Building a fuller picture of biomaterials

Biomaterials are an important part of modern healthcare, used in both implants and for regenerative purposes, yet it remains difficult to understand how an individual patient will react when they are introduced. The PANBioRA project aims to develop a new method for assessing biomaterials, which could inform their ongoing development, as **Dr Engin Vrana** explains.

The PANBioRA project team.

The healthcare sector makes intensive use of biomaterials, both in replacing a physical part of the body with an implant, and also in stimulating regeneration, for example in wound healing. While biomaterials are characterised very thoroughly and have to meet rigorous standards before they can be applied, it remains very difficult to predict how an individual will react to the introduction of a biomaterial. "Each of us has a unique immune system, depending on our genetics, where we have lived, and the kinds of pathogens and materials that we have been exposed to. So it is very hard to have a clear idea of how an individual person will react to a given biomaterial," explains Dr Engin Vrana, CEO of SPARTHA Medical. As the Principal Investigator of the PANBioRA project, Dr Vrana is working to develop a new risk assessment method for biomaterials. "The concept in the project is to develop a comprehensive system, that can be used not only for existing biomaterials, but also new materials. We want to provide a normalised test for the evaluation of biomaterials," he outlines.

PANBioRA project

This research is built on a recognition of the limitations of existing methods, which are typically based on animal tests or are very simple *in vitro*, cell-based tests. These kinds of approaches do not reflect the unique genetic background and physiology of each individual patient, a major motivating factor behind the project's work. "That is what we are trying to bring to the field," stresses Dr Vrana. A new automated, modular testing system is being developed in the project which is designed to provide deeper insights into how an individual patient will respond to a specific material. "We take blood from the patient and check whether they have antibodies reacting to a given biomaterial, this is one part," says Dr Vrana. "Then, from the same blood sample, we obtain the immune cells of the patient, and we interact these cells with the biomaterial and see how they react at different levels. We can then look at things like what they secrete, how they stay alive or not and whether they are pro-inflammatory or anti-inflammatory. This is how the personalised part is handled."

The system itself integrates several different technologies and methods, so it can also be used to assess new biomaterials. Both new and existing biomaterials can be rapidly and cost-effectively assessed using organs-on-a-chip, which are advanced *in vitro* models. "In this system we have three organs, which are basically the respiratory system, the gut and the liver, and they are connected to each other. We can not only look at the effect of the biomaterial in the places where it generally enters the body, but we can also see its subsequent interactions and assess its impact in a more comprehensive way," continues Dr Vrana. Some tests take a long time to provide results, another topic of interest in the project, while Dr Vrana and his colleagues are also working to provide a firmer basis to compare different biomaterials. "At the moment biomaterials are just tested with respect to certain thresholds, without having an overview of how they stand with respect to other materials," he says.

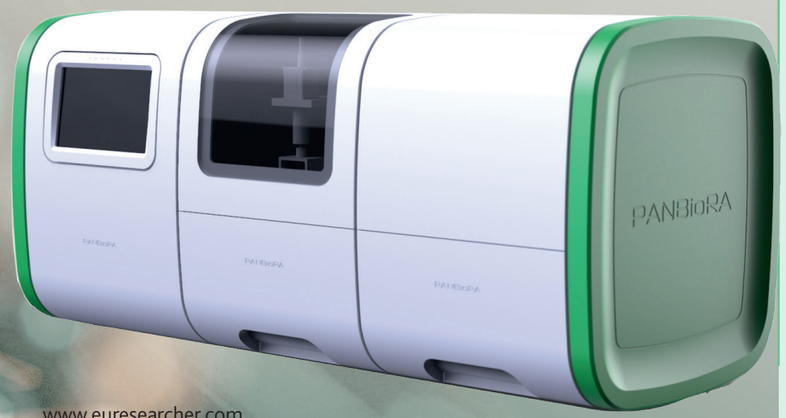
A material like collagen is fairly well known for example, now researchers are working to develop a ratings system which will help clinicians assess the relative effectiveness of different materials. This will provide a kind of benchmark, and help clinicians make better informed decisions. "Let's say we are going to give collagen a rating of 96. Then imagine that you've synthesised a completely new material, and conducted all the tests, then you can compare how it stands against collagen. Maybe it will stand at 94, maybe it will come in at 60," outlines Dr Vrana. This can then inform decisions on which material to use, comparable in a way to the role of building standards in the construction industry. "In civil engineering you have standards which guides you in choosing the right option, like the right foundations or type of steel for a given area," explains Dr Vrana. It's not like that in the biomedical field, because it's a fairly new kind of engineering, particularly the parts about regeneration and organ replacement. This is one of the major motivations of the project."

The concept in the project is to develop a **comprehensive system,** that can be used **not only for existing biomaterials,** but also **new materials.** We want to provide a **normalised test** for the **evaluation of biomaterials.**

Reducing complications

This research could have a wider impact on the healthcare sector by giving clinicians greater confidence in using biomaterials, while also opening up the possibility of applying them in a more precise way. This will reduce the risk of complications in patients, which Dr Vrana says is also an important consideration in terms of guiding the ongoing development of biomaterials. "With reduced complications we will have more reliable data, which will also help in terms of improving the materials in future," he outlines. A working prototype of the system has been developed, and there is a lot of interest from companies in testing it once it has been validated. "The next step for us would be to test it in hospitals, or with new implant materials," continues Dr Vrana. "The vision is to have an instrument that can be sold to industry, and to research and development institutes, so that they can do normalised tests. We hope to establish a spin-off company that will continue to develop modules in this system."

The testing system has been designed in such a way that new tests can be added as required, which will be a central activity for a future spin-off company. The modular nature of the system and its technical sophistication makes it particularly attractive to research institutes, believes Dr Vrana. "It is like a platform. They can establish their own system, but they will then benefit from all the connections, automation and data analysis," he says. If this system is used more widely then it will generate a lot of comparable data, which could be highly valuable as a resource for researchers, another topic researchers are exploring. "We have already started to put in the foundations for using this data. For example, two partners in the project are working on simulations, so that we can extrapolate to longer experiments," says Dr Vrana.



The current PANBioRA prototype.

PANBioRA

Personalised and generalised integrated biomaterial risk assessment

Project Objectives

The main objective of PANBioRA is to develop a method that allows the cost- and time effective assessment of;

- a new biomaterial under healthy or disease state conditions (generalised testing) or
- a given biomaterial for a specific patient (personalised testing)

To achieve this goal, the PANBioRA consortium aims to develop a modular system using cross-disciplinary techniques that will predict the patient-specific response to a given biomaterial. The testing system will integrate different technologies (refined, miniaturised versions of existing methods and new evaluation technologies) into a single instrument that will be able to perform multiple analyses on cell and micro-tissue levels.

With its multidisciplinary protocols and procedures, the PANBioRA testing system will set a new standard for the evaluation of biomaterials.

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Project Partners

https://www.panbiora.eu/consortium/

Contact Details

Scientific coordinator
Spartha Medical
Dr. Engin Vrana
E: evrana@sparthamedical.eu

Administrative coordinator
Steinbeis S2i GmbH
Timo Doll
E: doll@steinbeis-europa.de
W: https://www.panbiora.eu/
W: https://showroom.panbiora.eu/

Dr. Engin Vrana

Dr. Nihal Engin Vrana is CEO of SPARTHA Medical. He obtained his PhD in 2009 at Dublin City University. His major research interests are implants, nanoscale antimicrobial coatings, tissue engineering, cell encapsulation, immunomodulation, controlled delivery, biomaterial assessment and cell biomaterials interactions.

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