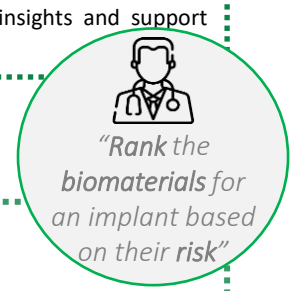
PANBioRA

Risk Management in biomaterials: From pre-market risk rating to post-market vigilance and monitoring

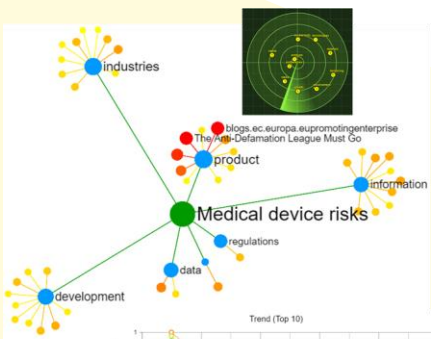
The problem

The development of new and safe biomaterials and related products/devices needs to be complemented with the identification of the potential hazards to human health and environment. With new and innovative materials and methods used in biomaterial development and production, existing guidance is insufficient for biomaterial risk assessment. Furthermore, a risk-based approach involving identification and monitoring of the new and emerging risks posed by such material or production technologies is also not widely available in the market. There is a lack of structured biomaterial test data availability and infrastructure to leverage the data to gain insights and support decision making.



The solution

The PANBioRA Risk Radar and the Risk Rating tool, in the form of web tools are aimed to aid and support stakeholder decisions based on anticipatory and adaptive data in addition to experimental and modelling data used for biological evaluation of biomaterials and related medical products and devices. The Risk Radar allows user-specific input of topic and continuously identify, analyse and monitor emerging risks in the field of biomaterials to anticipate the risks and opportunities, specifically identifying the "key issues/topics" which may be of importance in the near future and present. The Risk Rating tool is using the multi-criteria decision method (MCDM) to aid material selection based on evaluation of multiple criteria with conflicting outcomes. The criteria and their weights can be modified based with an initial PANBioRA criteria set to include Mimotope Variance Analysis (MVA), cytotoxicity, hepatoxicity, barrier integrity, inflammation markers and genotoxicity.



The Horizon scanning Risk Radar tool uses natural language processing (NLP) techniques to continuously scan and monitor for emerging risks based on user-defined inputs and selected sources (including scientific publications, regulators, news articles, blog posts etc.). In PANBioRA project, the tool is used to spot and analyse emerging risks of general and specific biomaterials and related medical devices. The results are automatically generated in the form of a network and radar chart with highlighted keywords and information sources, an automated report and trend analysis over a period of time. Keywords/potential risks are quantified and ranked using the NLP based algorithm and plotted in the radar map, with a keyword with a high "criticality" plotted closer to the center of the radar map.

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The value

An intuitive and user-friendly set of tested web-based tools including a **Risk Radar as a horizon scanning tool**:

- Search topic and source selection can be customized by the user
- Regular and automated monitoring of results
- Source tracing for transparency: from results to news/article/publication
- Trend monitoring and potential alert system

Risk Rating as a decision support tool:

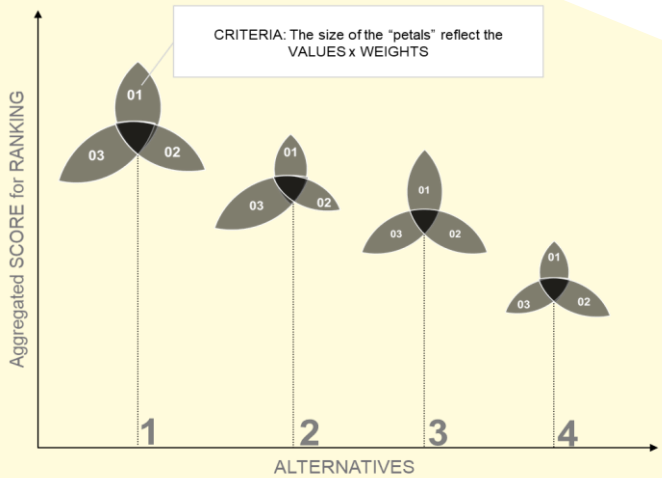
- Transparent, reason-based approach using multi-criteria decision method (MCDM)
- Traceability of decisions made in a clinical setting
- Perform sensitivity analysis and multiple "what if"-analysis using an interactive slider with an intuitive "petal-chart"
- Tailored to suit user requirements (through selection of criteria)
- Allows addition of new cases and not limited to a training dataset
- Ability to save and reuse data and analysis – saving time and cost

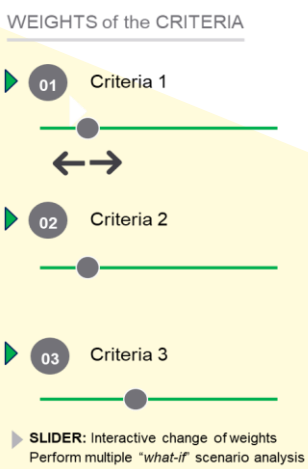
The challenge

1. **Rank/prioritize** new and existing biomaterials based on:
   a. Biomaterials' test data
   b. Background data as well as other non-technical data such as cost, availability, sustainability (life span)
2. **Optimize** biomaterial selection:
   a. Customized at the manufacturer-/surgeon-/patient- level
   b. Including risk mitigation

→ In order to meet these goals, the project has developed a special tool/module allowing to make transparent decisions in the cases about taking into account:

- Biomaterials (as "**alternatives**")
- Biomaterial tests and other background data (as "**criteria**"), and
- Possible importance of single criteria in single cases (as "**weights**")





The default ranking of results is shown as a multi-dimensional "petal chart" with each petal representing the contribution of criteria weight and criteria value for each alternative, whereas the sum of all petals is calculated on a 0-100 scale and represented in the Y-axis. The sliders on the right can be adjusted for criteria (or sub-criteria) which can be used to redistribute the criteria weights from the default values (on a scale of 1-10, with 10 being the most important).

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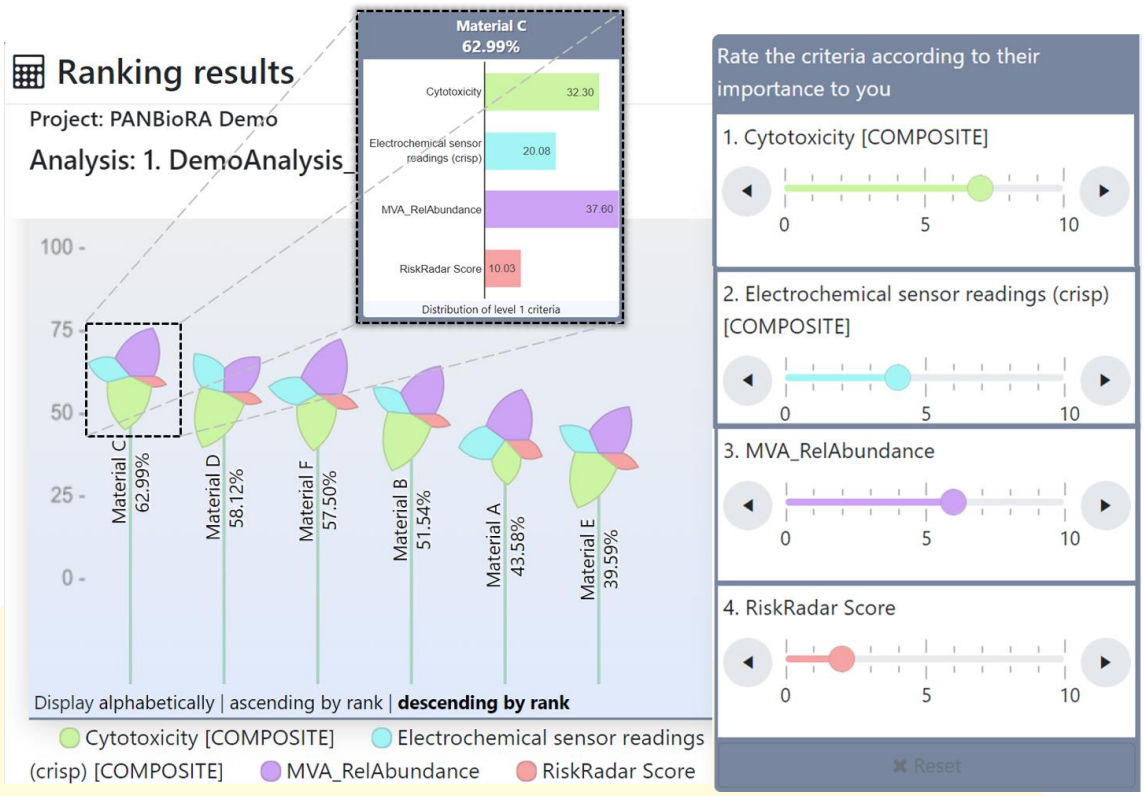
Steps in the MCDM Risk Rating tool:

- Import/introduce the biomaterials as alternatives
- Biomaterial tests (e.g. cytotoxicity, MVA immunoprofile etc.) are defined as criteria of evaluation with pre-defined maximum, minimum, and target values.
  Relevant background criteria (e.g. Risk Radar score, etc.) are also introduced.
- Input criteria values for the alternative biomaterials

In this example case-study, the criteria for risk rating and biomaterial selection decision support included Cytotoxicity, MVA, Electrochemical sensor, and the criticality score (from the Risk Radar tool). The criteria were defined based on a selected dataset from different WPs in the PANBioRA project.

Note: The values used in this analysis are used for illustration only and may not reflect the actual values obtained in the experimental or numerical studies.



In the particular case study , the "biomaterial with the least risk" is Material C primarily due to higher value and importance of Cytotoxicity test results, as selected by the decision maker, followed by the importance of criteria MVA, electrochemical sensor readouts and lastly, the Risk Radar score used for evaluation.

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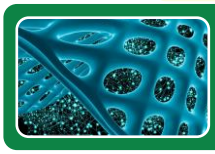
Product segments



New biomaterials

- New synthetic polymers
- New alloys
- New hybrid materials

New medical devices

- Implants
- Sensors
- Organ replacement systems

New emerging markets (BRICS)

→ other than developed markets

Patient specific biomaterial (implants)

→ selection using the Risk Rating

Customer segments

Medical device companies

- New product development and testing
- Medical device risk management purposes and device optimisation

Policy makers

Identification and assessment of biomaterial specific trends related to safety and efficacy impacting public health

University laboratories

- Laboratory managers in universities
- Academicians in the biomaterial research fields

Hospitals

Documentation of the implant decision making process with reusable analysis

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Unique selling advantage

- ✓ Customizable solution for monitoring emerging risks in the biomaterial sector
- ✓ Practical steps for addressing the ISO 31050 standard – guidance for managing emerging risks to enhance resilience
- ✓ Resource and time efficient operation with no technical skills required for the end-user
- ✓ Quantification and ranking of risk based on objective reason-based analysis using MCDM
- ✓ Aligned with current standards in biological evaluation such as the ISO 10993:2008
- ✓ Integration platform is compatible with existing and prospective innovative technologies in the sector

Cost structure

- **Assessment and Certification-as-a-Service (consultancy):** A European Risk & Resilience Assessment (ERRA) and Rating Initiative is envisioned for a 3-tier system including self-assessment, audited self-assessment (for a fee), and 3rd party audit services (audit by members + assessment fee). The tools and services could be made free-to-use for registered members.
- **Data Providers:** Researchers, hospitals and medical device companies.
- **R&D:** New services, new features and functionality, added security features (e.g. off-site server-based installation), new use case development.

Market potential

The patient safety and risk management solutions market is estimated to be worth USD 2.2 billion by 2024 from a value of USD 1.3 billion in 2019, growing at a CAGR of 11.2% during the forecast period. The contributing factors include increasing incidences of medical errors & hospital-acquired infections, and growing government initiatives to improve patient safety and patient outcomes. On the other hand, the dearth of in-house IT expertise and the reluctance of healthcare providers to adopt new methods of patient safety and risk management are expected to restrain the growth of the market to a certain extent during the forecast period.

Broader impact

The Risk Radar will enable simple horizon scanning of biomaterials and related medical devices supporting pre-risk assessment with limited or no experimental data availability for a biomaterial. Furthermore, the method can facilitate and simplify certain policy (regulatory and standardization) requirements for pre- and post-market monitoring and vigilance.

Existing alternatives / Competition

While there are risk-assessment tools along with horizon scanning tools in the market, there are no direct alternatives focussing specifically on new and existing biomaterials and related medical devices, especially one related to automated scanning and analysing of emerging risks in the burgeoning biomaterial sector within the framework of biomaterial risk governance.

The main competitors are horizon scanner tools developed and used by insurance companies but are often used in-house and not made available for external use. There are existing MDM tools available but there is a lack of intuitive web-based apps with a preexisting dataset of new and existing biomaterials (sourced form PANBioRA project results).

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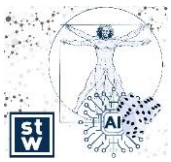
Key partners



Steinbeis Advanced Risk Technologies GmbH (R-Tech): development and maintenance

Hospitals and research labs: as early adopters and biomaterial data aggregation

Early adopter university labs: use case development

Data management tools and facilities: cloud tools, local server or 3rd party services such as AWS

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