, like REACH2020 technology, are a necessity"
Thomas Linner, Scientific Direct and project manager of REACH2020

https://reach2020.eu/

STANDARDISATION FLOW

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LEARN MORE

Standardisation policy: https://europa.eu/!Gd86Vt
EU valorisation policy: https://europa.eu/!bV76vw

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Fact Sheet on Standards published by the European Commission on World Standards Day on 14th October 2020

SPIDIA4P as one the EC's 3 success stories.

https://ec.europa.eu/info/sites/info/files/research_and_innovation/strategy_on_research_and_innovation/documents/ec_rtd_valorisation-policies_factsheet.pdf

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