Health & Technology

By Convergence

Convergence Health & Technology
Theme: Improving Health Journeys
Matchmaking event 7 September follow-up

1. List of pitches summaries
2. Pitches (slides) from presenters who wish to share their idea

List of pitches summaries

Pitched by	Email	Inst.	Summary
Jeffrey Sweeney	sweeney@rsm.nl	EUR	There is a need for Digital Health Technologies to reduce the impact of environmental risk exposures (e.g., viral pathogens). In response, the Rapid Prediction and Response System (RPARS), a prototype dynamic messaging technology, tracks health and risk exposure to guide individual behavior. Collaborators are needed to further pilot and test.
Marjon Cnossen/ Ans van der Ploeg	m.cnossen@erasmusmc.nl	EMC	The Rare Disease Innovation Center. We aim to develop a (white label) module for patient journeys applicable for patients with a rare disease (ever rising costs and risks/ novel therapies) in general using conceptual, ICT, economic expertise to develop best treatment for acceptable costs, in a world of changing therapeutic modalities, with SYMPHONY consortium (NWO-NWA grant) as a showcase/ stepping stone.
Bas Donkers/ Esther de Bekker-Grob	donkers@ese.eur.nl	EUR	The aim of our research project is to make the health care process more pro-active by creating integrative care networks supported with digital tooling and predictive analytics. Our ambition is to engage the elderly and their care givers in this process.
Pieter Bakx	Bakx@eshpm.eur.nl	EUR	This flagship uses longitudinal data to study the choices of older adults with chronic illness about the care types they use during their health journey. It shows how these are influenced by government policy and technological change. Thus, it will improve these decisions and contributes to improving well-being and limiting inequalities.

List of pitches summaries

Saba Hinrichs	s.hinrichs@tudelft.nl	TUD	Resilient HealthCare:Current realities of hospitals are not equipped to deal with patient transitions and seamless journeys/treatments, because their organisational systems (IT, supplies, materials and capacity management) are not resilient to disruptions and ready to support promising technological advances. Our idea is to build a large programme of work spanning: 1.Resilient workforce: Enabling clinical and non-clinical staff to rapidly overcome disruptions, adapt to, innovate and learn from crises; 2.Resilience in administration, operations, supplies: Use of AI, big data and IOT in logistics, capacity management, and support systems, for improved forecasting and emergency preparedness; 3. Resilience across providers: Modelling complex interactions and data linkages across providers such as GPs, hospitals, GGDs, etc and connected health and non-health infrastructures
Ellen Verweel-Bossenbroek	e.bossenbroek@erasmusmc.nl	EMC	1. Ontwikkelen van 1 wekelijks regionaal MDO (in plaats van de 5 verschillende MDO's waarbij sommige om de week plaats vindt). Waarbij het mogelijk is om tijdens het MDO inzicht te hebben in de OK capaciteit, waardoor het mogelijk is om direct te besluiten in welk ziekenhuis de patiënte geopereerd gaat worden (Op basis van de juiste zorg op de juiste plaats, zo snel mogelijk en voorkeur van de patiënte). Dit vindt in de huidige situatie plaats tijdens de centrale triage; een wekelijks overleg tussen de opererende centra waarbij patiënten na MDO worden verwezen naar het opererende centra. 2. De algemene patientenreis staat beschreven op onze regionale website (www.eierstokkankernetwerk.nl). We zouden de patientenreis graag individualiseren, waarbij het voor patiënten inzichtelijk is in welk ziekenhuis ze welke afspraken/behandelingen krijgen, contact kunnen krijgen met de professional en vragenlijsten kunnen invullen om het consult beter op de behoeften van de patiënt af te stemmen en tevens onderzoek uit te kunnen voeren om de zorg voor de patiënten te verbeteren.

List of pitches summaries

Yvonne Everdingen	yeverdingen@rsm.nl	EUR	The idea for our flagship is to investigate the effectiveness of the use of virtual reality (and maybe also augmented reality) for prevention / diagnosis and treatment / care, and how this can be used at home rather than at the hospital. For example, how can VR be effectively used to reduce stress or pain, but also how can VR help in guiding care before and after a surgery?
Hester Lingsma/ Kevin ten Haaf	h.lingsma@erasmusmc.nl	EMC	Towards personalised health journeys. To improve individual health journeys, interventions should be tailored to personal characteristics and preferences. We aim to develop an integral framework for personalized prevention and treatment throughout the life-course. We will integrate data-, decision- and medical- and policy science to develop personalized interventions tailored to patient preferences, and facilitate their clinical implementation.
Marco Rozendaal/ Armagan Albayrak	a.albayrak@tudelft.nl	TUD	We propose to explore smart technologies in support of the nursing staff from a health journey perspective. Defining the supporting role smart technology can play requires looking into the values and competencies of nursing staff and patients in relation to the capabilities of smart technology. In this way technology can truly become embedded in everyday care practices. Please join us in our efforts!
Dennis Fok	dfok@ese.eur.nl	EUR	We propose a Health Analytics lab to concentrate and develop methodological expertise for health care problems requiring advanced data analysis. Examples are personalized medicine, gene association/fMRI studies, and behavioral studies. At the same time we want to stimulate the interest of students by starting a health analytics minor.

List of pitches summaries

Ryan Muetzel	r.muetzel@erasmusmc.nl	EMC	Biological age represents an estimated age based on various biological/-omic data. When contrasted with actual chronological age, the discrepancy with biological age (or delta) has shown to be informative in the context of pathology and may predict relevant outcomes. Accelerated biological aging (i.e., when biological age is higher than chronological age) is associated with more medical problems and all-cause mortality, whereas younger biological age is associated with healthier lifestyles and the absence of severe medical problems. Traditionally, biological age is estimated within a particular “modality”, such as “brainAge” etimated from neuroimaging data, “epigeneticAge” estimated from DNA methylation data, or vascularAge estimated from vascular imaging data. Thus, biological age estimates can be organ or system-specific. Novel multivariate techniques are often the modelling strategy of choice for estimating biological age, for example ranging from standard machine learning methods such as support vector machine to deep learning techniques involving convolutional neural networks.
Melek Rousian/ Joris Pothof	m.rousian@erasmusmc.nl	EMC	Smarter healthy ageing across the life course . Age-related diseases impact health, quality of life, society and healthcare. This flagship aims to promote health span across the life span by integrating evidence-based medicine, mental and lifestyle care for the creation of digital individual health journeys using AI and advanced technologies. This digital ‘healthy ageing twin’ will catalyze research between the 3 Universities and public and private stakeholders and as such contribute to health care and a resilient society.

List of pitches summaries

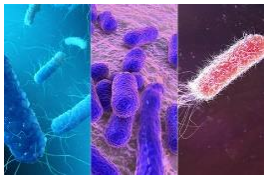
Lenie van Rossem	l.vanrossem@erasmusmc.nl	EMC	'Our Smart Neighbourhood Buddy'. Our smart neighbourhood buddy will be a digital lifestyle support platform for young families living in deprived neighbourhoods. The buddy will be developed in co-creation and co-design with the end-users and stakeholders. Community building will be used for motivation, engagement, adoption and sustainable use of the platform and AI for personalization and to meet the needs of a specific family.
Trudy Voortman	trudy.voortman@erasmusmc.nl	EUR	Physical activity is a key factor in prevention of a wide range of chronic diseases and functional limitations, including mobility problems. Futhermore, activity and exercise could play a role in treatment for various patient groups. In order to optimize primary prevention and the role of exercise as medicine, more knowledge is needed about what optimal physical behaviour throughout the life-course and in different patient groups looks like in terms of amount, type, frequency, timing, etc. We aim to study physical activity behaviour within different populations, its determinants and health outcomes. Additionally, we will study the parameters of optimal physical activity patterns in terms of e.g. frequency, time, type of activity, composition with other activity behaviours during the day such as sedentary behaviour and sleep, using novel sensor technology and advanced data analysis techniques. Furthermore, we will study strategies for behavior change to promote physical activity in various groups and develop interventions.

List of pitches summaries

Judith Rietjens	j.rietjens@erasmusmc.nl	EMC	The patient is the largest and least utilized resource in healthcare. Unstructured “patient experience” data such as expressed in patient fora, social media and patient emails), can be leveraged by novel data driven AI/NLP techniques and citizen science methods to give insight into patients’ experiences with their care and treatment. In ongoing interdisciplinary work with colleagues at EMC, the EUR and TU Delft, this highly scalable methodological approach is currently in development, with a wealth of applications (eg: improving self-management of persons with dementia and their caregivers; improving cancer patients’ care pathways; insight into stigma experiences by persons with a psychotic disorder). The patient is the largest and least utilized resource in healthcare. Unstructured “patient experience” data such as expressed in patient fora, social media and patient emails), can be leveraged by novel data driven AI/NLP techniques and citizen science methods to give insight into patients’ experiences with their care and treatment. In ongoing interdisciplinary work with colleagues at EMC, the EUR and TU Delft, this highly scalable methodological approach is currently in development, with a wealth of applications (eg: improving self-management of persons with dementia and their caregivers; improving cancer patients’ care pathways; insight into stigma experiences by persons with a psychotic disorder). The patient is the largest and least utilized resource in healthcare. Unstructured “patient experience” data such as expressed in patient fora, social media and patient emails), can be leveraged by novel data driven AI/NLP techniques and citizen science methods to give insight into patients’ experiences with their care and treatment. In ongoing interdisciplinary work with colleagues at EMC, the EUR and TU Delft, this highly scalable methodological approach is currently in development, with a wealth of applications (eg: improving self-management of persons with dementia and their caregivers; improving cancer patients’ care pathways; insight into stigma experiences by persons with a psychotic disorder).

Pitches (slides) from presenters who wish to share their idea

Problem Definition



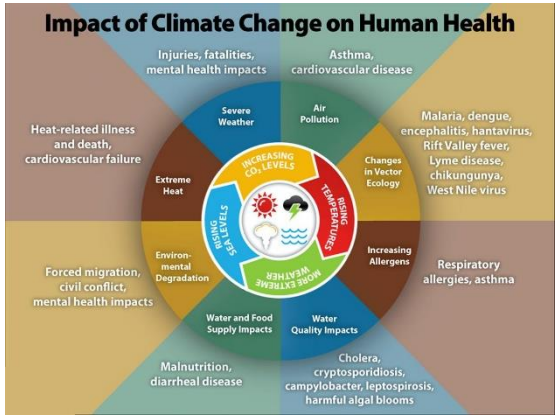
Environmental Risk Information originates from many sources, e.g.,

- National/Local Governments
- Public Health Agencies
- Academic Institutions
- Public/Private Companies
- Medical Associations
- Social Media, etc.

Often leading to inaccurate and conflicting information
(disruptions in the information space)

Environmental risk exposures are more likely to occur due to global trends such as climate change, ozone depletion, urbanization, and population growth

The likelihood and impact of environmental risks differ across individuals, but interventions are administered at the population level



https://www.cdc.gov/climateandhealth/docs/Health_Impacts_Climate_Change-508_final.pdf

There is a growing need to develop Next-Generation Digital Health Technologies (DHTs) to personally guide citizens towards maintaining healthy lifestyles while equitably reducing the likelihood and impact of environmental risk exposures

However, there are many medical, technical, behavioral, and ethical challenges to overcome before better solutions are found - addressing these challenges requires convergence of knowledge held throughout the Erasmus / TU Delft community

Solution Outline

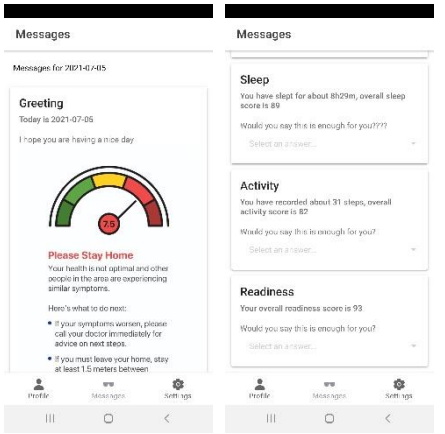
The Rapid Prediction and Response System (RPARS) is a prototype dynamic messaging technology which securely and privately records individual health and risk exposure information to present users with dynamically-generated personalized guidance

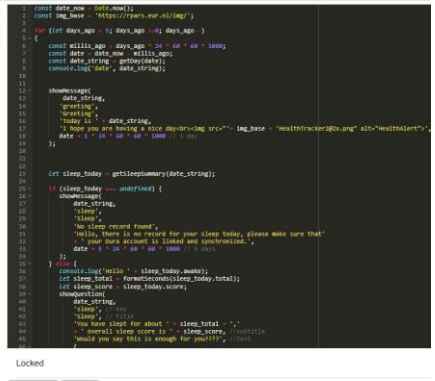
RPARS provides researchers with an adaptable environment to iteratively develop and test prototypes aimed at guiding individuals towards healthy behaviors while reducing risk exposure

The RPARS architecture consists of the following technical components for further development

- *An app interface* (iOS or Android) which stores global positioning system (GPS) data, user input, and health data in an encrypted file held on the user's mobile device. The app presents dynamic messages to the user and requests user feedback
- *A backend server* which provides an interface for researchers to edit and deploy decision-logic to the app. Researchers may assign users to groups for testing and evaluation of dynamic messages (e.g., A/B testing)
- *A wearable biometric monitoring device* which records user sleep, physical activity, resting heart rate, heart rate variability, body temperature, and breath rate. The device allows for continuous monitoring of user health and behavior metrics

RPARS may serve as a boundary object to collaborate across knowledge domains towards a common research goal: Do you want to help develop and test the RPARS prototype in real-world contexts? Medical, technical, behavioral, and ethical expertise is needed





Proactive **A**daptive **C**are **N**etworks for an **A**ging **P**opulation (PACNAP)

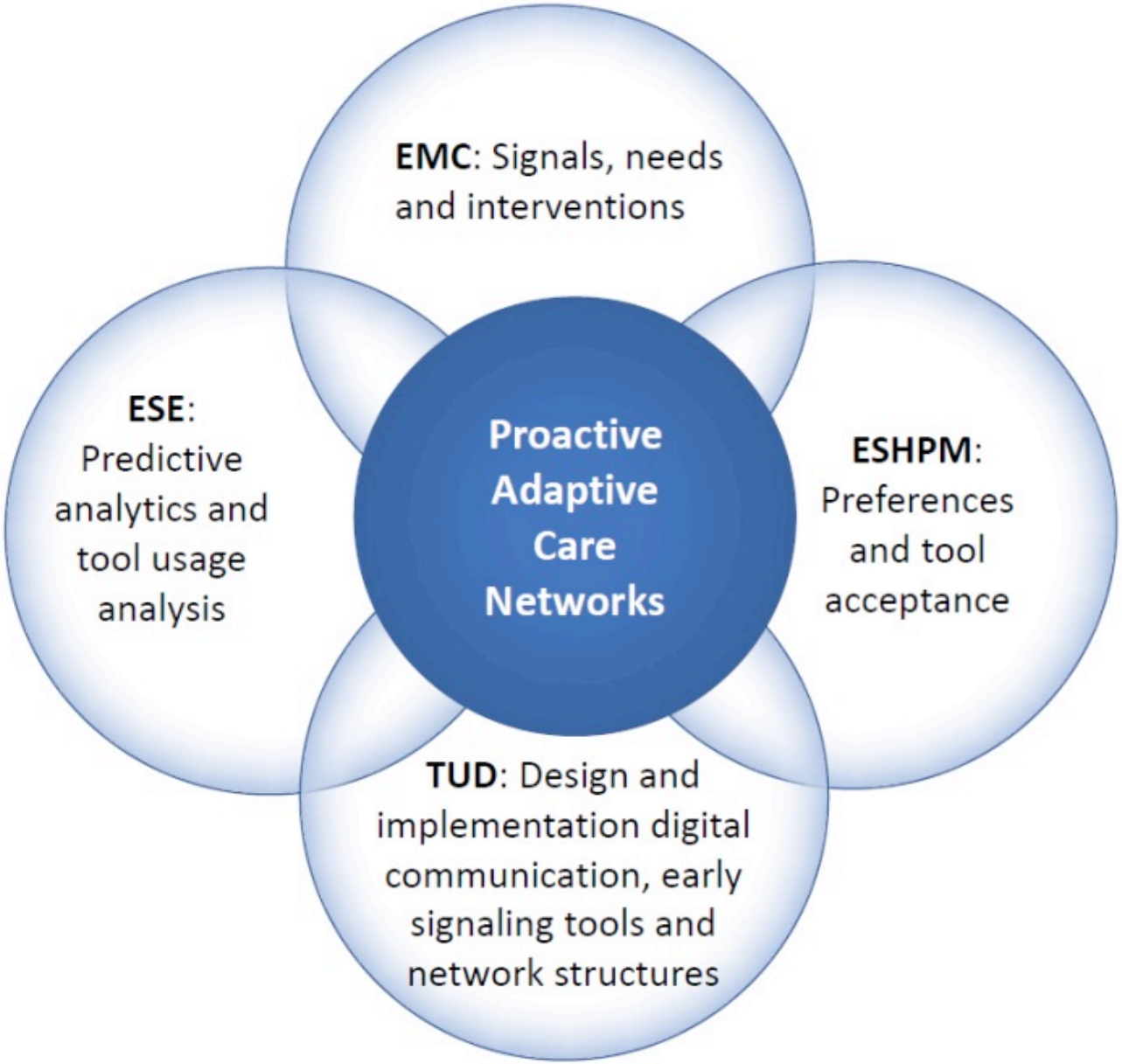
A sustainable healthcare system in times of an ageing population

SOLUTION → Innovative, urgent, and interdisciplinary program:
- Explore, develop, value & validate proactive adaptive care networks
- That lead to timely delivery of adequate, lower cost care and support for the elderly who live independently

PROBLEM
- Reactive design leads to a lower quality of life of elderly and their informal care takers
- Serious aggravation of problems due to size of elderly population
- An increased chance of using acute and often more expensive care

CURRENT SITUATION
- Soon 25% of Dutch population will be aged 65 years or older
- Most elderly are living independently and government encourages them to live at home as long as possible
- Health care system is largely designed to be reactive to changes in health conditions of the elderly

Proactive Adaptive Care Networks for an Aging Population (PACNAP)



- Networks combine the elderly, informal care givers, and formal care in fast-track innovations through digital technology and predictive analytics
- The proposed proactive and adaptive care network is unique worldwide and highly innovative. New theorizing and empirical evidence on (drivers of) willingness to act on predictive health information
- Knowledge & skills: will you be joining us?
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  - donkers@ese.eur.nl
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  - veldwijk@eshpm.eur.nl

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Chronic illness: difficult, complex decisions

Choices and outcomes vary:

- Over time
- Across subgroups of patients
- Across providers

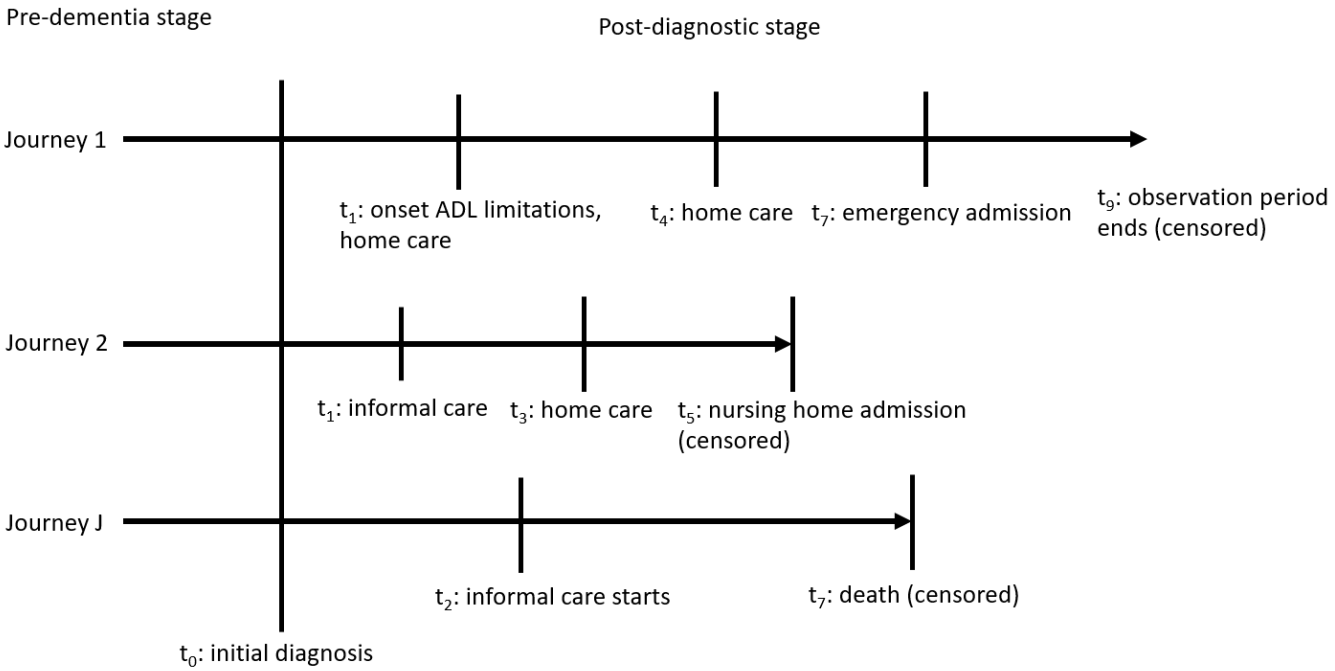
How are these shaped by government rationing and innovations?

How do these choices contribute to inequalities in health?

How may we improve these choices?

→ The right mix of care, provided in the right setting

For this, we need comprehensive health journeys



Combining data creates a better understanding

- My contribution: study variation in health journeys of 20+ years in linked, observational data
  - All types of care and beyond: other aspects of life, including well-being
- Obviously, much room for complementing research:
  - Medical/epidemiological
  - Insight in decision making
  - Analysis of big data
  - Understanding and (re-)designing interventions
  - ....

→ What is the right mix of care and the right setting?

Let’s get in touch

Pieter Bakx

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Erasmus School of Health Policy & Management

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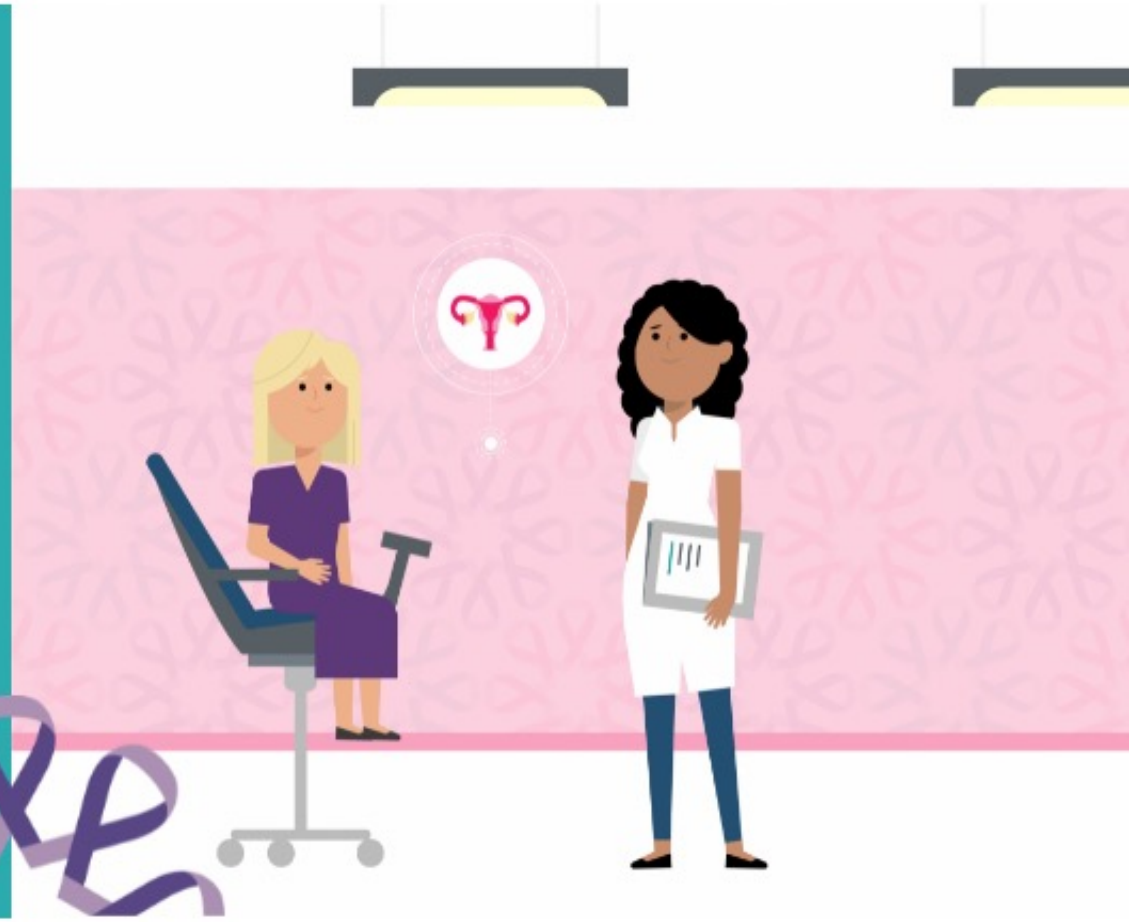
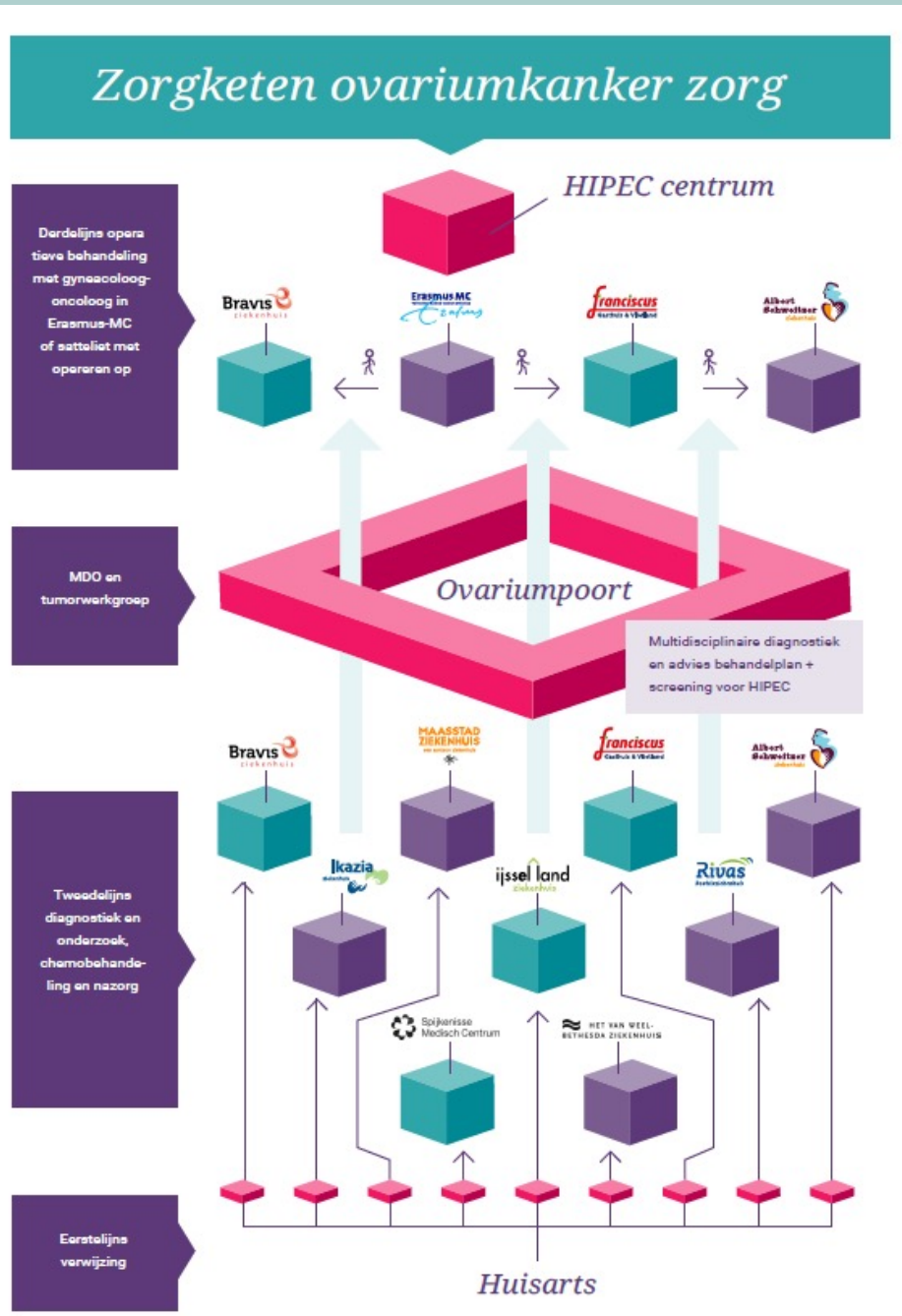
REGION
eierstokkankernetwerk.nl

Ovarian cancer patients in the region Southwest Netherland

Samenwerking voor de beste gynaecologische oncologische zorg in de regio Zuidwest Nederland



Ellen Verweel – Bossenbroek Nurse practitioner Erasmus MC



COLLABORATION TO THE FUTURE

- Multidisciplinairy consultation and central triage combined
- System for the patients to keep track of their health journey

Technology and collaboration, for the best individual patient care.

Driving adoption of new technologies for (mental) healthcare applications

Prof.dr. Yvonne van Everdingen (EUR, RSM)

Prof.dr. Matthias Wieser (EUR, ESSB)

Dr. Marta Andreatta (EUR, ESSB)

Driving adoption of new technologies for (mental) healthcare applications

Overall

New technologies are easily accessible and can be applied in (mental) healthcare, in particular for ***anxiety- and stress-related disorders***, ***pain***, and for promoting ***healthy decision making and well-being***.

In this project, we aim to focus on **virtual reality** (VR) and **augmented reality** (AR) applications aiming at improving (mental) health.

Limitations

Both patients and clinicians show resistance in using new technologies persistently, despite the first hints on the effectiveness of VR/AR treatments. Even less is known about the effectiveness of VR/AR for prevention (e.g., by promoting a healthy lifestyle).

Problems / RQ's

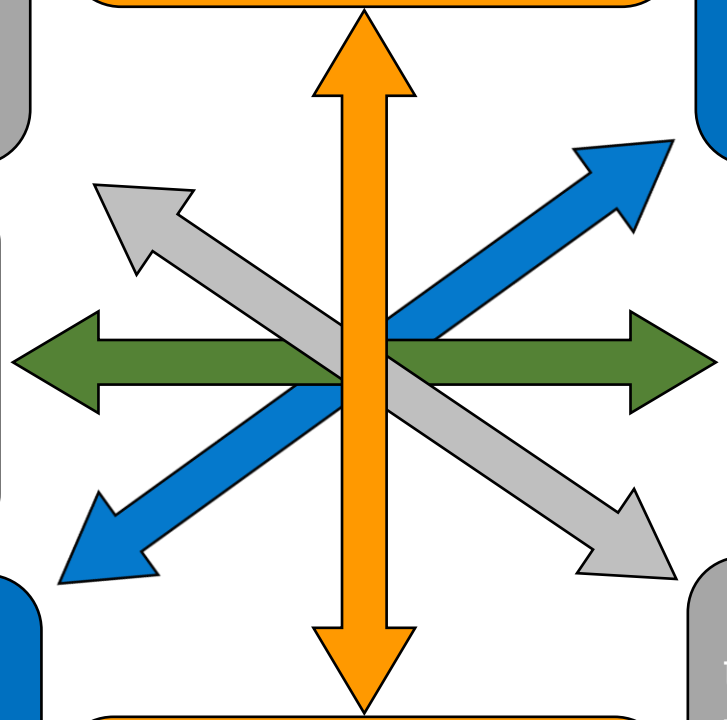
1. How effective are treatments based on these new technologies relative to existing treatments?
2. Can the treatments and the prevention strategies be individualized and offered @home? If yes, how do we motivate individuals to persistently use the new technologies?

virtual reality (VR)
the application of ecological valid and highly controlled environments

motivation
to strengthen the individual motivation in using the developed technological tools, not only frequently but also in the long-run

personalized
individualized virtual environments and app-based strategies for prevention and therapy of mental, neurological, or medical disorders

prevention / diagnosis
- VR for stress reduction / management to prevent mental, neurological, or medical disorders
- AR for determining symptoms / real-time patient data



treatment / care
- therapies for anxiety as well as pain-related disorders
- guidance for a healthy lifestyle
- guidance for revalidation processes

@home
giving the possibility to the individuals to easily use the developed tools at home (whenever they like)

effectiveness
to establish the efficacy of the technological tools in treatment and prevention of mental and neurological disorders

augmented reality (AR)
adding a computer-generated image on a user's view of the real world

Driving adoption of new technologies for (mental) healthcare applications

The researchers and their expertise:

EUR, ESSB:
Prof. dr. Matthias Wieser (experimental psychopathology of anxiety, stress, and pain; individualized treatment approaches)
Dr. Marta Andreatta (anxiety- and fear-related disorders, virtual reality, inter-individual differences)
Dr. Marilisa Boffo (e-health, digital interventions) – inquired, not confirmed yet

EUR, RSM:
Prof.dr. Yvonne van Everdingen (Adoption and Diffusion of New Technologies; Launching New Products; Virtual and Augmented Reality).
Dr. Anne Klesse (Psychology behind consumer decision making; healthy food choices; effectiveness of mobile apps)
Dr. Romain Cadario (Psychology behind consumer decision making; healthy food choices; mHealth App for skin care prevention / detection)

EUR, ESE:
Prof.dr. Stefan Stremersch (Marketing of New Technologies, Diffusion of Innovations; Healthcare and Pharmaceutical Marketing)

Erasmus MC:
Prof.dr. Reginé Steegers-Theunissen ((eHealth)lifestyle, digital coaching, epic

TU Delft:
Dr.ir. Stefan van der Spek (urban design, VR Lab) – intended to meet in last w

Input needed from:
TUD – the development of VR environments
Erasmus MC:
- Stress / pain reduction: psychiatry, neurology, anesthesiology
- Social interactions: autism, anxiety

Our ideas relate to / overlap with diverse other flagship ideas on VR/AR applications:

VR/AR treatments - mental health care

- Session 3 Tuesday Aug 31 – Loes Keijsers (EUR, ESSB) + her contacts at Erasmus MC / TUD
- Session 12 Thursday Sept 2 – Olya Kudina (TUD)

VR/AR applications to stimulate a healthy lifestyle

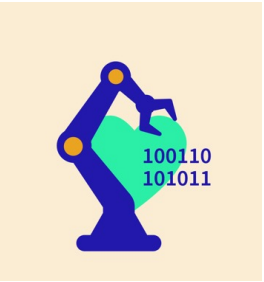
- Session 1 Tuesday Aug 31 – Régine Steegers-Theunissen (Erasmus MC)

VR/AR applications / education - surgeries

- Session 5 (Smart Surgery Lab) Thursday Sept 2 – John Vlot (Erasmus MC), Marie-Lise van Veelen (Erasmus MC)
- Session 11 (Image guided interventions) Thursday Sept 2 - Jenny Dankelman (TUD), Gijs van Soest (Erasmus MC), Meng Li (TUD), and others

Personalised prevention and treatment

Target health care interventions to those that benefit most



Develop an interdisciplinary framework for personalized prevention and treatment

Department of Public Health Erasmus MC:

Large experience research in primary and secondary prevention

Specific expertise in screening and medical decision making

Erasmus MC

Personalised prevention and treatment

We have:

- Extensive knowledge + international reputation on statistical modelling for personalized prevention (screening) and treatment
- Strong network
- Access to data

We are looking for:

Medical informatics, AI, Ethics, Implementation, Patient preferences, …. , …

Contact: h.lingsma@erasmusmc.nl

Erasmus MC

Establishing a *Health Analytics Lab*

Research: cutting-edge methodology meets applications

For instance, *work packages* on:

- Personalized medicine: e.g., causal inference, heterogeneous treatment effects
- Gene association / fMRI studies: e.g., regularization, post-selection inference
- Behavioral studies: e.g., robust methods for rating-scale data, latent variable models
- Health care operations research: e.g., transplant allocation, personalized screening programs

Establishing a *Health Analytics Lab*

Education: health & medical topics are increasingly popular for students with Analytics/Econometrics/Data science profile.

Starting new educational programs:

- Short term: Health Analytics minor/major (could be part of the Econometrics program at Erasmus School of Economics)
- Long term aim: Health Analytics Master as a joint program of EUR, Erasmus MC, and TU Delft

Interested in cooperating?
Contact Dennis Fok at dfok@ese.eur.nl

Biological Age

Convergence: Improving Health Journeys

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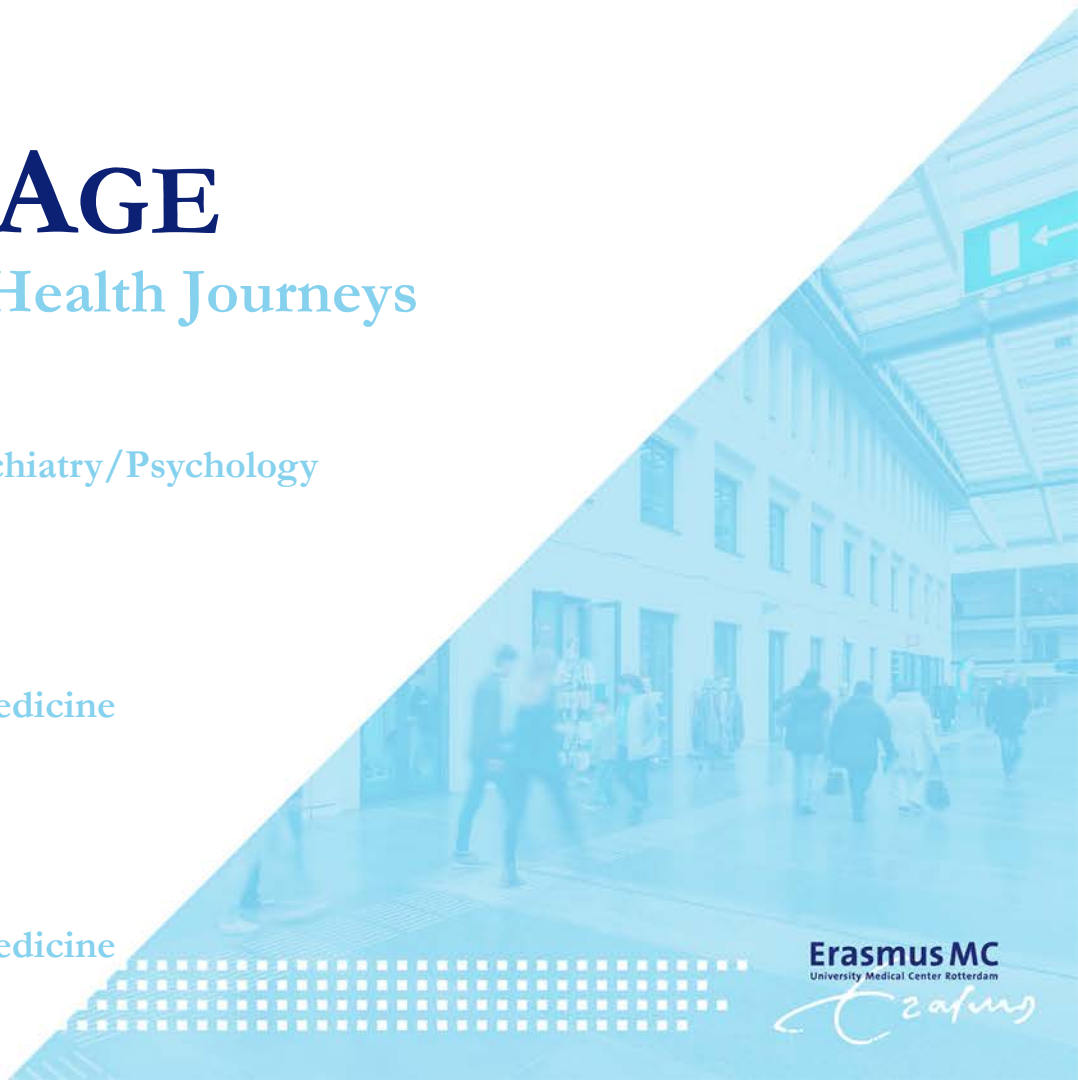

BIOLOGICAL AGE

An estimated age based on various biological/-omic data.

Multivariate techniques (e.g., Deep Learning) used for predicting age

High dimensional (big) data (e.g., whole-brain MRI, epigenome data)

Discrepancy between predicted and actual age is informative

- Accelerated biological aging (older predicted age) associated with more medical problems
- younger biological age associated with healthier lifestyles and fewer medical problems
- In the context of pathology, may predict relevant outcomes
- Route to highlight and understand risk and resilience

BIOLOGICAL AGE

Goal I: improve the prediction of different forms of biological age (e.g., *BrainAge, EpigeneticAge, CardiovascularAge, MSKAge).*

Goal II: multimodal data fusion and integration for a single, overall "biological age" indicator across organ systems

Goal III: Develop app/tools for clinicians to use to estimate biological age in clinic

Expertise Needed:

- Technical Expertise in multivariate techniques
- Clinical expertise to identify new biological age targets

Erasmus MC

Biological Age

Convergence: Improving Health Journeys

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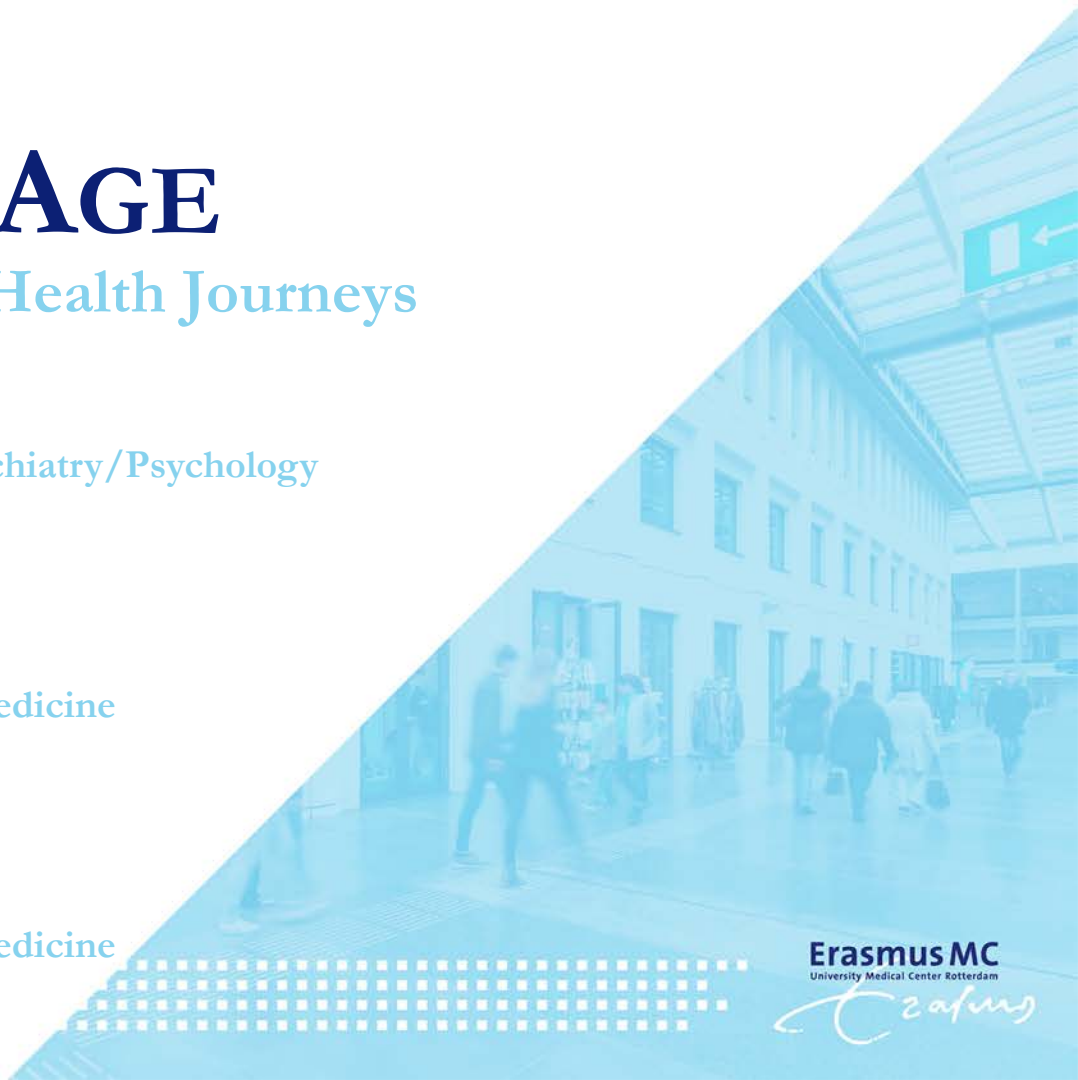


How do we make patients' health journeys truly patient centered?

- Care paths are **insufficiently patient centered**
  - Often do not fit patients' preferences and needs
- We need novel, interdisciplinary approaches to get insight in patients' perspectives, contexts and "language" to improve their **care paths**

- The patient is the **largest** but **least utilized resource** in healthcare
- Analyses of unstructured "patient experience" **big data**
  - Analyze patient fora, social media, blogs, patient emails, […] with AI/NLP techniques
  - Citizen science: collaborate with citizens / patients
- Identify relevant experiences and preferences → contextualize and improve care paths

Reaching convergence

- We are developing a scalable methodological approach, wealth of possible applications
- We are building capacity
  - Public Health, Medical Informatics, Ethics, Psychology, Alzheimer Center, Oncological depts, ESHPM, Library, Industrial Design.
- First steps in attracting external funding very positive
  - EMC/EUR: improving self-management of persons with dementia and informal caregivers (ZonMw/health Holland)
  - EMC/EUR/TU Delft: insight into stigma experiences by persons with a psychotic disorder (Open Mind, convergence)
  - EMC, TU Delft, European partners: improving cancer care pathways (H2020/21)
- Question to you: fields of application (data, clinical settings), Flagship collaboration to add patient perspectives to clinical focus

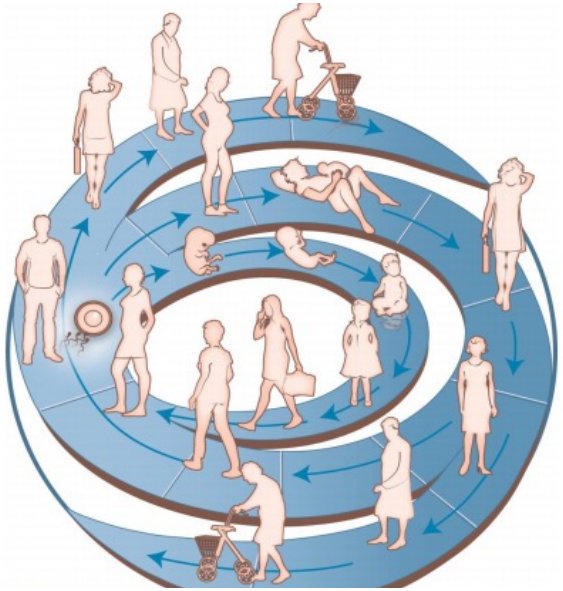
Pre-proposal
Flagship “Healthy ageing across the life course”

Main Aim

To develop personalized, context medicine and effective preventive strategies to promote healthspan through lifestyle care as roadmap,

and to integrate with (non)medical and societal care.

Co-creation, adoption and implemention of evidence-based digital life course care journeys using blended care approaches.



Healthy ageing across the life course

1. Elucidating mechanisms underlying the living environment on healthspan;

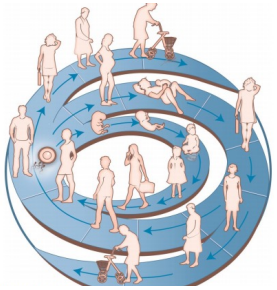
2. Analyzing nongenetic stressors across the life-course on healthspan;

3. Delineating the genetics of ageing;

4. Implementing insights, including lifestyle intervention apps, biomarkers and polygenic risk scores in society using AI, digital and eHealth technology;

5. Implementation in digital life course care journeys, which incorporates adoption, feed-back on sustainable healthcare funding, and Start-ups incorporated in the Flagship.

Flagship Team i.d.
Pre-proposal “Healthy ageing across the life course”



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HiX

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HEALTHY PREGNANCY 4 ALL

Integrate and implement Genetics into Personalized Medicine and Prevention

Proposed by:
-Prof.Dr. André Uitterlinden, dept Internal Medicine, Erasmus MC
-Prof.Dr. Ron van Schaik, dept Clinical Chemistry, Erasmus MC
-Prof.Dr. Maureen Rutten-van Molken, iMTA, EUR

Content:
We propose to integrate and implement **"genetic information"** into health care and prevention. Genetic information can be determined cheaply and comprehensively by DNA analysis (e.g., by arrays for <30 euro/sample) and contains -clinically relevant- information on risk for all diseases (common and rare), all risk factors (e.g., cholesterol), personal characteristics (e.g. ethnicity, HLA, blood groups), and response-to-treatment (pharmacogenetics). This project will transform health care and prevention by taking a more holistic approach in a personalized setting.

Context:
Proposal is based on ongoing and planned projects:

-Genotyping on ALL patients: GOALL (Koers23 project, Erasmus MC)

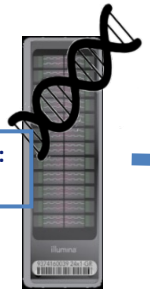
-Societal impact of gENetic SciencE: SENSE (NWA application, to be submitted 7 okt 2021)

-EU 1 Million Genomes project: 1MG (EU Horizon2020 project+national genome programs+Genome of Europe (GoE))

An example of large-scale application of genetics in health care: the GOALL (Genotyping On ALL patients) project

Hofstra, Uitterlinden; Strategic Koers23 project of Board of Directors; start May 2019 with several pilot projects

Genomics Core Facility:
DNA Array Processing



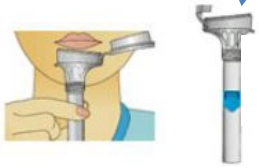
***Interpretation/Counseling**:
Clinical depts : Complex Diseases
Clinical Genetics : Mendelian Diseases
Clinical Chemistry : Pharmacogenetics

***Patient inflow/Reporting**:
Clinical departments (per disease)

As Academic Medical Center: creation of a research database with genetic and phenotype information based on 300,000 new patients/year

Pilot projects:
-Breast Cancer
-Eye Disease*
-Fam. Hyperchol.
-Cor. Art. Disease
-PGx
-Osteoarthritis
-Osteoporosis

*A clinical trial is running now using PRS for slowing progression of macula degeneration coupled to dietary-advice



The ultimate GOALL is that:

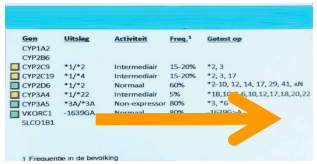
***ALL** patients undergo DNA array genotyping

*Patient DNA Array results are available **BEFORE** clinician sees the patient

Information and Consent

Patient's Home

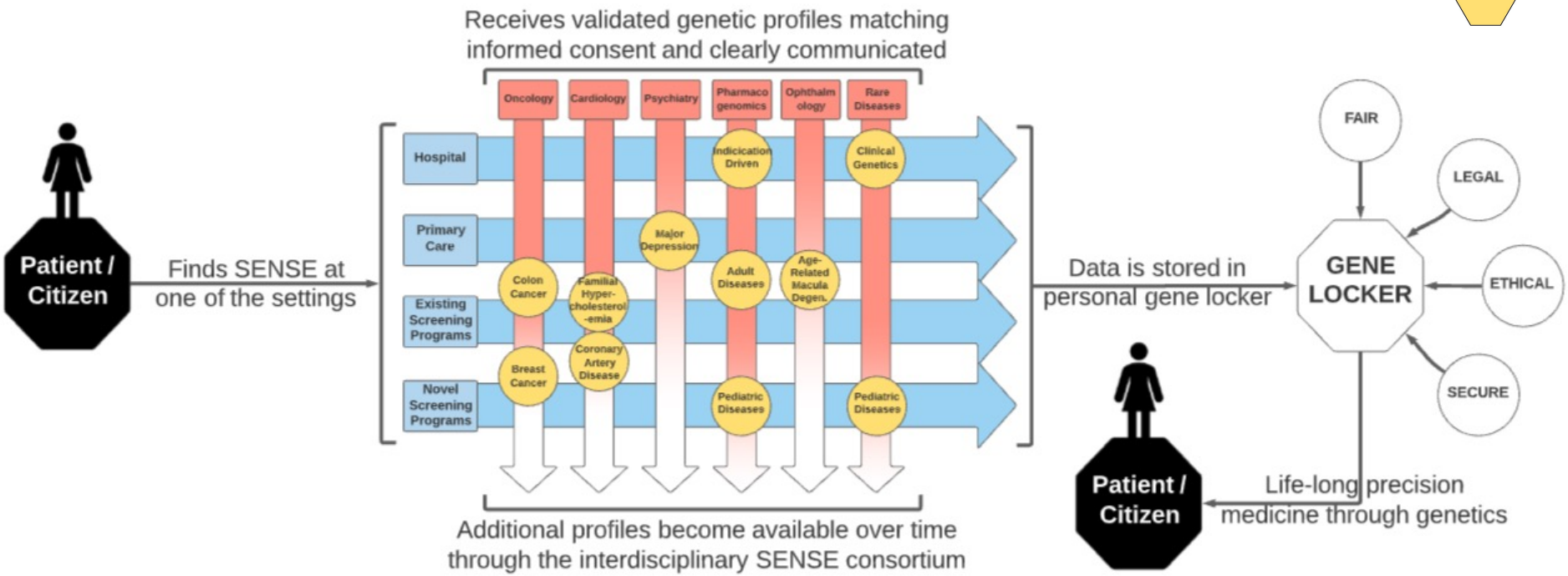
Subscription to GENETIC REPORT



Regular updates with advice/treatment

The “SENSE” project: societal use of genetic information

2021: Proposal NWO/NWA:
Nationale Wetenschaps Agenda (to be submitted 7 okt 2021)



> Create a central cohort of ~30,000 subjects to pilot several applications <