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YOUR HEALTH IN THE BLINK OF AN EYE

VITAL SIGNS AND ENVIRONMENTAL MONITORING: TOWARDS CONNECTED HEALTH

DR. PATRICK DE BOEVER
VITO & HASSELT UNIVERSITY

VITO - VISION ON TECHNOLOGY

Strategic research

Applied innovative technology

Industry

Government

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HEALTH

VITO-Health is at the forefront of research into precision medicine, from biomolecular research to mobile health monitoring technologies

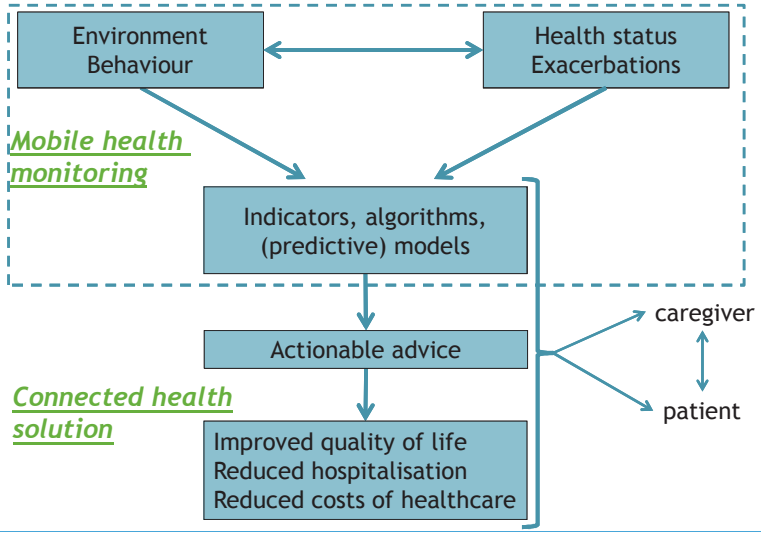
VITO-Health is developing biomarkers for early diagnostics, screening and prognosis and is testing and integrating sensors for convenient and every day monitoring. Data science and analytics is key in al of our research

VITO-Health performs contract research with a focus on improving environment, health and safety aspects in public and private sectors

CONNECTED HEALTH CAN LEAD INNOVATION IN HEALTHCARE

- VITO-Health is working on Connected Health solutions
- Develop innovative services designed around the needs of patient & healthcare professional
  - Prevention and lifestyle management
  - Therapeutic compliance (pharmacological and non-pharmacological)
- Collect data from patient using smart sensors and integrate with existing medical information
  - Heterogeneous patient data
  - Regular ambulatory measurements
  - Patient records
- Use data analytics to develop decision-support to predict and prevent
- “rather than continuously developing more complex hardware without addressing their implementation and valorisation targets, … deep integration of existing technology into innvative solutions and innovative business models are needed.”

FROM MOBILE HEALTH TO CONNECTED HEALTH



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PUBLIC HEALTH AND IMPACT OF AMBIENT AIR QUALITY

17.09.2015

OUTDOOR AIR POLLUTION KILLS MORE PEOPLE EACH YEAR THAN MALARIA AND HIV/AIDS COMBINED

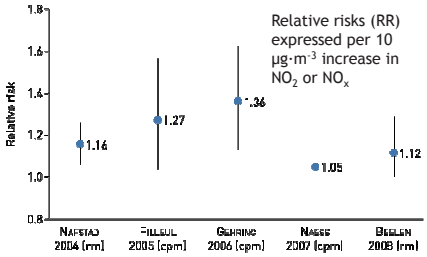
Over 3 million people die prematurely as a result of exposure to outdoor air pollution each year – more deaths than those caused by malaria and HIV/AIDS combined, according to a new study.

The paper, published in the journal, *Nature*, considered different sources of outdoor air pollution – including traffic, power stations and farming – alongside a computer model of the global atmosphere to work out how different communities were affected.

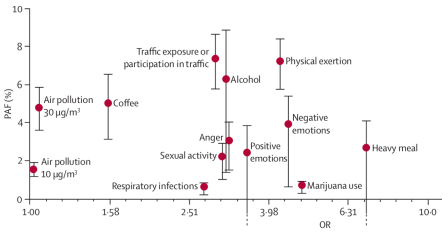
The researchers found that the burning of wood and coal for heating and power was overall the leading cause of pollution-related deaths, especially in Asia. They also noted the huge impact of farming, which was the second-leading cause of pollution-related deaths.

The paper also warned that, without any action to tackle the issue, the number of deaths related to air pollution could double by 2050.

Read the original paper.



Relative risks (RR) expressed per 10 $\mu g \cdot m^{-3}$ increase in NO_2 or NO_x



» Exposure over a few hours to weeks can trigger cardiovascular disease-related mortality and nonfatal events; longer-term exposure increases the risk for cardiovascular disease development.

» Air pollution causes 3% mortality of cardiopulmonary disease and it is a co-factor for several diseases.

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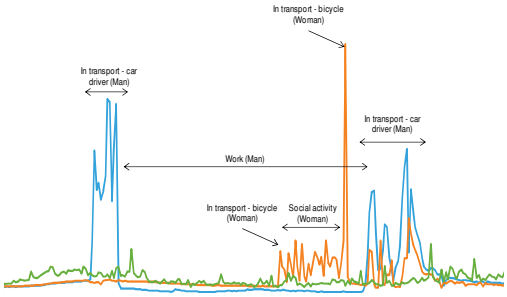
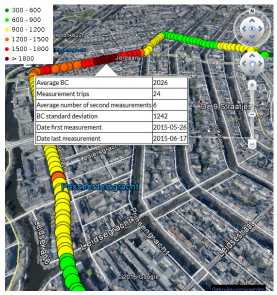
EXPOSURE ASSESSMENT WITH PORTABLE SENSORS

- Personalized monitoring
- Activity levels and ventilation rates
- Behaviour (routes, transport modus,…)
- Whereabouts



6% of time in transport=25% of daily soot exposure



Identification of hot spots

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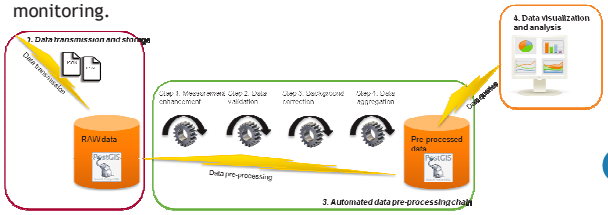
AIR-Q-MAP: PORTABLE APPLICATION FOR AIR QUALITY MAPPING

airQmap collects large amounts of mobile BC measurements and processes them into personal exposure maps and street-level exposure maps using participatory monitoring.



airQmap

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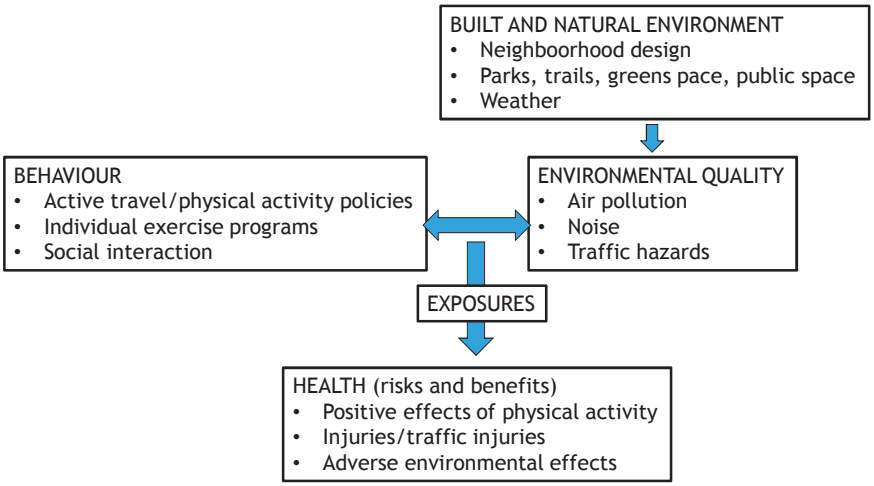
HEALTHY LUNGS FOR LIFE ROUTE FOR WALKING AND CYCLING

http://www.airqmap.com/ 9 vito

FACTORS CONTRIBUTING TO HEALTH IMPACT IN A BUILT ENVIRONMENT



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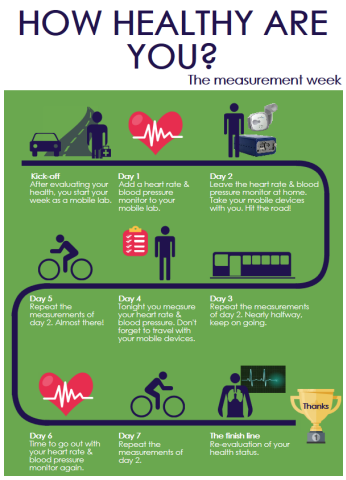
VITO STUDIES HEALTH IMPACT OF ACTIVE TRAVEL IN EUROPEAN CONTEXT

- Field study with volunteers to better understand impact of activity and environmental quality on health
- 120 participants; 4 seasons; 1 week/season
  - Antwerp
  - London
  - Barcelona
- Convient monitoring with wearable and portable sensors
  - Transport mode
  - Activity levels
  - Personal exposure levels
  - Vital signs & physiological parameters
- PASTA online survey on mobility and physical activity
  - Crowdsourcing on 14,000 participants/7 cities
  - What are determinants of active travel?
  - What are good measures to promote active travel?



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SENSORS USED TO STUDY IMPACT OF ACTIVITY AND ENVIRONMENTAL QUALITY

- Environmental quality and activity

µ-Aethalometer

Sensewear

GPS

Zephyr BioHarness

Smartphone (ExpoApp)

- Vital signs and physiological parameters

Heart rate variability

Blood pressure

Retinal imaging

Lung inflammation

Lung function

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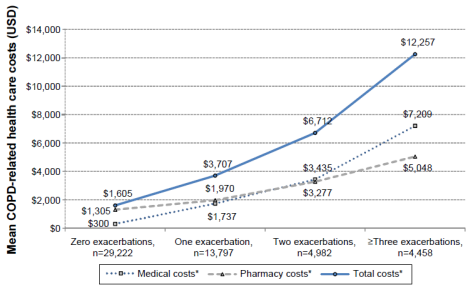
CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD) AND DISEASE FACTORS

In the adult population aged over 40 years, **moderate and severe COPD** is prevalent in 5-10% of the population and including mild cases the prevalence is **15-20%**

Every year, 300,000 Europeans die from COPD



Particulate matter air pollution exposure: role in the development and exacerbation of chronic obstructive pulmonary disease

An official European Respiratory Society statement on physical activity in COPD

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WEARABLE SENSORS FOR PREDICTING ONSET OF EXACERBATION

Hurst *et al. BMC Pulmonary Medicine* 2010, **10**:52
http://www.biomedcentral.com/1471-2466/10/52

BMC Pulmonary Medicine

RESEARCH ARTICLE Open Access

Domiciliary pulse-oximetry at exacerbation of chronic obstructive pulmonary disease: prospective pilot study

John R Hurst*, Gavin C Donaldson, Jennifer K Quint, James JP Goldring, Anant RC Patel, Jadwiga A Wedzicha

Heart rate (HR)
Oxygen saturation (SpO_2)
Peak-expiratory flow (PEF)

Pedone *et al. BMC Health Services Research* 2013, **13**:82
http://www.biomedcentral.com/1472-6963/13/82

BMC Health Services Research

RESEARCH ARTICLE Open Access

HR
SpO_2
Physical activity (PA)
Near-body temperature

Efficacy of multiparametric telemonitoring on respiratory outcomes in elderly people with COPD: a randomized controlled trial

Claudio Pedone[1,2*], Domenica Chiurco[1*], Simone Scarlata[1] and Raffaele Antonelli Incalzi[1,3]

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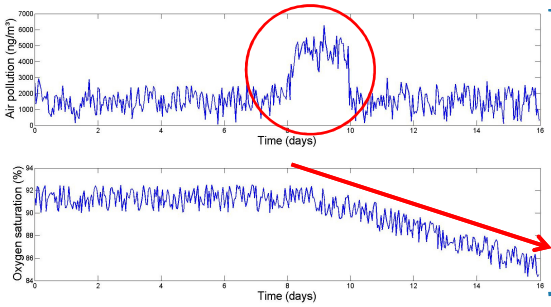
VITO DEPLOYS WEARABLE SENSORS FOR A COPD MONITORING SYSTEM

- 20 COPD patients + 20 partners
- Variables:
  - O_2 saturation + heart rate: Nonin WristOx2
  - Physical activity : SenseWear Armband
  - Environmental quality: microAethalometer+ GPS
  - Heart rate/ECG monitoring: Zephyr Bioharness 3



Day 16:
Patient health status ↓

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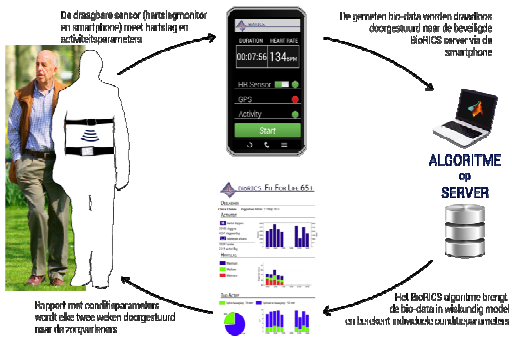
FIT-4-LIFE 65+ PROOF OF CONCEPT STUDY FOR WEARABLE SENSORS

- Monitor physical activity in elderly patients
- Estimate physical activity trends
- Predict more continuously fitness levels



nv SOPRIM@ beheer van woonzorgcentra
BioRICS
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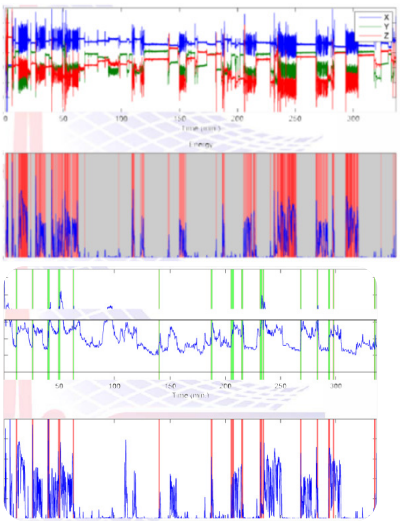
CALCULATED PERFORMANCE SCORE VERSUS PHYSICAL FITNESS TEST



- Strength: stand up and 8 foot up & go
- Fitness: 10 m and 2 min walk test
- Flexibility: backscratch and chair sit/reach

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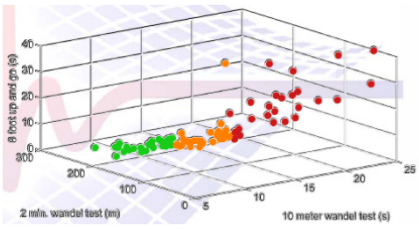
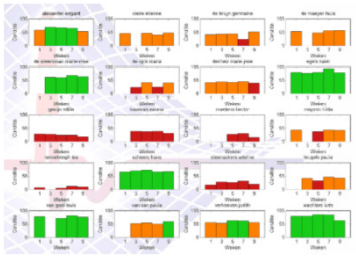
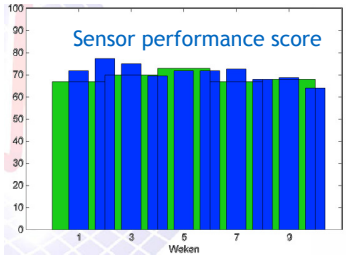
DAILY PERFORMANCE OF THE SENSOR IN ELDERLY HOMECARE







- Sensor estimates fitness and discremination between 3 fitness levels
- With 75% correct classification, the sensor has promise as a field tool to monitor activity and performance
- Sensor was well accepted by participants and health care professionals, but usability needs refinement

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HEALTH

iflexis
eye on health

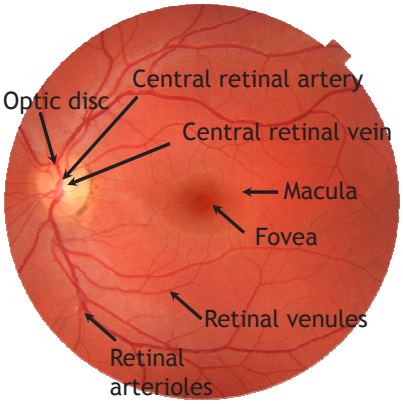
Comfortable health screening and better disease detection in the blink of an eye

Non invasive retinal imaging and data analytics

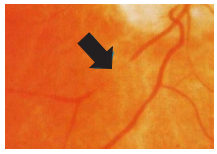
Software for quantitative retinal image analysis and algorithms for decision-making

THE RETINA IN HEALTH AND DISEASE

Healthy retina

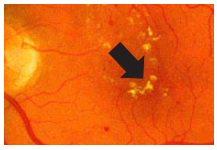


Examples of retinal disease signs



Arteriolar narrowing

Neovascularization



Hard exudates

Cotton wool spots

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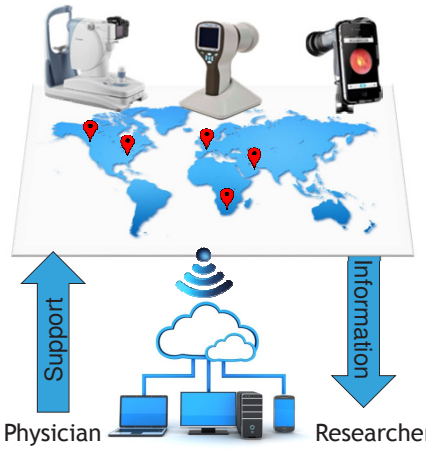
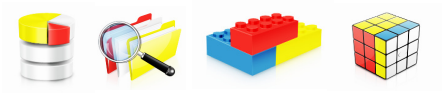
CONVENIENT MONITORING WITH CLOUD ANALYTICS FOR HEALTH ASSESSMENT



- Minimal client deployment
- Interactive environment
- Easy-to-use interface
- Store and manage data
- Customizable analysis workflows
- Structured searches
- Aggregation and reporting



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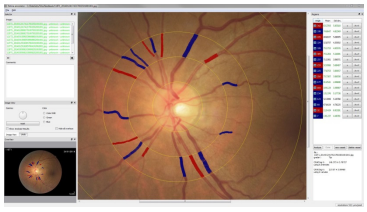
SYSTEMIC MICROVASCULATURE AND RETINAL MICROVASCULATURE AS PROXY

Microvasculature

- Vessel diameter < 150µm
- Functions
  - Tissue perfusion
  - Exchange O_2/CO_2 and nutrients/waste
  - Blood flow & blood pressure
  - Body temperature regulation
- Retina allows visualisation of microvessels

Quantification of retinal vasculature

- Width of blood vessels
  - Individual blood vessels
  - Central artery & vein (CRAE & CRVE)
- Geometric complexity
  - Tortuosity
  - Branching pattern (angles, end points,…)
  - Fractal dimension



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EPIDEMIOLOGICAL OBSERVATIONS OF CHANGES IN RETINAL VASCULATURE

Narrowing of arterioles, widening of venules and
changes in the geometric pattern leading to suboptimal blood flow

- Disease evolution and disease severity in patients
  - Diabetic retinopathy
  - Hypertension
  - Alzheimer & cognitive impairment in elderly
  - Ischemic stroke
- Physiological observations in healthy individuals
  - Chronic effect of physical inactivity and time spent before TV screen
  - Impact of carbohydrate nutrition
  - Long term exposure to air pollution and particulate matter

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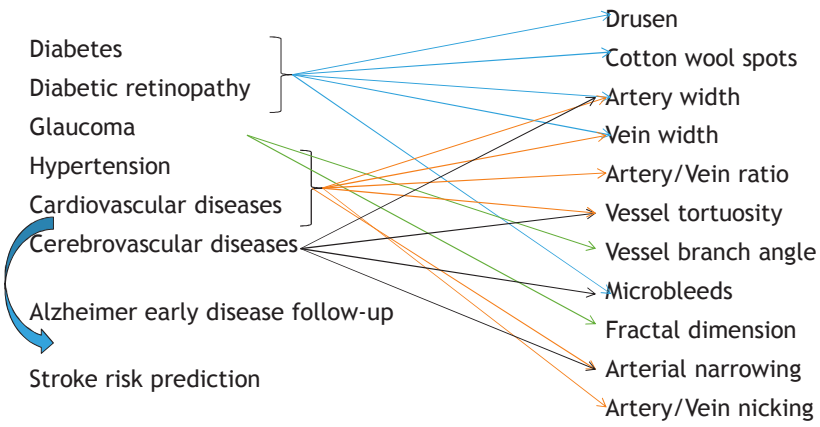
DISEASES ASSOCIATED WITH RETINOVASCULAR PARAMETERS



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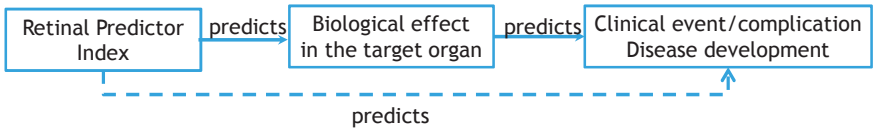
MODEL FOR USING RETINAL BIOMARKERS

- Need for unobtrusive and longitudinal monitoring
- Point-of-care testing systems and decentralized monitoring
- Sensitive biomarkers and decision support systems



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CONCLUSION

- Many technologies for monitoring physiological signals exist in the market
- Products/services with added-value have to be created for further adoption in healthcare
- Benchmarking is needed in terms of available standards, field application and deployment cost
- Combination of heterogeneous data gives more insight
- Environment & lifestyle are increasingly taken into account for mobile/connected health
- VITO Connected Health works at interphase between technology providers and end users
  - Environmental quality/activity for population monitoring and COPD patient monitoring
  - Activity and fitness monitoring of elderly
  - Retinal scanning as a convenient analysis for early disease identification & follow-up

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