The **future**
belongs to those
who **create** it

Holst Centre

Open Innovation by imec and TNO

Health Patch Platform for Customized Remote Patient Monitoring

Biography of the speaker

Ashok Sridhar, PhD

- Business development Manager - Healthcare TNO@Holst Centre
- Focus: wearable devices, smart clothing and large-area sensors
- PhD in Printed Electronics from University of Twente (the Netherlands) (2010)
- MBA from TIAS School for Business and Society (the Netherlands) (2016)
- Various techno-commercial roles in Printed Electronics and 3D Printing

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Introduction

About Holst Centre

Who we are

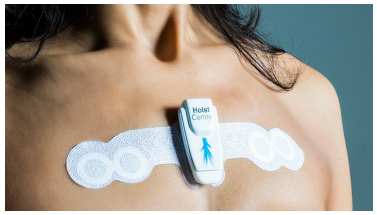
- Innovation centre founded in 2005 by The Netherlands Organization for Applied Scientific Research (TNO) and IMEC, Belgium
- Located on High Tech Campus, Eindhoven, The Netherlands

What we do

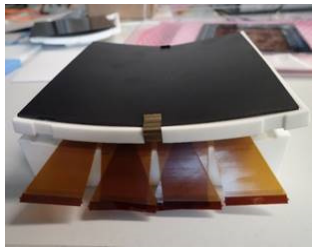
- Enable electronic devices that are flexible, stretchable, wearable, washable and formable
- **Healthcare and Vitality**, IoT, Mobility and Energy are major application areas
- We help companies to bring out products with seamlessly integrated electronics

Healthcare innovations at TNO@Holst Centre

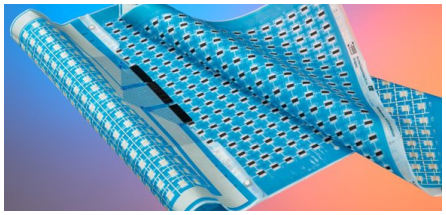
Jaundice blanket



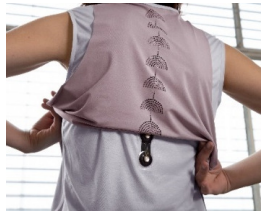
Wearable patch Gen 1



Flex imagers/ detectors



Posture monitoring blanket



MYSA smart garment

2010 ● ▶ 2021

Smart blister package

Illuminated retractor

Baby monitoring belt

Wearable patch Gen 2

Flight sensing shirt/suit

Human-centric healthcare

What is “human-centric” in healthcare?

People at the core, technology is the enabler

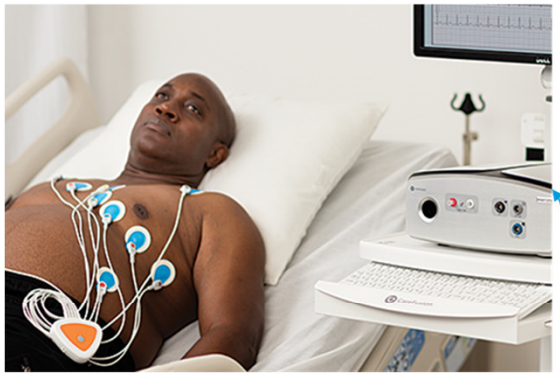
- Leverage advancements in digital health to shift the focus away from ‘treating patients’ towards ‘ensuring the well-being of human beings’
- Moving away from care at hospitals to remote care
- Highly personalized and not a one-type-fits-all approach
- Healthcare providers evaluated by “health and well-being of populace” and not by “services rendered”

What is “human-centric” in healthcare?

Ensuring human well-being by creating a system that emphasizes on

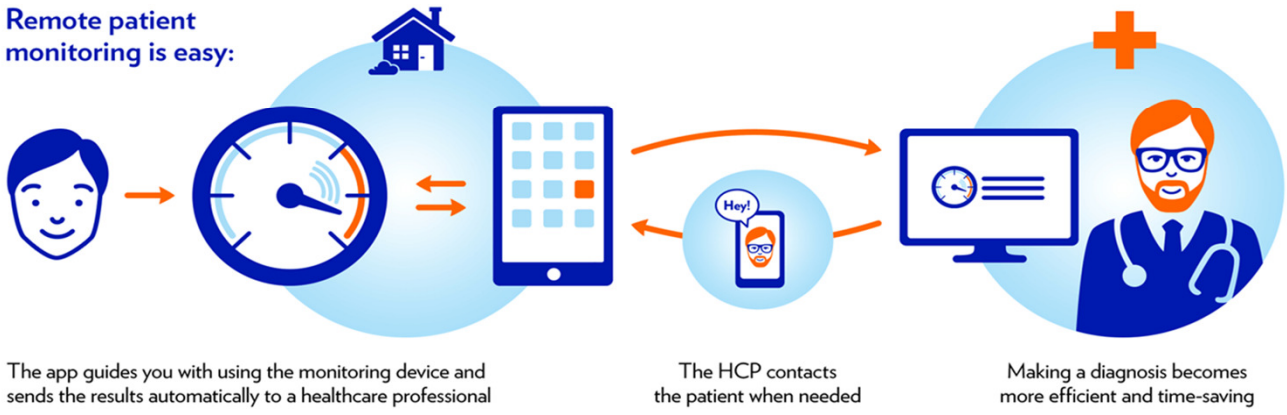
- Promoting healthy living and prevention
- Early detection of illnesses
- Continuous (remote) monitoring of patients and high-risk groups
- Providing optimal treatment everywhere

Wearables as key enabler



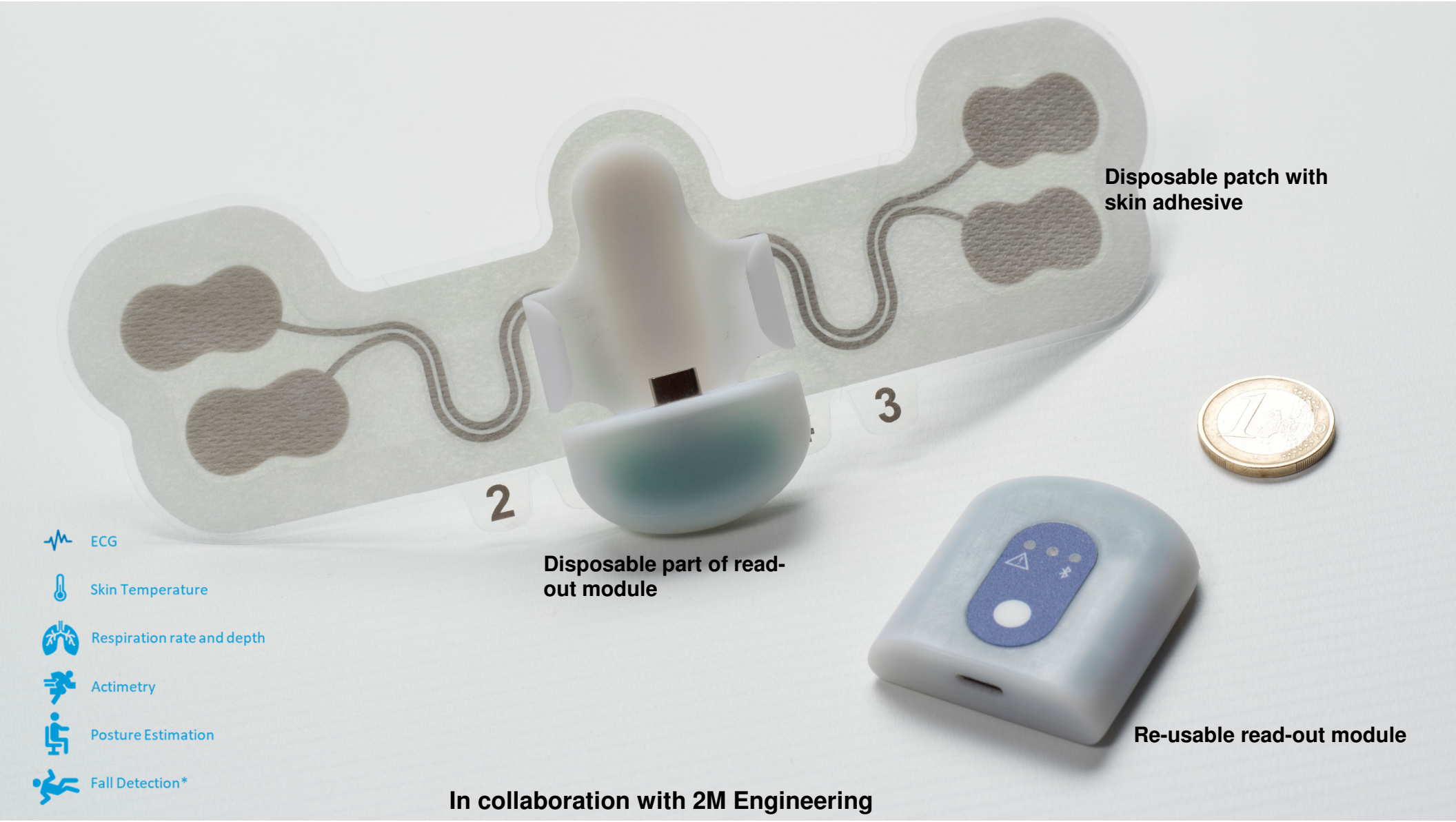
Today: Wired solutions in clinical settings

Emerging and Future: Remote monitoring



https://emedmultispecialtygroup.com/remote-patient-monitoring/

TNO@Holst Centre's wearable health patch platform


Disposable patch with skin adhesive
2
3
Disposable part of read-out module
Re-usable read-out module
ECG
Skin Temperature
Respiration rate and depth
Actimetry
Posture Estimation
Fall Detection*
In collaboration with 2M Engineering

Wearable health patch platform

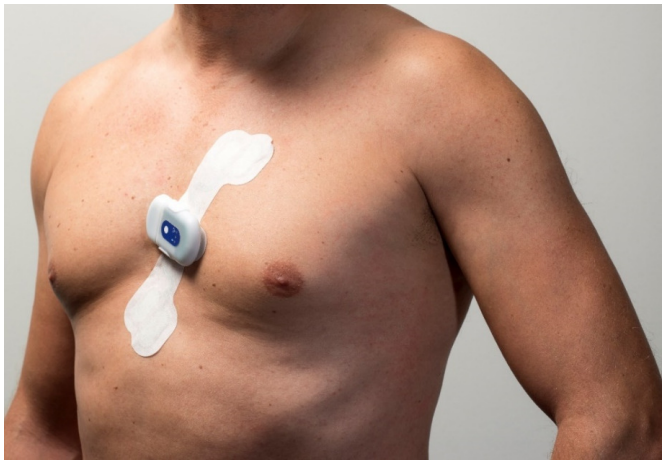
ECG	BIO-IMPEDANCE	ACCELEROMETER
POSTURE	CORE BODY TEMPERATURE	SPO_2
DRY ELECTRODES	BLUETOOTH	ON-BOARD DATA STORAGE
SOFTWARE FOR DATA COLLECTION	WATER PROOFING	FALL DETECTION ALGORITHM

INDEX

CURRENTLY AVAILABLE

DEVELOPMENT

Key features



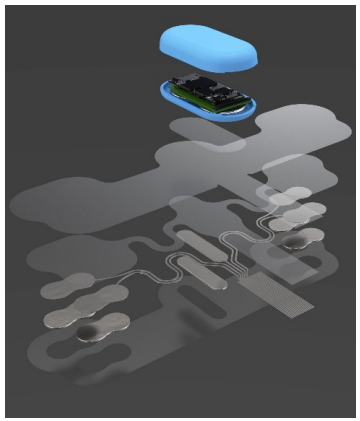
The health patch platform has the following key features:

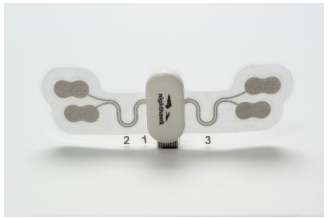
- Multi-sensor platform for clinical-grade data
- Disposable patch – reusable electronics
- Dry electrode technology
- Stretchable circuitry on stretchable substrate
- Waterproof
- Long-term monitoring: Wearable up to 7 days, working towards 14 days
- **Clinical studies ongoing**
- **Customizable for COPD, IBD, cardiac monitoring, COVID-19, pre- and post-operation, etc.**

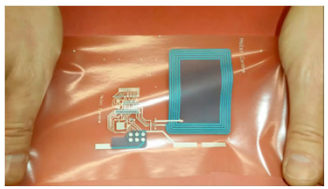
Health patch: Simplified process flow

Design

- application-specific form factor
- sensor selection
- material choices (circuits, electrodes, adhesives)
- electronics + firmware + app development
- regulations (safety, etc.)

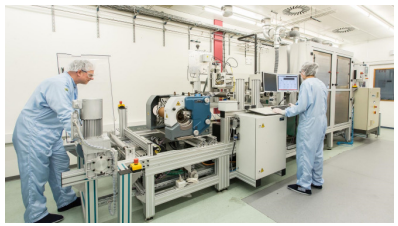






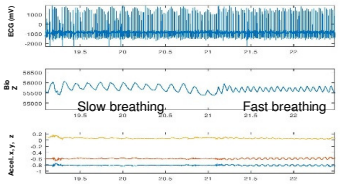
Development

- In-house facilities for prototyping
- Pre-series manufacturing
- Technology transfer



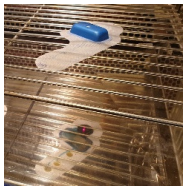
(Clinical) validation

- lab testing on volunteers
- device reliability and performance testing
- clinical testing
- CE/FDA/other certification



Productization

- ISO 13485 for medical devices



Ultrasound Patch

Ultrasound patches versus handheld transducers

Advantages

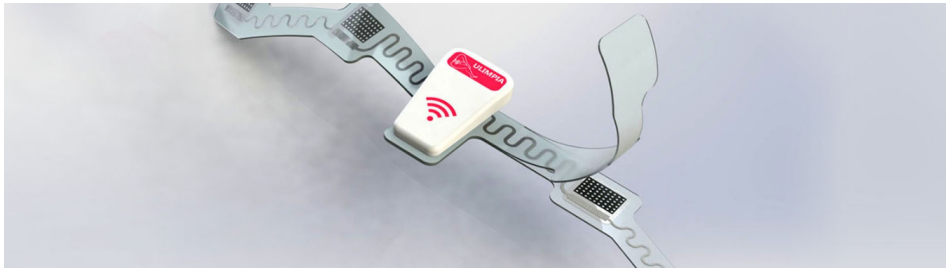
- Hands-free and sonographer independent
- Conforms to shape of body
- Remote monitoring
- Continuous monitoring

Challenges

- Positioning (re-positioning until location verified)
- Acoustic interface: hydro-gel free to favour multi-day monitoring
- Wearability: conformability and breathability
- Wear comfort: Power vs size/weight
- Safety: Water/splash-proofness

Ultrasound patch development at TNO@Holst Centre

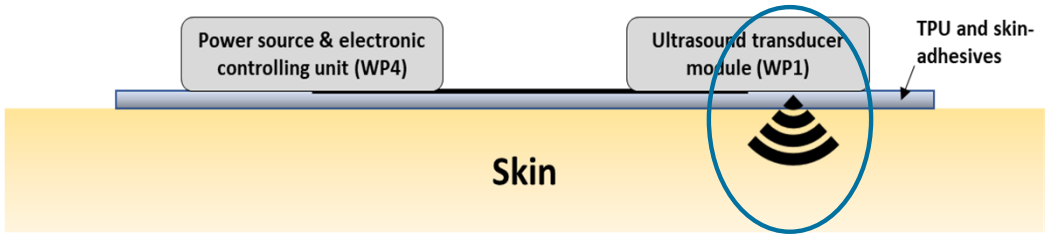
- An example use-case is the bladder monitoring patch, which was developed in the framework of “Ulimpia” project
- Goal of project:
  - Creation of technology platform for ultra-thin wearable ultrasound patches
  - Integration of modular US transducers, stretchable circuitry, US transparency monitoring window
  - Use-case: Multi-day Bladder monitoring for adults, with battery driven CMUT ultrasound patch



ULIMPIA is a labelled a PENTA project endorsed by EUREKA under PENTA cluster number E!9911

ULIMPIA
ULTRA-SOUND BODY PATCHES

“Ulimpia” patch build-up (Design)



Development of patch technology platform for:

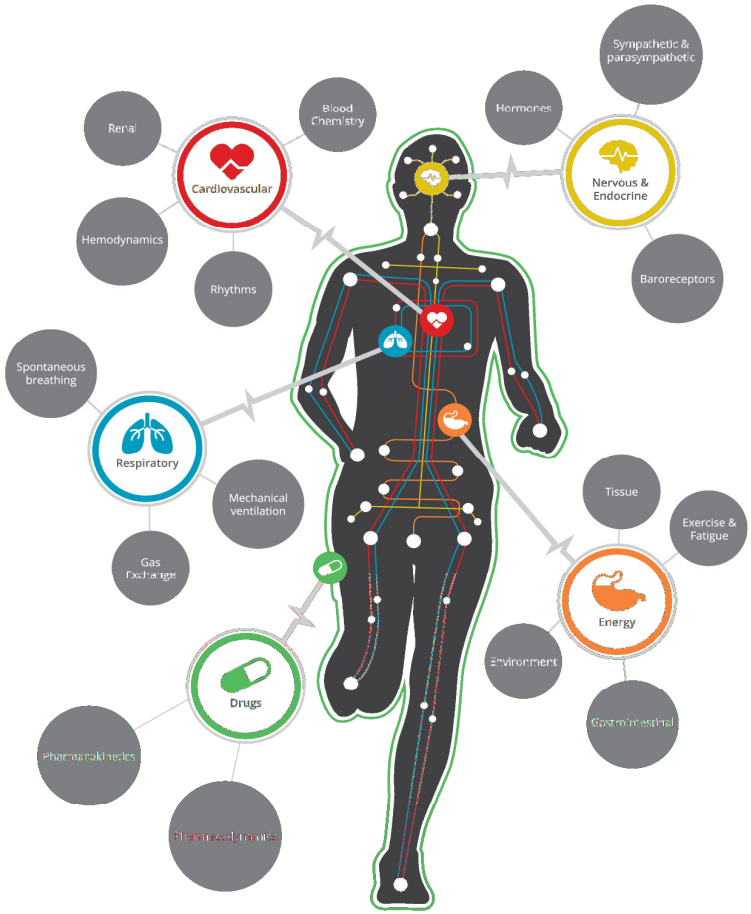
- Acoustic interface: adhesive materials
- Stretchable interconnects between transducer and central controller: for increased wear comfort
- Integration technologies for patch manufacturing: focussing on scalable and low-cost industrial processes

ULIMPIA
ULTRA-SOUND BODY PATCHES

Ongoing R&D

Digital biomarkers

How can we utilize signals from inside the human body and recommend prevention mechanisms?



Digital biomarkers

“Biomarkers collected by a wearable or portable system of sensors, electronics and algorithms that generate a long-term, real-time digital signal to enable frequent, non-invasive monitoring under daily life conditions”.

Source: doi: 10.1038/s41746-019-0119-8

Ongoing R&D

We are combining digital biomarkers and wearables to provide a holistic picture

- Our goal is to empower individuals to control their health preventively, instead of the current focus on disease management.

- **Besides vital signs, sleep and activity patterns, wearable devices that can quantify biomolecules in sweat, saliva and other body fluids will be developed.**

- Digital biomarkers quantified by non-invasive wearable devices will enable a truly “Human-centric preventive healthcare”.

Resources

Our publication on digital biomarkers can be viewed here:

- https://www.frontiersin.org/articles/10.3389/fdgth.2020.614670/full

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