research estonia

Health Technologies 2.0

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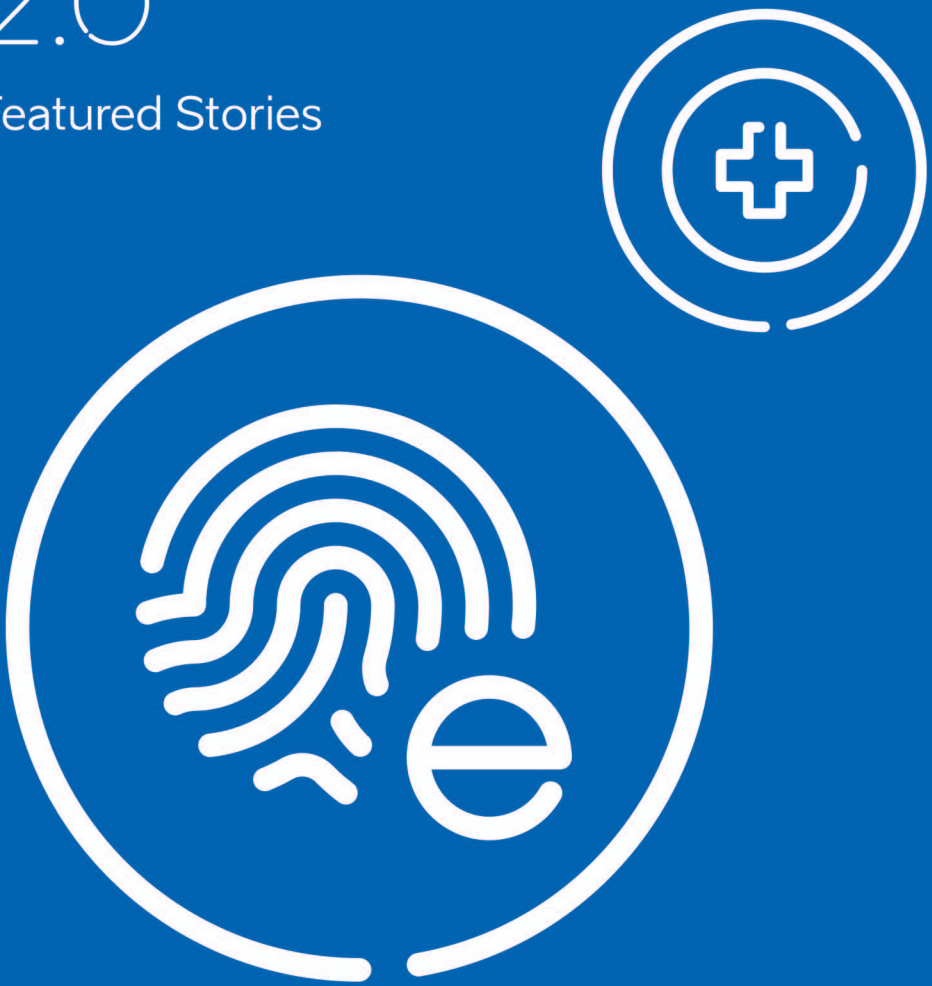

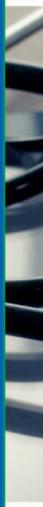

Produced by Estonian Research Council

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Introduction

Aging, subfertile, in need of personalised monitoring—challenges for Europe, solutions from researchers.

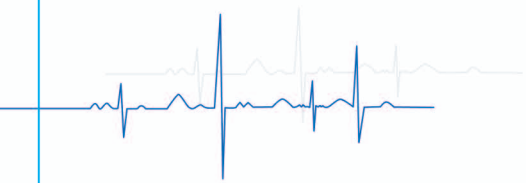
The European population is getting older. Women are postponing maternity—the average age of becoming a mother in Europe is 28.7 years. At the same time, fertility has steadily declined from the mid-1960s to the turn of the century in the EU member states. Increasingly more people suffer from cardiovascular and neurodegenerative diseases. These are common challenges for contemporary medicine in most Western societies.

According to the Estonian Research and Development and Innovation (RDI) strategy investments selected and managed with the smart specialisation method encourage the development of growth fields at a faster than expected pace. The strategy identifies health technologies and services as one of the selected fields of growth.

Since accession to the European Union a significant proportion of EU structural fund aid has been directed to the development of RD infrastructure, human capital and entrepreneurship. This has helped create modern conditions and an attractive environment for research, added to the number of researchers and broadened opportunities for international cooperation.

Thanks to the efficiency of research and an increase in its volume, researchers in Estonia have reached the forefront in several fields on a global level. Health technologies have some of the highest publication rates compared to all other fields of research. Competence centres support the cooperation of enterprises and research institutions both in Estonia and internationally. The cluster programme facilitates the cooperation of enterprises but the latter have provided no support to RD activities.

In the field of health technologies and services, interdisciplinary collaboration with researchers in IT, technical engineering, design and arts, etc. is being performed. This has resulted in working on countermeasures to emerging virus threats (Ebola or Zika), personalising medicine with genetic testing, developing non-invasive medical monitoring and smart needles, combining design and technology for healthcare... you name it—Estonian researchers already have a solution.



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eHealth – first step towards nationwide personalised medicine

eHealth is the part of health care which incorporates Electronic Health Records, Digital Image, eAmbulance, Digital Prescriptions and some other new cross-sectoral e-services. The idea behind eHealth is that no matter where you are located, your digital health information, health records and visits to different doctors are safely accessible in one place. By March 2017, there were over 28.5 million medical documents saved in the eHealth system.

eHealth is widely used by healthcare professionals to access patients' health information, e.g., the attending doctor or nurse can quickly access the patient's complete health information all over Estonia. It means that the doctor no longer makes the decision only on the basis of what the patient is saying or displaying during the appointment and gets a much more comprehensive picture of the patient's health on the basis of a variety of health records. Genome data are also used more and more to predict health risks and order precise treatment. All of that is more accurate and personalised than merely a single brief visit to the doctor. This, in turn, decreases the number of unnecessary appointments, e.g., for prescription refills, duplicate lab tests and screenings, effectively using the patient as a courier to make inquiries about getting an appointment with a specialist etc.

In addition to medical professionals, there is another group that uses eHealth actively: patients themselves. After prices of personal health care made accessible for patients in 2016, the "curiosity" raised the number of active eHealth users from 10 per cent to 17 per cent of the population (Estonian population is 1.3 million). And, of course, eHealth is an innovative convenience-service: it is very easy, for example, to fill in an application for a drivers' licence health certificate and then come by your family doctor to have a blood test. It saves both the patient's and the doctor's time.

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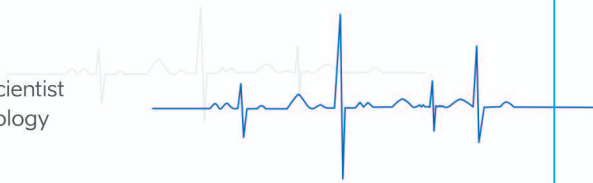

Prenatal testing for chromosome disorders

Prenatal diagnostics is a way to assess the likelihood of a congenital disease of a foetus before birth. Congenital diseases are mostly chromosome disorders; the most prevalent are aneuploidies or changes in the number of chromosomes like Down syndrome (chromosome 21 trisomy), Edwards syndrome (chromosome 18 trisomy), and Patau syndrome (chromosome 13 trisomy). The genetic prenatal diagnosis of foetal aneuploidy is an important part of prenatal medicine.

Non-invasive prenatal genetic testing (NIPT) is the latest and most precise screening method for detecting aneuploidy, and it is based on whole genome analysis. It applies second-generation sequencing of cell-free foetal DNA (cffDNA) in the mother's blood circulation. NIPT analysis requires 10 ml of the pregnant woman's blood, and the procedure is no more dangerous than taking a routine blood sample.

cffDNA is detectable in maternal plasma as early as in 4 weeks after conception. However, the earliest time for conducting reliable NIPT is between 9 and 11 weeks


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of pregnancy. The half-life of cffDNA is short, about 30 minutes, and it is no longer detectable in the maternal blood a few hours after the delivery, which means that the woman's previous pregnancies do not affect the outcome of NIPT.

In particular, the use of the NIPT method in prenatal diagnostics can reduce the number of women undergoing risky and stressful invasive procedures. These include pregnant women whose foetuses do not actually have chromosome disorders but who are sent to undergo amniocentesis or chorionic villus sampling due to false positive results of screening. Turning NIPT from the current research-intensive method into a staple of clinical practice will significantly reduce the price of NIPT and make it available for the majority of pregnant women. We have developed analytical tools like the NIPTmer software for whole genome analysis and the patent-pending TAC-seq technology. TAC-seq with related software will become the basis of cost-effective next generation NIPT.

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Predicting female fertility

Assessing female fertility and predicting reproductive aging is a new modern challenge at a time when increasingly more women are postponing motherhood. Although menopause is usually considered the time point that marks the loss of female fertility, in reality, subfertility and sterility can manifest 10—20 years earlier. Women who experience early (before the age of 45) or premature menopause (before the age of 40) are at risk of earlier reproductive senescence already in their thirties, which can result in age-related infertility combined with the fact that women's age at first childbirth is increasing.

Menopausal age not only affects a woman's fertility but can have a considerable impact on her general wellbeing. For this reason, markers that could predict menopausal age have been extensively sought for but all currently proposed biomarkers for predicting menopause have several shortcomings. Menopausal age also has a strong genetic component, which is illustrated by the fact that a mother's age at menopause is one of the best predictors for a daughter's menopausal age.

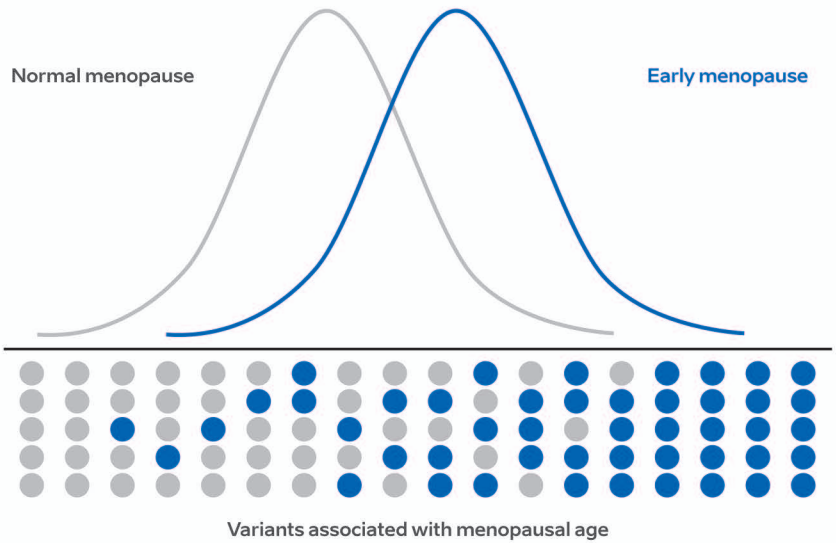

Figure 1. Principle of genetic risk profiling. For each marker associated with age at menopause, the number of variants for lowering the menopausal age is counted and weighted according to the volume of the effect the marker has on menopausal age, resulting in a risk score across all associated markers. Women with earlier menopause have greater risk scores—they have more variants that lower the menopausal age.

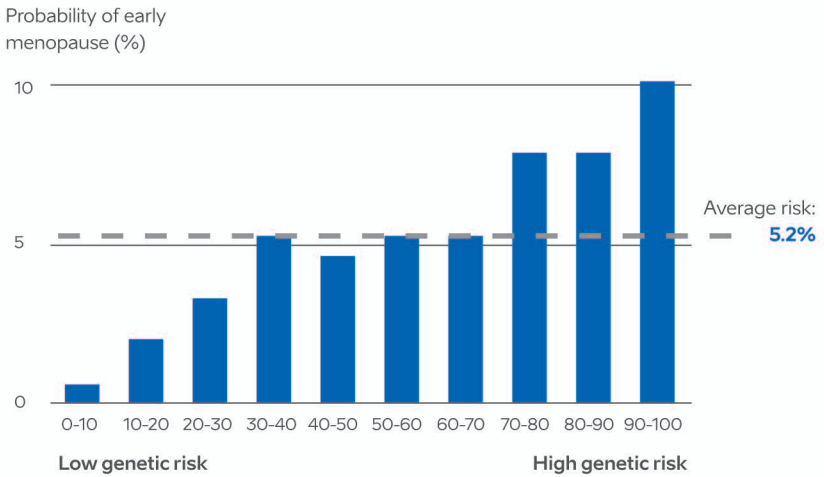

Figure 2. Risk of early menopause according to genetic risk profile.

Recent years have seen numerous studies exploring the genetic architecture of reproductive aging using a genome-wide approach and reporting variants that are connected to menopausal age. This knowledge was used to develop the Fertify test, which uses polygenic risk scores (Figure 1) for predicting the risk of early menopause and the concomitant earlier decrease in fertility. Using genetic risk profiling, it was demonstrated that women at the extremes of the genetic risk score have a ten-fold difference in their risk for earlier reproductive aging (Figure 2).

Genetic risk profiling has several advantages over conventional markers, such as robustness, stability and usability even for young women who do not show remarkable changes in hormone dynamics or have no information on their mother's menopausal age. Researchers believe that genetic risk profiling for reproductive aging can be used to offer women evidence-based advice for family planning.

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Figure 1. Organic experimental field. Clover—an important part of organic farming—pictured in the foreground.

Figure 2. Setting up an experiment for a research on pollinators at the Polli strawberry field.

Health from safe food

Intensive conventional agriculture causes increased risks: decreased biodiversity, pollution of water, soil and food with pesticides. Organic farming as alternative agriculture faces challenges in improving environmental factors and food quality by using balanced renewable resources, natural plant protection means and nature-friendly technologies. Managing pests, diseases and weeds without synthetic pesticides is one of the key issues in organic farming.

Studies conducted at the Estonian University of Life Sciences have shown that increased biodiversity in a field achieved through mixed cropping and diverse field margins increases conservation biocontrol. Plant extracts effectively regulate the occurrence of pests. Targeted precision biocontrol with bumblebees and honeybees as carriers to spread biofungicides reduces diseases in berries. Organic crop rotation with winter cover crops and composted manure significantly improves soil biological, chemical and physical properties and crops yield and quality.

The comparison of conventionally and organically produced products has also shown certain quality differences. For example, there are no pesticide residues in organic products, and organic products have been found to contain more antioxidants than conventional ones. Also significantly different microbial composition and higher amount of metabolites have found in organic cereals than in conventional ones. In different varieties of cereals, the quality of protein was better in organic crops than in conventionally cultivated cereals. Thus, organic production systems have shown certain advantages in view of environmental factors as well as from the point of view of product quality parameters, which have significant health benefits.

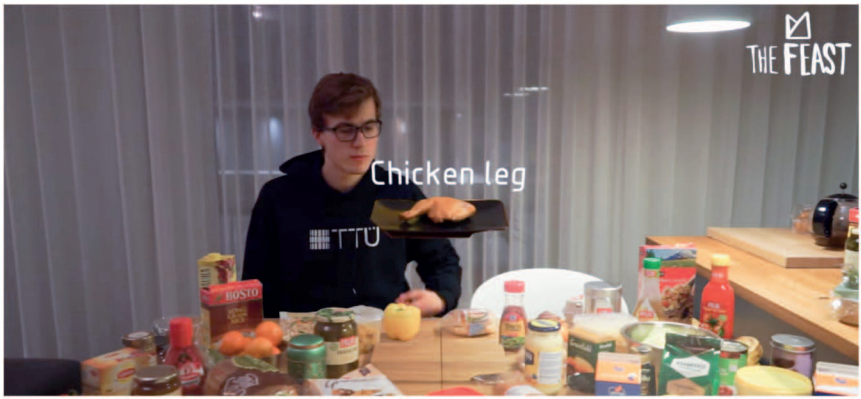

Figure 3. A still from the video introducing the food-sharing platform The Feast.

Regarding food, it is understood that in retail, wasting food is a big, though quite recent problem that is in direct correlation with human development. To tackle food wasting, design and engineering students from the Estonian Academy of Arts in cooperation with students from the Tallinn University of Technology started a project that focused on the end user, mainly because this has the maximum impact and is not overly restricted in view of legal regulations.

It was understood that wasting food is not connected to people's mind-set; it became clear from interviews that people consistently felt bad about throwing away food but they lacked tools that would enable to reduce the generation of food waste. The final outcome of the project was a service: a food-sharing platform called The Feast for people living in close proximity to each other. The platform utilizes virtual reality to show the users the extra food that is available in the food storages near them so they could then choose what they like and take it, which in turn enables social interaction and reduces food waste.

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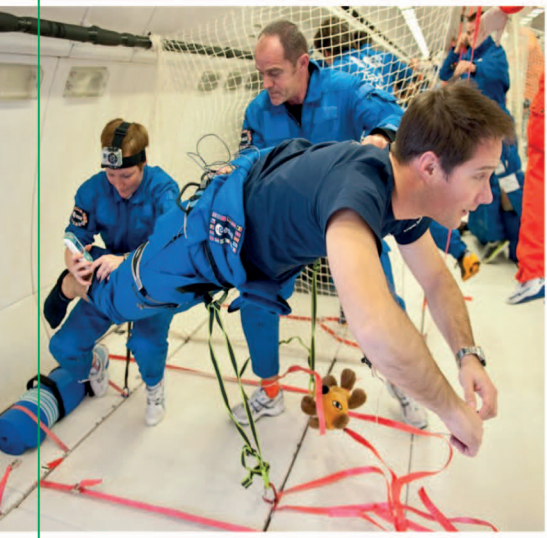
Using Myoton to evaluate superficial skeletal muscles

There is currently no cost-effective and easy-to-use method to 1) obtain objective information about muscle condition that could help to diagnose muscle diseases at an early stage 2) get quick numeric measurement results to describe the progress of muscle development that could increase patient and physician motivation and 3) determine the effectiveness of muscle-training and optimise it. The myometric method and a device called Myoton provide a novel solution for obtaining unique evidence-based data on superficial skeletal muscles.

The hand held device and method has been developed to non-invasively evaluate *in vivo* superficial skeletal muscles, tendons, ligaments and other biological soft tissue. It is based on a three-step measuring process. First, generating a constant pre-load to the soft tissue, second, generating a single mechanical impulse with quick release, and third, detecting the reaction of the tissue being evaluated with an accelerometer. It does not cause neurological reaction or non-elastic deformation of the biological tissue being evaluated. The mechanical change in the shape of the tissue and its mechanical response are registered as a graph of the tissue's oscillations measured by the accelerometer. For calculating the parameters, the time span on the graph,



which starts at the beginning of the oscillation period, is used. The method is simple and conducting the test will not take for one muscle more than a minute.

Myoton has a wide area of use. It can be employed to assess the effect of interventions in science and medicine, prevent overload injuries in sport and work environments, assess the asymmetry of body sides, evaluate rehabilitation efficiency, and to evaluate and monitor the training process of athletes. The more advanced myometric device MyotonPRO even allows to monitor astronauts' muscle health before during and after space flights.

This method and device enable recording and data-processing to be performed simultaneously, as well as statistically significant estimates to be made in real time. The parameters obtained with this non-invasive device correlate well with the parameters measured with classical diagnostic methods. Therefore, this device enables to accelerate the process of diagnosing, including in extreme situations.

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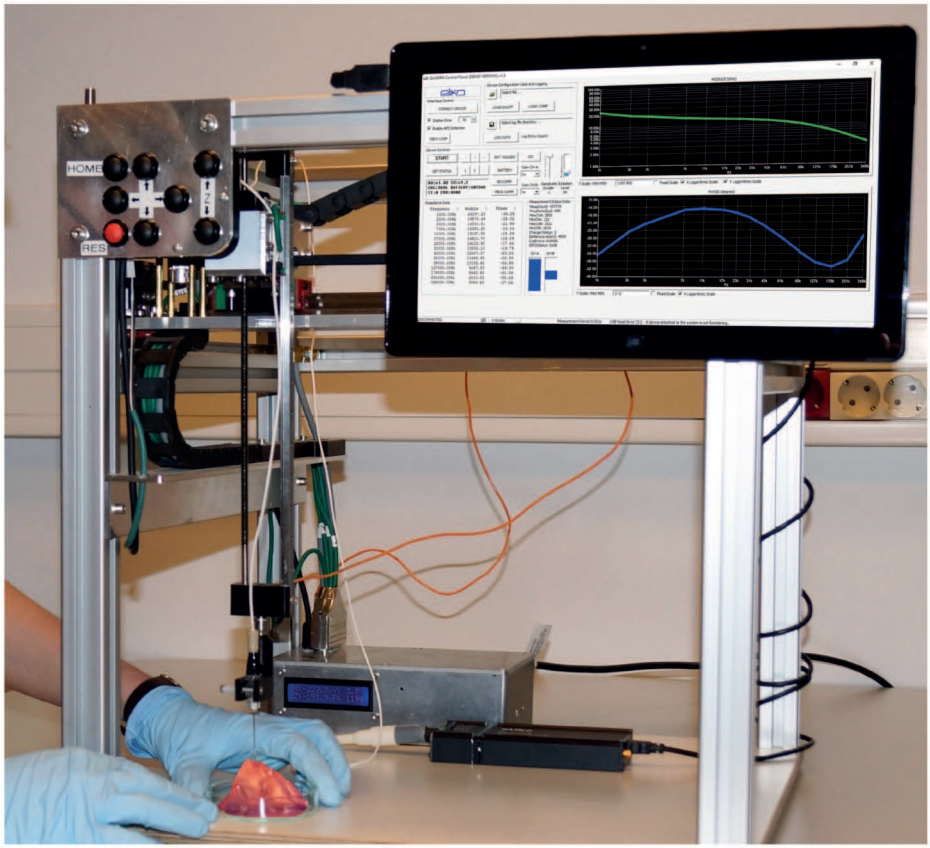

Figure 1: Set-up for tissue impedance measurement with needle electrodes.

Non-invasive medical monitoring and smart needles: electronics makes it possible

Electronics makes possible performing the medical monitoring, diagnosing and treatment almost continuously—everywhere at every moment—day and night at home, workplace, gym, clinics. For that, the remote sensing of health indicators is required. Bioimpedance spectroscopy, based on the measurement of electrical impedance of living tissues and organs over a wide frequency band, gives us an opportunity.

For example, the central (aortic) blood pressure is much better predictor of cardiovascular health than standard brachial pressure. Bioimpedance spectroscopy enables to evaluate the central pressure non-invasively from the electrical impedance of patient's wrist. The impedance data reflect the aortic blood pressure curve through mathematical transformations. Human experiments are under way at East-Tallinn Central Hospital.

Another example—using needles. Physicians traditionally rely on their experience to guide the needle into human body during an invasive procedure, but in spinal anaesthesia, for example, they often does not reach the spinal canal with the first attempt. The duration of spinal puncture may vary from 9 seconds to 19 minutes, especially in the case of neonatal patients. Repetitive probing increases the risk of complications. Bioimpedance spectroscopy based information helps to navigate the needle in the body to reach the destination.

Injeq Oy is a medical device company that has developed a new generation of smart needles for real-time tissue identification. The solution bases on the QUADRA impedance mapping system integrated with Injeq Oy software and knowledge for tissue identification.

The new device guides the physician to the right location in the body using audio-visual signalling, thus improving the safety and efficiency of spinal anaesthesia, intrathecal injections and other invasive medical procedures. Smart needles are in use also in such clinical applications as lumbar puncture and intra-articular injections in orthopaedics and rheumatology.

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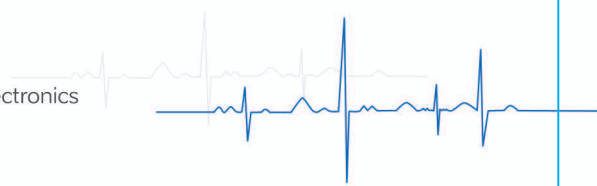


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Combating Alzheimer's disease with BRICHOS proteins

Amyloid is the main constituent of protein deposits associated with certain human diseases. One of them—Alzheimer's disease (AD)—creates major medical and socioeconomic challenges. AD is the most common cause of dementia in elderly people, and it is reaching epidemic proportions.

Symptomatic treatments exist but in terms of disease-modifying therapies research has so far failed in the final clinical stages of testing. Although effective treatment is greatly needed scientists are slowly acknowledging that it is unlikely that a single cure for AD will be found.

AD is a complex multifactorial disease. There are several approaches in AD treatment but the majority of them are connected to disrupting amyloid beta (Aß) peptide misfolding, aggregation or clearance in the brain. Besides AD, there are approximately 40 other diseases connected to proteins that form amyloid. However, compared to Aß-peptide, a very small fraction of these proteins form toxic aggregates under normal physiological conditions, although they all should do so considering their

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molecular structural properties. Thus, nature has developed something that prevents toxic outcomes.

Good examples of this are BRICHOS proteins that contain a certain chaperon-like domain, which has the ability to counteract aggregation and toxic amyloid formation. In Aß-peptide this helper-domain is missing. However, under experimental conditions the BRICHOS domain is also able to inhibit Aß-peptide misfolding and aggregation. Thus, the BRICHOS domain is the first described example of a chaperone that may be used for the future treatment of other amyloid diseases.

Researchers of Tallinn University in collaboration with the Stockholm Karolinska Institute AD Centre are working on several BRICHOS proteins. Some of them are already being tested in mouse models, while others are new and tested *in vitro*. The main characteristics analysed are structural properties and behaviour.

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One size fits all? Not in precision medicine

Inter-individual variability in drug metabolism and drug toxicity is a major problem in drug development and treatment. Increased capacity for drug elimination or drug action reduces drug efficacy, while lacking metabolic properties can lead to drug side effects, which place unnecessary health and economic burdens on both individuals and society. In short, for more than 90% of commonly prescribed drugs, the desired effect is only achieved in 30—50% of the population. To a great extent this variation is based on genetic differences in drug metabolism enzymes, transporters or drug targets. Although over 100 drugs now carry pharmacogenomic labels regarding mandatory or suggested genetic testing prior to prescription, few countries have systems in place for proper pharmacogenetic testing.

The Estonian Genome Center (EGC) of the University of Tartu has put a lot of effort

into promoting personalised medicine on a national scale in Estonia. Lili Milani, Senior Researcher at EGC, explains that her research enables to identify previously unknown genetic variants associated with drug metabolism. We now have sufficient information regarding the human genome to start implementing genetic testing in everyday medical practice. It is finally possible to move away from the "one-size-fits-all" approach and eliminate the trial-and-error method of prescribing owing to considering the functionality of each individual's genes, and the ways in which this may affect the efficacy of the patient's current and/or future treatments. Such approaches are commonly termed personalised or precision medicine, in which drugs and their dosing are optimised for each individual's unique genetic makeup.

But how can this be turned into reality?
The EGC suggests that everyone aged 35 to 65 in Estonia should be offered to get genotyped, i.e., have their personal genetic card. So far, 52,000 Estonians have donated their blood to create the Estonian Biobank, and all participants have been genotyped for over 700,000 different genetic variants. The data generated in the Biobank enables using individual genomic variation obtained from genetic analysis and computational methods to predict and prevent diseases, and optimise drug treatment.

The data collected at the Biobank has been further improved by incorporating data from the nation-wide health database of the Estonian National Health Information System and other more specific registries. These extensive health records and molecular profiling data of the biobank participants are used to calculate disease risk and likely drug response. Since both databases are continually improving, estimates of the disease risks and probable drug responses must be re-calculated regularly.

Estonia is currently in a position to be one of the first countries in the world to start the implementation of personalised medicine for common and rare diseases on a national scale. Implementing personal genetic information together with automated decision support systems will help physicians and have a huge impact on disease prediction, prevention and treatment. Personalised medicine should be viewed just as a new, additional instrument available for physicians. Therefore, one-size-fits-all may soon be history in the Estonian health care system.

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Cancer diagnostics with bioenergetic profiling

How do we know whether a cell is normal or a cancer cell? Tuuli Käämbre is a senior researcher at the National Institute of Chemical Physics and Biophysics and her research aims to define the mechanisms that cause critical shifts in the regulation of energy metabolism and the alterations in the cytoskeleton structure in tumour cells in comparison to normal cells. How does that relate to cancer diagnostics? She uses a recently developed methodological approach, Molecular System Bioenergetics (MSB), which provides ground-breaking solutions in the field of cancer and muscle cell bioenergetics. MSB enables to outline the tumour-specific bioenergetic profiles of the cells. In the future this may be used for diagnostic and prognostic purposes in *in vivo* studies.

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Using health data without violating the privacy of an individual

Although many genetic risk factors are known, key causes of common diseases with complex heritage patterns are still unknown. Identification of such complex traits requires a targeted study over a large collection of data. However, large-scale data aggregation raises many privacy issues.

There is one solution for jointly performing genome-wide association studies (GWAS) on data from multiple sources without violating the privacy of individual donors and leaking the data to third parties. Secure GWAS methodology provides cryptographic privacy during both data collection and analysis: a researcher posts inclusion criteria for case and control groups and all computations are done by the host.

This solution can significantly improve privacy in two scenarios. First, public services that provide genetic profiling for individuals can improve the privacy of their customers. Second, genome banks can combine their patient cohorts to improve the validity of their results.

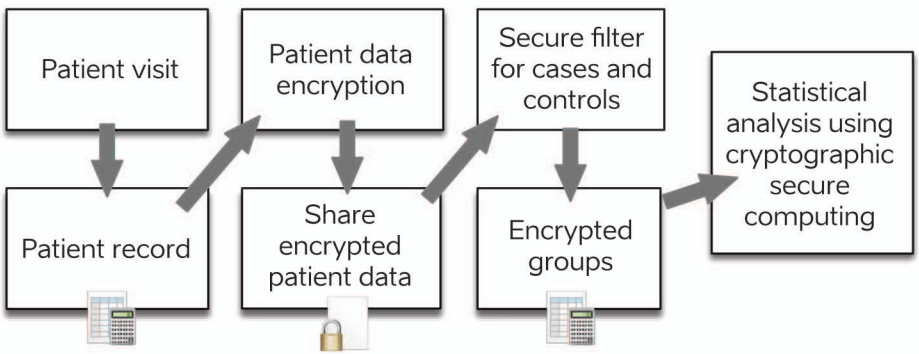

Figure 1. Secure workflow of a genome-wide association study.

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Leader of personalised medicine research in Competence Centre on Health Technologies

The research is focused on personalised medicine, particularly, on eliminating several bottlenecks that globally hinder the application of the achievements of digital data sharing, molecular medicine as well as information and communication technology (ICT) in the interests of human health. The aim is to combine recent key advances in medical and population genetics, bioinformatics, eHealth and ICT in general in order to develop preventive, diagnostic and treatment algorithms and decision-support systems for personalised medicine for common complex diseases.

Photo: salzburgresearch.at

Estonia has a unique situation in regard of genome research and eHealth ecosystem readiness. The Estonian Biobank, the nation-wide Health Information System and the compulsory Health Insurance Fund database have been in use for several years. This is complemented by the government-provided secure internet based data exchange layer (x-road) and a mature legal environment concerning genome data and healthcare data collection, handling, storing and exchange.

To achieve the set targets, the research is divided into 3 sub-projects. First, the assessment of terms for the development of clinically valid and commercially viable personalized medicine products and services. Second, the development of decision-support algorithms and communication tools for digital medical data and genome-based testing in personalised medicine. Finally, the development of longitudinal digital medical data and genome-based testing service prototype of complex diseases. Based on the above, a specific software platform will be developed, which will integrate different genome and health-related databases and allow the use of the created decision support algorithms as well as the development of new scripts.

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In search for disease with nanoparticles

Magnetic Resonance Imaging (MRI) units are the fastest growing diagnostic technology in medicine since MRI scans do not include the risk of ionising radiation for patients. As an example, many research and development resources have been invested into superparamagnetic iron oxide nanoparticles (SPIONs) as contrast agents for MRI, e.g., Feridex and Resovist. On the other hand, previously reported results indicate that pure metal-based (e.g., Fe) nanospheres provide greatly enhanced magnetic properties compared to SPIONs and could therefore act as improved contrast agents for high performance MRI. Our proposed research takes a leap forward in the field of MRI contrast agents to get magnetically improved and stable core-shell structured metal-organic nanoparticles for practical applications. We aspire to develop magnetically improved metal cores and corrosion-resistant organic shells for nanoparticles that could replace existing technologies.

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Studying the development of multi-resistant superbacteria

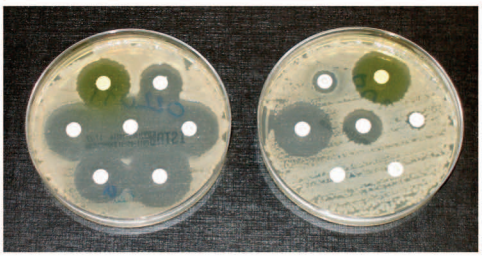

Photo: Dr Graham Beards/Wikimedia Commons

The development of antibiotics is considered one of the biggest achievements of medicine. Currently we are witnessing an increase in drug resistance that might considerably decrease the therapeutic potency of antibiotics. Issues that concern antibiotic resistance are not limited to medicine. More than half of the amount of antibiotics produced is used in animal husbandry and veterinary practice. In farms, workers are in contact with animals and might exchange resistant bacteria. Antibiotic residues and resistant bacteria are spread from farms to fields with sludge. The emergence and spread of antibiotic resistance can be understood by analysing complex networks containing different nodes. Researchers at the University of Tartu have analysed the spread of several bacteria and resistance genes that are critical for human medicine. The research is based on the work of specialists in different fields: physicians, veterinarians, environmental researchers, microbiologists and bioinformaticians. A detailed analysis of bacteria is performed with the help of high-throughput sequencing of DNA.

So far studies have identified several bacterial strains that spread in all environments studied: humans, animals and soil. This suggests that antibiotic resistance can be transferred rapidly between humans, animals and the environment.

In this context the current increase in the usage of antibiotics in Estonian animal husbandry is a worrying trend. Researchers continue to monitor the trends in antibiotic resistance and endeavour to find practical solutions that could slow down the emergence and spread of resistance.

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Design + technology = technology designed for health

Design thinking combined with well-focused scientific research creates significant outcomes that help to broaden the scope of research by bringing out latent possibilities in the problem ecosystem and help to define the best and most valuable use scenarios.

Technomedicum has worked out a new optical method to monitor uremic toxins in the blood in the haemolysis process. Design & Engineering students performed a design-led research with all stakeholders and proved that the innovation offers valuable feedback to doctors but can also provide an independent monitoring and controlling system that would increase patient motivation and the ability to take better care of their dialysis process.

Currently, there are about 600,000 old haemodialysis machines worldwide. Many of these machines are in good condition but lack certain functions limiting the treatment modalities a clinic can perform. Those functionalities could be diversified significantly by adding a precise sensor, extra screen and well-defined user interface to the machines. The information measured by the sensor would be instantly displayed on the screen. All the process would be taken to a new level for patients, nurses and doctors, saving time and offering real-time information.

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Photo: Pan American Health Organization/Creative Commons

Working on countermeasures to emerging virus threats

Resent global emergencies with the Chikungunya virus (CHIKV), Ebola virus (EBOV) and, most recently, Zika virus (ZIKV), have encouraged researchers from the University of Tartu to develop countermeasures to these threats, including prototypes of antiviral compounds, vaccine candidates and approaches to limit the transmission of CHIKV and ZIKV by mosquito vectors. Professor of Biomedical Technology Mart Ustav together with colleague Andres Merits, Professor of Applied Virology, has constructed synthetic CHIKV and ZIKV genomes, the genetic structure of which can be altered according to necessity; such tools have been made available for researchers from 15 different countries. They have flagged these viruses for the better monitoring of the infection. A flagged virus means a virus carrying luciferase (light-emitting) or fluorescent protein genes. Such viruses are used to monitor *in vivo* infections, test potential antiviral drug candidates and identify viral and host sequences required for or inhibiting virus replication. Among other things this information could be used for developing mosquitos that are unable to transmit these viruses.


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Similarly, genomes of CHIKV and ZIKV have been engineered into vaccine candidates tested in monkey models (CHIKV) or entering into pre-clinical trials (ZIKV). Antigens from EBOV and ZIKV have been incorporated into viral and non-viral expression vectors that can be used for immunisation purposes. This enables to isolate genes encoding for antiviral antibodies quickly and efficiently. By using those genes, it is possible to produce the necessary antibodies in large quantities and, in principle, use them to create an antiviral protection in humans.

The research is performed in collaboration with science and industry and involves cooperation with research teams from different countries. It is funded by Estonian Research Council, University of Tartu and The Wellcome Trust.

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The dementia project of Estonia: Implementation and outcomes of creative arts therapy program

According to the World Health Organization (2015), 47.5 million people have been diagnosed with dementia worldwide, and there are 7.7 million new cases every year. Dementia mainly affects older people and causes the deterioration of memory, thinking, behaviour and the ability to perform everyday activities. Dementia is one of the major causes for the disability and dependency of the elderly.

The proportion of people aged 65 and older is increasing in Estonia, and so is the number of people suffering from dementia. However, specific dementia care still needs further development. In 2013—2014, there was the first attempt at adding creative arts therapy to dementia care in Estonia. The powerful aspect of creative arts therapy is that communication occurs in the realm of expression, encompassing visual language, music and movement. For people who struggle with the spoken word, working with art as a tool of communication can be incredibly liberating.


Photo: Jaroslav A. Polák/Creative Commons

Currently developments take place in two directions. First, the health promoting use of creative arts therapies to promote active ageing. Relying on the previous research outcomes that engagement in arts has potential to reduce the use of medications, isolation, depression, and loneliness. Second, Tallinn University has contributed to vibroacoustic (VA) therapy practice, research and the development of the relevant equipment since the 1980s. The newest device, whose prototype was launched by the Centre of Excellence in Health Promotion and Rehabilitation of Haapsalu College, was introduced at the 1st International VIBRAC Conference in Lahti, Finland, in 2016. VA therapy is defined as a treatment method based on low frequency sound vibrations and music. Depending on the choice of sound vibrations, the effect is either relaxing or stimulating, which allows VA therapy to be used for general relaxation and for more specific functional purposes. Within this topic of research, the specific aim is to investigate the effect of the treatment on the functional state in case of Alzheimer Disease and Parkinsonism.

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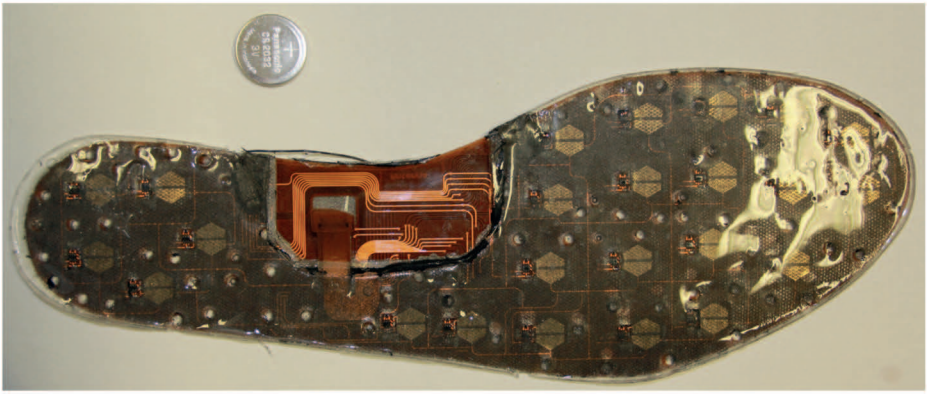

Smart sole—
miniaturisable wearable sensory

As people spend a considerable time on their feet, gait and posture can considerably affect overall human health. Perhaps the easiest way to measure and diagnose various problems with feet, legs, the pelvis, and spine is with plantar pressure maps measured while a person is standing, walking, and running. The stationary sensor platform variety is used and developed the most extensively.

These platforms have a dense matrix of pressure sensors; they are large enough to capture a few consequential steps and are relatively accurate if operated properly. The system measures plantar pressure on the go and sends the information to a mobile device but also stores it for subsequent data analysis. The application is not limited to sports, as abnormal plantar pressure distribution is of interest for several fields of medicine, even in the early detection of diabetic foot ulceration.

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