



Quality of Life Technologies Lab
 University of Geneva, Switzerland
www.qol.unige.ch



Treated by computers?

- a futuristic perspective of health care

Prof. Katarzyna Wac

2021



UNIVERSITÉ DE GENÈVE

UNIVERSITY OF COPENHAGEN



STANFORD SCHOOL OF MEDICINE

Stanford University Medical Center



EUROPEAN SCIENCE FOUNDATION



EUROPEAN COMMISSION



HORIZON 2020



Schweizerische Eidgenossenschaft
 Confédération suisse
 Confederazione Svizzera
 Confederaziun svizra



FONDS NATIONAL SUISSE
 SCHWEIZERISCHER NATIONALFONDS
 FONDO NAZIONALE SVIZZERO
 SWISS NATIONAL SCIENCE FOUNDATION



Research at Google

Disclosures

Relevant Financial Relationships

Novartis, Merck Group, Lundbeck

Google, Samsung, Quantac, HealBe, Amazfit / Huami, Withings, Intel, MigraineBuddy, AARDEX Group, Orchestral Networks, Acaster Lloyd Cons.

Off-Label Investigational Uses NONE

The Small Picture



A Patient (female, 69)

Type 2 Diabetes (1992)

Heart attack (2014)

Hip fracture & replacement (2016)

Loves cooking

Much (too much) food (carbs)



Not the Only One

Genetic

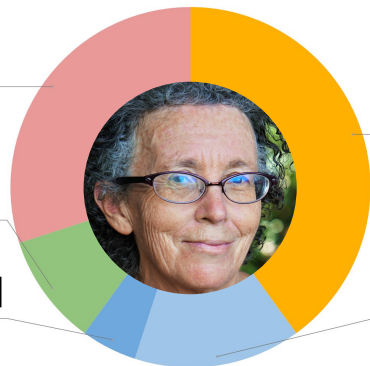
30.0%

Health care

10.0%

Environmental

5.0%



Behavioral

40.0%

Social

15.0%

Behavioural patterns

Deaths

Tobacco intake

18.1%

Poor diet

Physical inactivity

16.6%

Alcohol consumption

3.5%

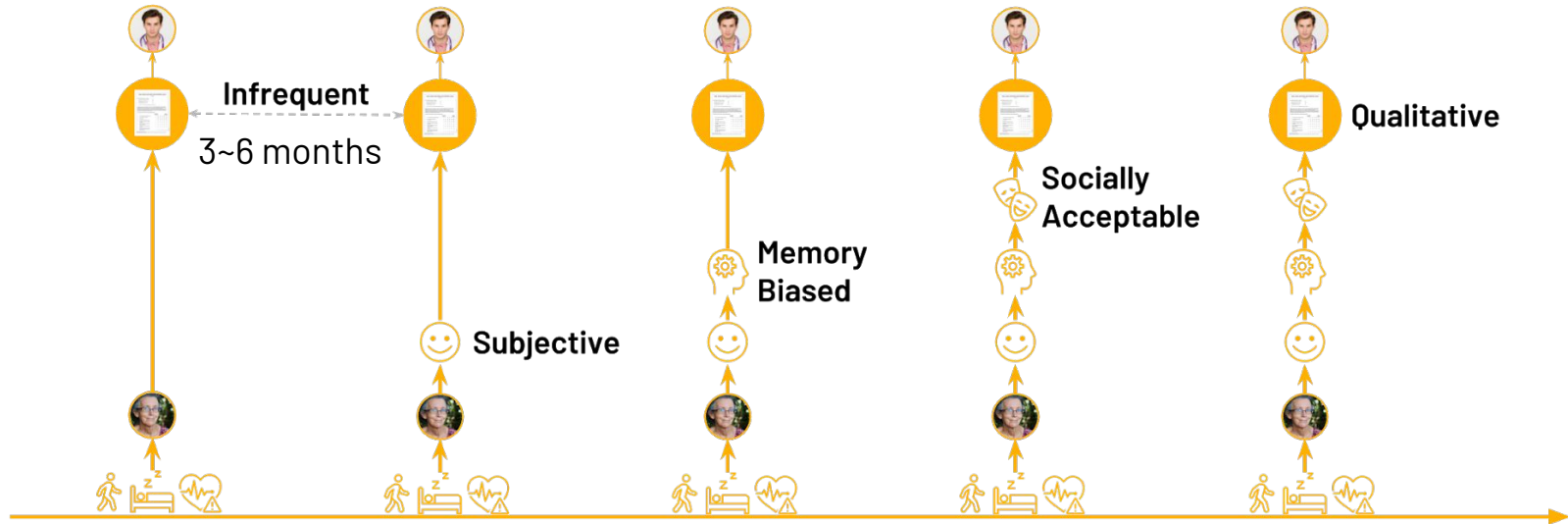
...

THE
LANCET **JAMA**

Naghavi, M., Abajobir, A. A., Abbafati, C., Abbas, K. M., Abd-Allah, F., Abera, S. F., ... & Ahmadi, A. (2017). *Global, Regional, And National Age-Sex Specific Mortality For 264 Causes Of Death, 1980-2016: A Systematic Analysis For The Global Burden Of Disease Study 2016*. *The Lancet*, 390(10100), 1151-1210.

Mokdad, A. H., Marks, J. S., Stroup, D. F., & Gerberding, J. L. (2004). *Actual Causes of Death in the United States, 2000*. *Jama*, 291(10), 1238-1245.

PROs: Self-Reported Outcomes



**'Behaviour marker', 'Behaviome',
(  'Digital Biomarkers')**

***If you can't measure it,
you can't improve it.***



The Big Picture



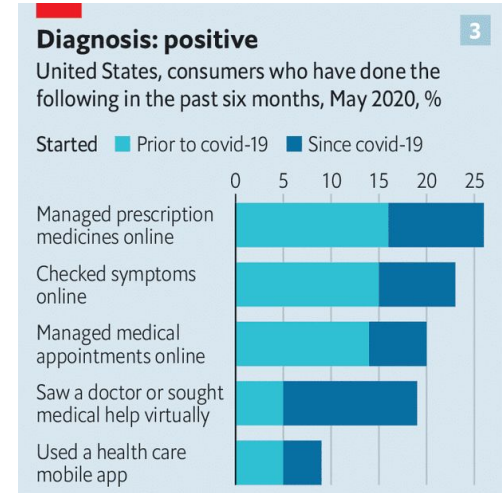
Smartphone

88%

of the time next to us



300'000+ health apps 200 added daily



Wearables

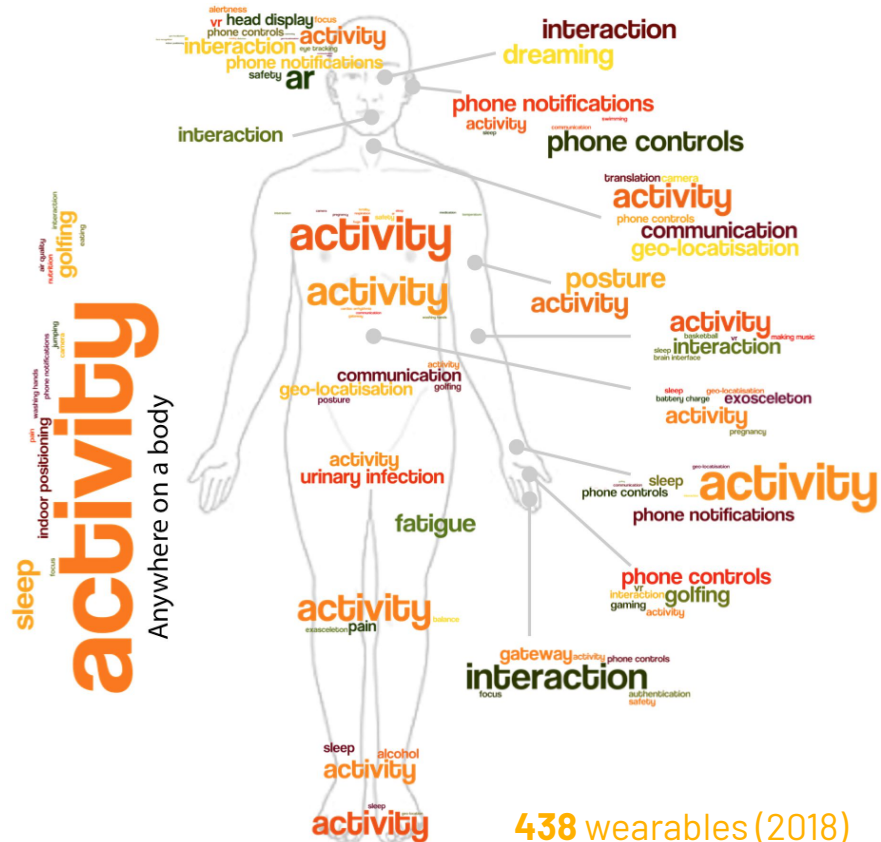
biomedicine
information technology
miniaturization (incl. battery)
wirelessness
mobility
connectivity



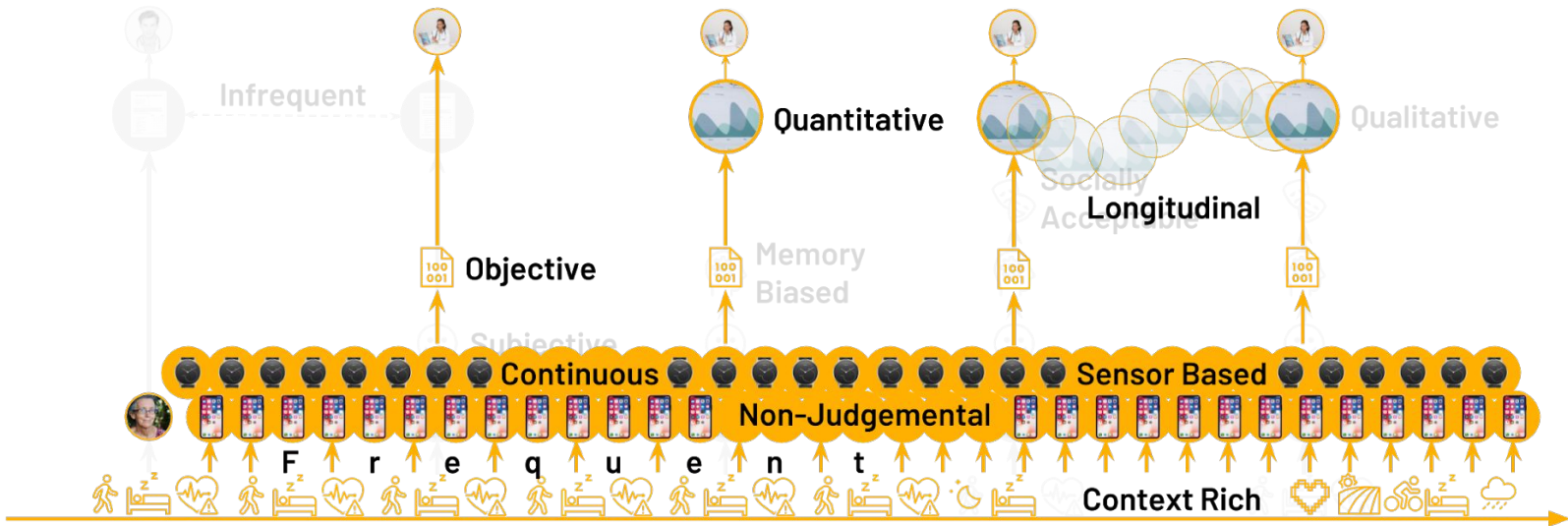
Wearables database vandrico.com/wearables.html (431 wearables as of 12.2.2021)

Wac, K. (2018). *From Quantified Self to Quality of Life*, Chapter in: Digital Health: Scaling Healthcare to the World, Series: Health Informatics, Springer Nature, Dordrecht, the Netherlands.

Annotated 438 wearables dataset doi.org/10.6084/m9.figshare.9702122



TechROs: 'Digital Biomarkers'



Patient Today



Patient Tomorrow = Primary Point of Care

Health care = personalized, predictive, preventative, participatory

Patient = expert in own health, equipped, enabled, engaged, empowered

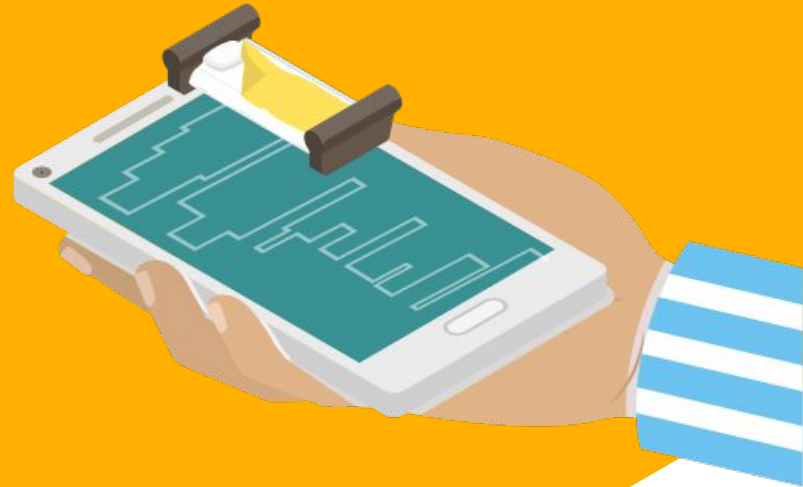


*team member
'augmented
reasoning'*



Algorithms

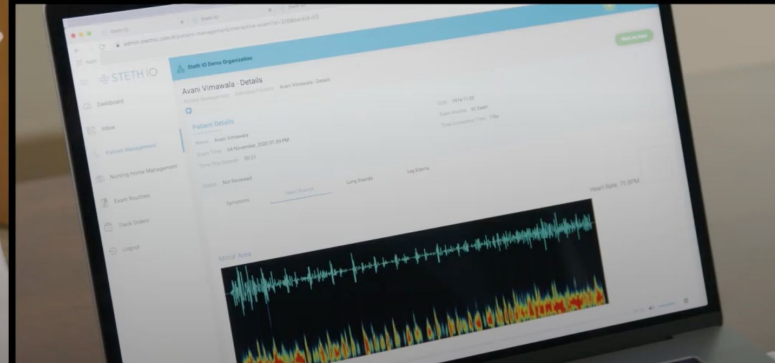
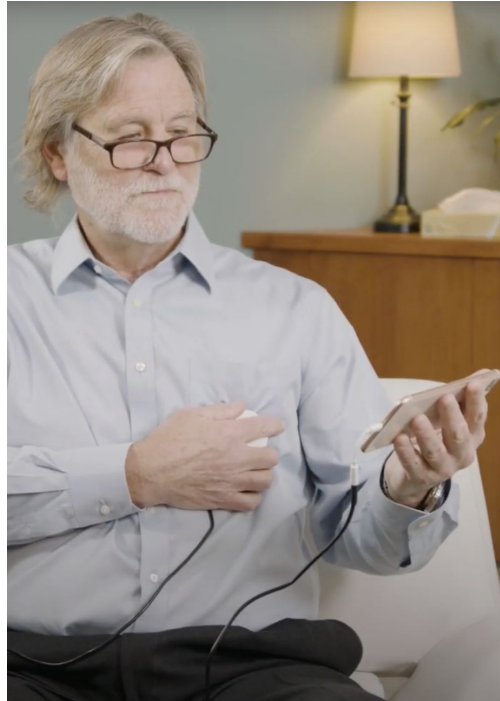
AI



2016: Digital Stethoscope (510(k))



AI: none
Symptoms/
Behaviours:
self-reported



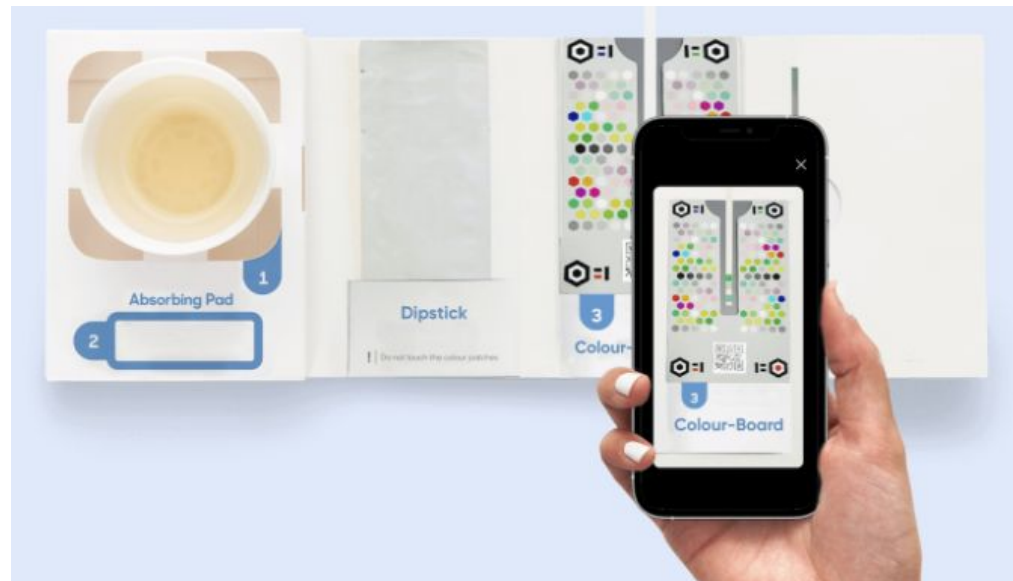
2019: ACR | LAB Urine Analysis Test (510(k))

AI-Assessment

ketones, leukocytes, nitrites, glucose, protein, blood, specific gravity, bilirubin, urobilinogen, pH

AI: computer vision for color matching

Symptoms/Behaviours: none



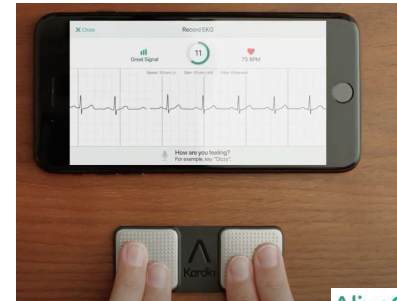
2012, 2014, 2017, ...: Cardiology (510(k))

AI-Assessment

- continuous ECG (RootiCare)
- atrial fibrillation (BodyGuardian, AliveCor 6-leads)
- physical activity

AI: detect AF episodes

Symptoms/Behaviours: self-reported



2019: Cardiac Ultrasound Imaging (de novo)



AI-Assessment

- cardiac sonographer skills

AI: computer vision for image acquisition and optimization, image analysis



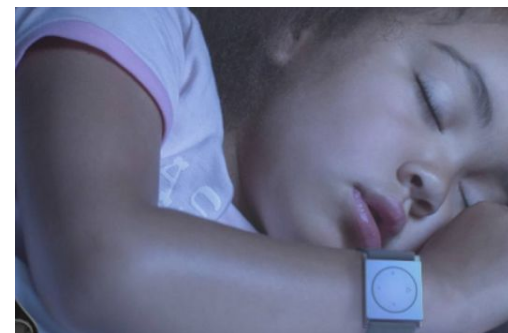
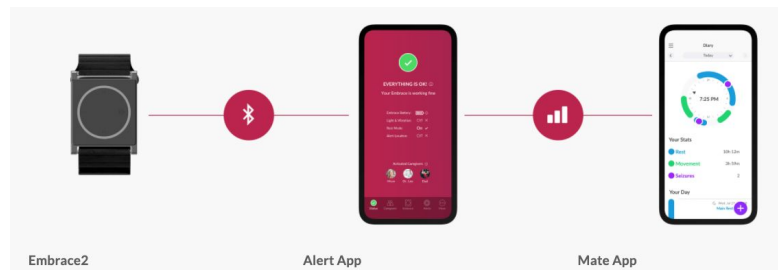
2018: Wearable for Seizure Monitoring (510(k))

AI-Assessment

- Electrodermal Activity (EDA)
- physical activity

AI: Detect tonic-clonic seizures

Symptoms/Behaviours: self-reported



Epilepsia

The Journal of the International League Against Epilepsy

2020: Gaming for Children with ADHD (de novo)

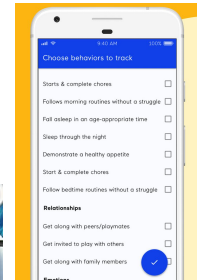
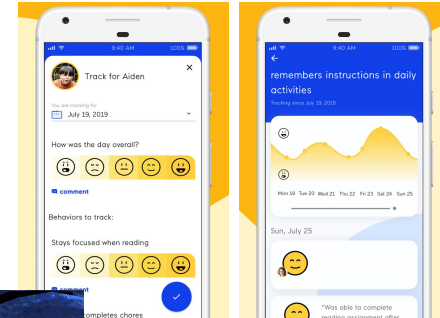
AI-Assessment

- attention
- movements, game insights (goals)

AI: Adapt interaction pattern

attention, impulsivity, working memory, goal management, spatial navigation, memory, and planning and organization

Symptoms/Behaviours: self-reported



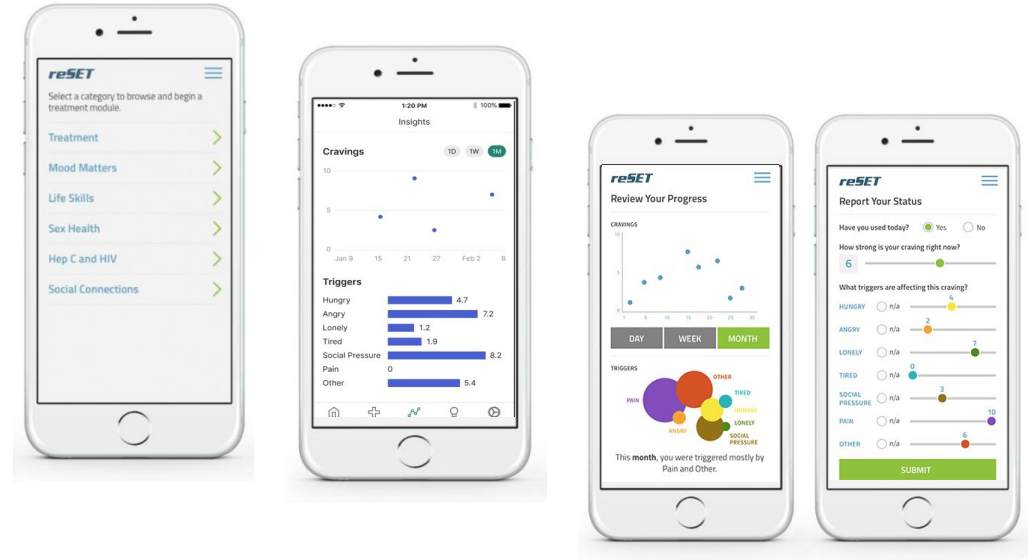
2019: Opioid Use Disorder (510(k))

AI-Assessment

- patterns of craving
- patterns of triggers

AI: none

Symptoms/Behaviours:
self-reported



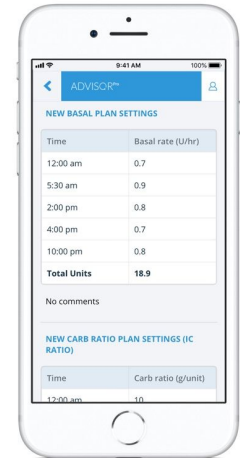
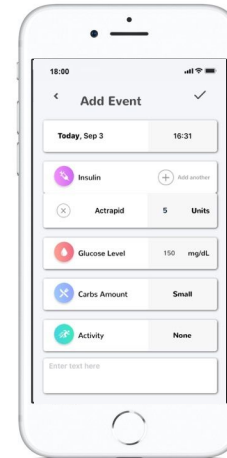
2018: Managing Type 1 Diabetes (de novo)

AI-Assessment: behavioural patterns

AI: insulin dose adjustment

every 3 weeks

Symptoms/Behaviours: self-reported
glucose and insulin, activity, carbs



Apps & Wearables

**Harvard
Business
Review**

Want to See the Future of Digital Health Tools? Look to Germany.

by Ariel D. Stern, Henrik Matthies, Julia Hagen, Jan B. Brönneke, and
Jörg F. Debatin

December 02, 2020

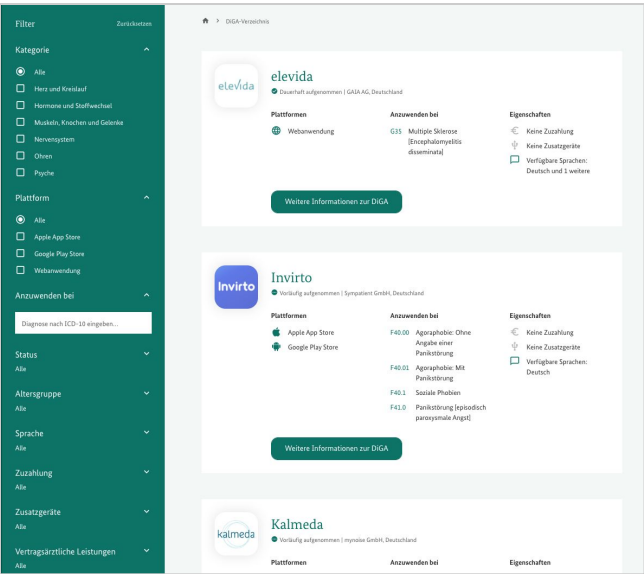


Nov 2019: Digital Healthcare Act (DVG: Digitale-Versorgung-Gesetz)

Digitalen Gesundheitsanwendungen (DiGA) Registry

Low Risk (class I or class IIa medical devices)

Evidence (12 m): safety, functionality, quality, data, protection/ security, care effect (SGB V, § (2): (i) medical benefit (i.e., therapeutic effect) or (ii) procedural/structural health care improvement



10 apps (17 Feb 2021)

7: provisionally approved

3: permanently approved

migraine mild depressive episode
 intracerebral hemorrhage
 cerebral transient ischemia and related syndromes non-organic insomnia
 other depressive episodes
 moderate depressive episode **panic disorder**
 obesity bilateral coxarthrosis due to dysplasia **social phobias**
agoraphobia with panic disorder
 agoraphobia without indication of panic disorder subarachnoid hemorrhage
episodic paroxysmal anxiety
 other primary coxarthrosis generalized anxiety disorder
 tinnitus aurium primary coxarthrosi bilaterale multiple sclerosis

personalized adjustable diet exposure training
 personalized adjustable diet guideline-compliant procedures for migraine prophylaxis
 personalized motivational and knowledge coaching **personalized adjustable exercises** cognitive behavioural therapy for insomnia
 digital headache diary **cognitive behavioural therapy**



M-sense Migräne: Migraine (provisional)

AI-Assessment

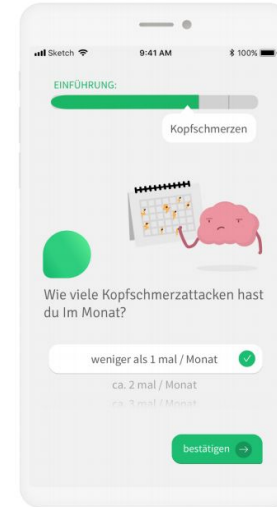
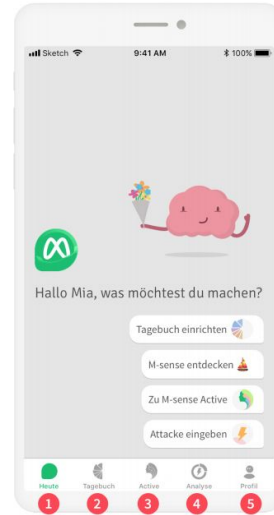
behavioural patterns

AI: attack classification

Symptoms/Behaviours:

self-reported attacks

Use: as needed, for life (?)



Rehappy: Aftercare of Stroke Patients (provisional)

AI-Assessment

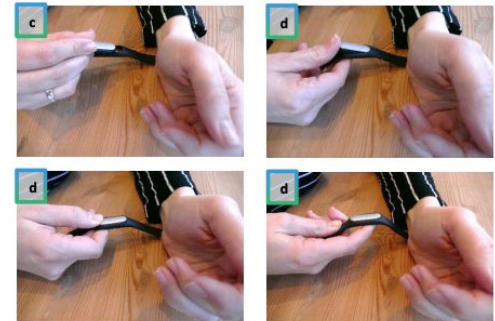
behavioural patterns incl. rehabilitation

AI: none

Symptoms/Behaviours:

self-reported + wearable

Use: 12 weeks



Zanadio: Obesity (provisional)

AI-Assessment
behavioural patterns

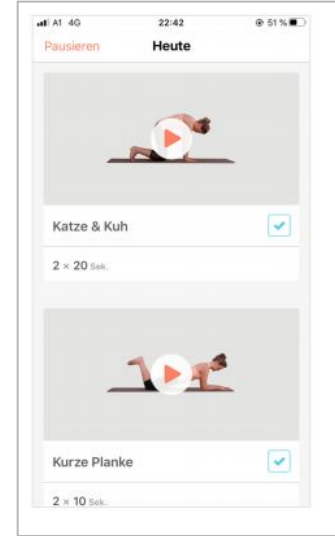
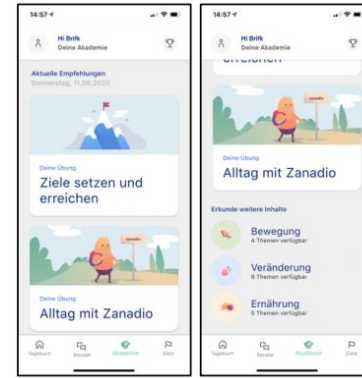
AI: none

Symptoms/Behaviours:
self-reported exercise and diet
wearable, smart scale

Use: as needed, for life (?)



Withings Body
Pulse HR Band



Invirto: Anxiety, Panic Disorder, Social Phobia

(provisional)

Cognitive Behavioural Therapy

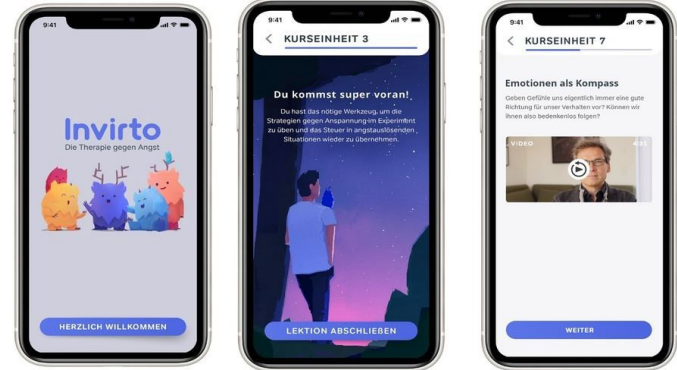
Exposure Therapy

AI-Assessment: none

AI: none

Symptoms/Behaviours: self-reported

Use: 8 weeks



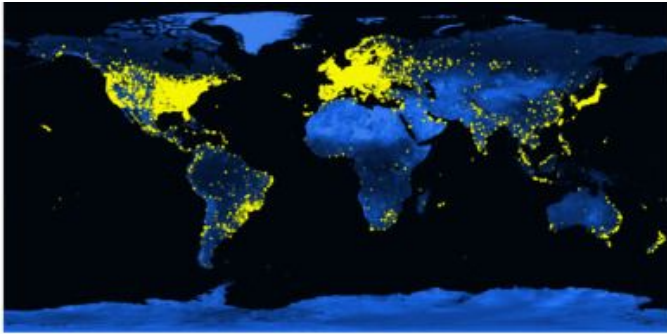
Crowdsourcing Data

*'Together,
we are
powerful'*



2000: Help to Find a Vaccine

Aggregated, crowdsourced synchronized computational resources
Running simulations to find potential drug candidates
For cancer, ALS, Parkinson's, COVID-19, ...



Progress on the current COVID Moonshot sprint to assess potential drugs
Sprint 5½ : Started Sun Jan 24 00:00:00 UTC 2021

96.507%

2004: Find me a Treatment



750000+ patients with 2,800+ conditions are sharing about their symptoms and how they manage them.

Community treatment reports
Click on a treatment to see what patients have to say about side-effects, perceived effectiveness, advice, burden, dosages and cost

Prescription drugs

Treatment	Patients
Duloxetine	71948
Pregabalin	51466
Gabapentin	50237
Prednisone	40101
Sertraline	36365

See all 2134 prescription drugs

Over the counter drugs

Treatment	Patients
Ibuprofen	21648
Naproxen	21038
Aspirin	13214
Acetaminophen (Paracetamol)	8048
Cetirizine	4499

See all 659 over the counter drugs

Supplements

Treatment	Patients
Vitamin D	14954
Multivitamins	8550
Omega 3 Fish Oil	6779
Vitamin D3 (cholecalciferol)	5679
Calcium-Vitamin D	5379

See all 2648 supplements

Physical therapy

Treatment	Patients
Physical Therapy	10452
Massage Therapy	2638
Occupational Therapy	2224
Speech / Language Therapy	1922
Pulmonary Rehabilitation	1706

See all 159 physical therapies

Equipment

Treatment	Patients
Walking Stick/Cane	9606
Walker	5191
Therapeutic brace	4335
Motorized scooter/chair	2828
Wheelchair (manual)	2700

See all 601 equipment

Procedures

Treatment	Patients
Radiation Ther...	6000
MRI (magnetic...	5000
CT Scan (comp...	4000
Neuromuscular Stimulation	3000
Acupuncture	2000

See all 652 pro...

Lifestyle modifications

Treatment	Patients
Handicap/Disability Parking Permit	2721

Psychotherapy

Treatment	Patients
Individual Therapy	49869

Exercises

Treatment	Patients
Physical Exercis...	1000

JOURNAL OF MEDICAL INTERNET RESEARCH

James et al

Original Paper

Characteristics, Symptom Severity, and Experiences of Patients Reporting Chronic Kidney Disease in the PatientsLikeMe Online Health Community: Retrospective and Qualitative Study

Glen James¹, PhD; Elisabeth Nyman², MSc; Marcy Fitz-Randolph³, DO, MPH; Anna Niklasson², PhD; Katarina Hedman², PhD; Jonatan Hedberg², MSc; Eric T Witbrodt⁴, PharmD, MPH; Jennie Medina⁵, MPH, PhD; Carol Moreno Quinn¹, MD, PhD; Alaster M Allum¹, MBBS, BA, DipSI; Cathy Emmas¹, PhD

¹AstraZeneca, Cambridge, United Kingdom
²AstraZeneca, Gothenburg, Sweden
³PatientsLikeMe, Inc, Cambridge, MA, United States
⁴AstraZeneca, Gaithersburg, MD, United States
⁵AstraZeneca, Luton, United Kingdom

Borenstein et al. *BMC Psychiatry* (2020) 20:384
<https://doi.org/10.1186/s12888-020-02758-y>

BMC Psychiatry

RESEARCH ARTICLE Open Access

Patient-reported outcomes in major depressive disorder with suicidal ideation: a real-world data analysis using PatientsLikeMe platform

Stephane Borenstein¹, Abigail I. Nash², Rachna Dayal¹ and Allitia DiBernardo¹

Rheumatol Ther (2020) 7:201–213
<https://doi.org/10.1007/s40744-020-00195-7>

ORIGINAL RESEARCH

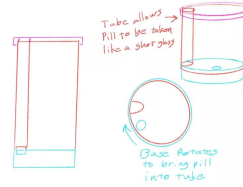
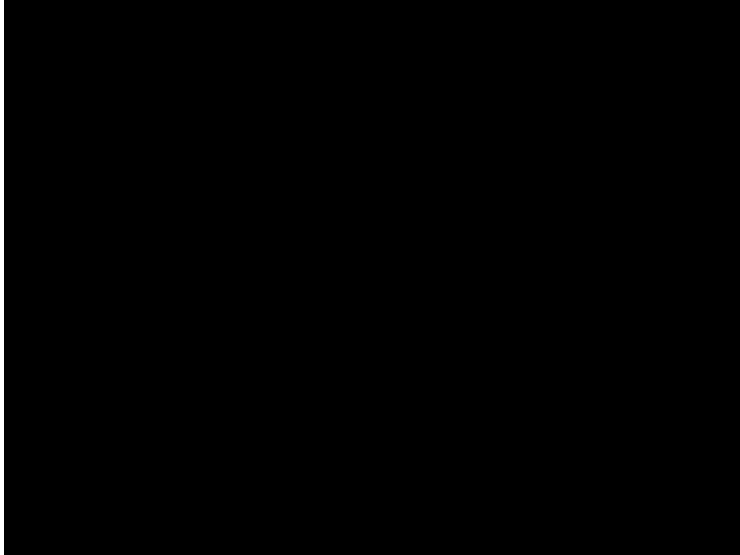
Characteristics and Symptom Severity of Patients Reporting Systemic Lupus Erythematosus in the PatientsLikeMe Online Health Community: A Retrospective Observational Study

Elisabeth Nyman · Timothy Vaughan · Barnabas Desta · Xia Wang · Volkan Barut · Cathy Emmas



2021: Design for My Needs

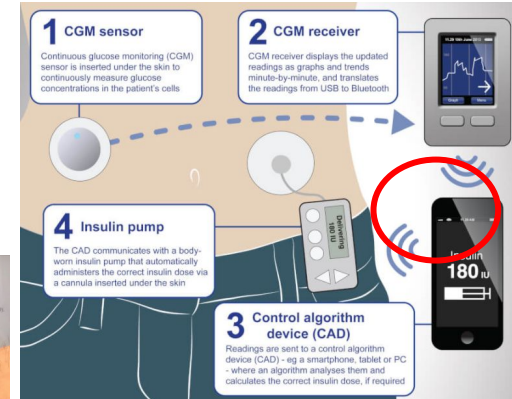
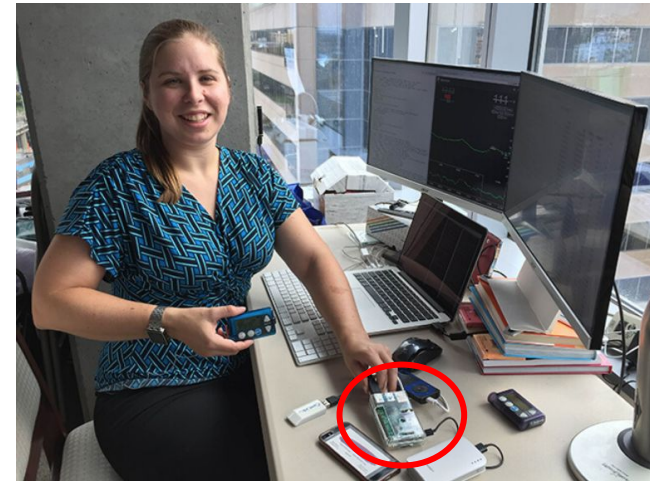
Young Onset Parkinson's disease: Jimmy Choi (44, since 27)



2015: Extreme DIY Treatment

T1DM: Dana Lewis (since age of 14)

- 2015: Open Artificial Pancreas System
 - Feb 2021: 2211 active users
- FDA Approvals & Actions
 - 2016: Artificial pancreas (Medtronic)
 - 2018: FDA Premarket approval (PMA)
 - Guardian Connect System^(R)
 - AI: predicting glucose 60 min ahead
 - 2019: Patient Engagement Advisory Committee



Human Factors

What about
the patient?



Human Factors

'I just want my life back' (S111)



What is your current experience of Quality of Life?



What applications do you use, that support your Quality of Life?



Human Factors

Q: Do you use technologies (smartphone/wearable) for your own health/care?

I don't!

I don't mix my smartphone with my health [visibly angry]
It's all in here [indicating own head]
I do not want a phone reminds me about my disease
I have got a [fitbit as a] gift and I dropped it

I would...

Privacy is an issue
It's complicated, I don't know how to use it, I am not a techie
It's inaccurate: I have compared [fitbit] to my husband's Garmin
and I was disappointed" [and have dropped it]

Study details

N = 200 participants (US)

Affinity clustering of significant factors

I do...



Interface design

Too complex!
Passwords
Notifications



Performance

Slow!
No sync
Malfunctioning
Internet is touchy



Battery

Too short
Carry 2 batteries
Walked for free!



Social Sharing

I have enough people
judging me offline
Doctor won't trust it



Accuracy

Not a medical accuracy
Accurate enough to
recognize my efforts



Emotions

Keeps me entertained
I hate it when gained weight
I get addicted



Cost

Smartphone is a basis
Wearables: Too Costly!



Self-Efficacy

I like to see my progress
I try harder
I can always walk tomorrow



Routines

For me when I need it
Non-routine events most
critical

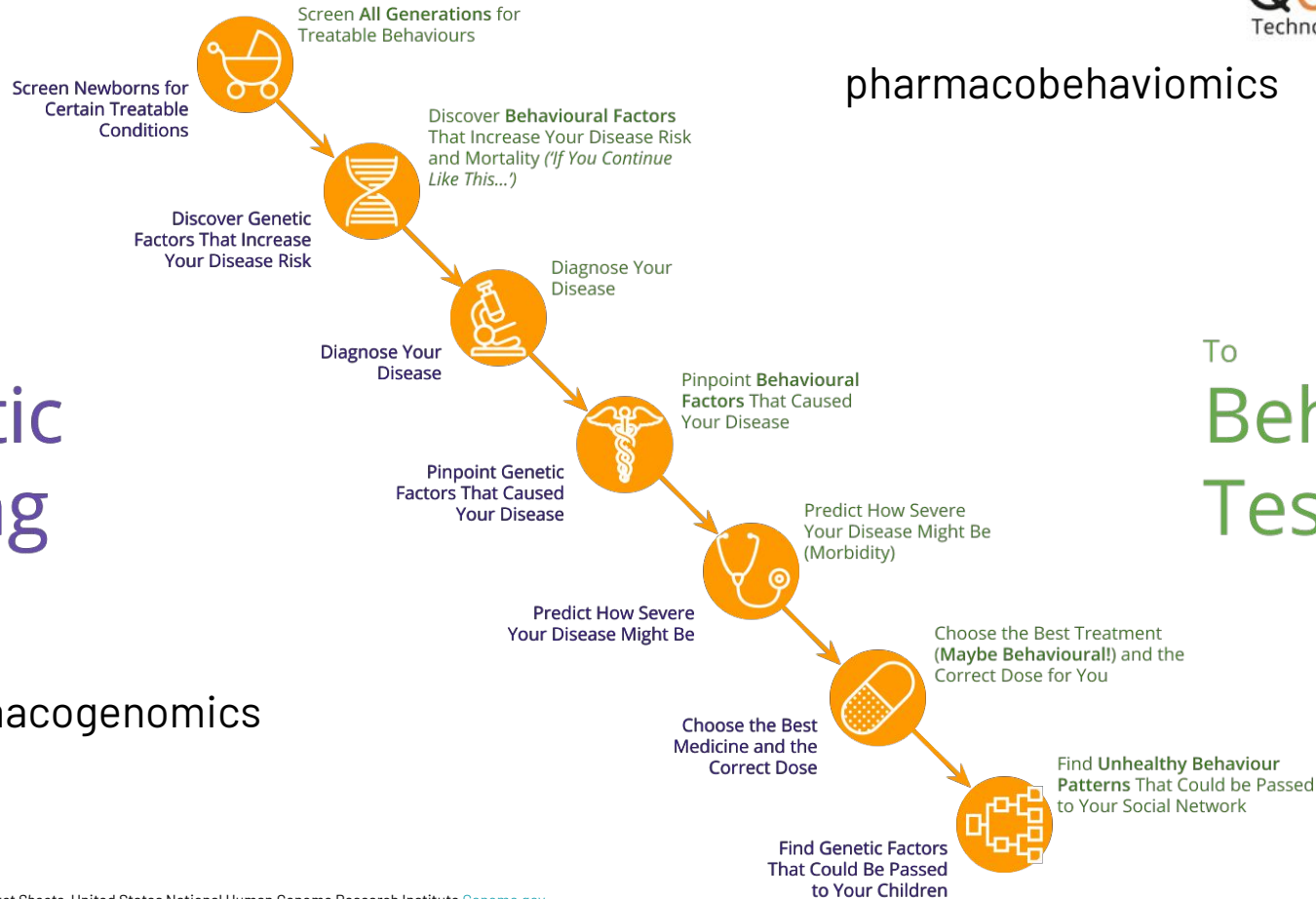


Back to

The Big Picture



pharmacobehaviomics



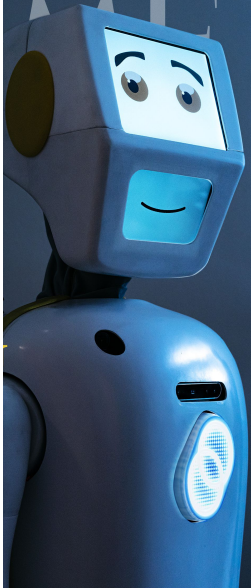
From
**Genetic
Testing**

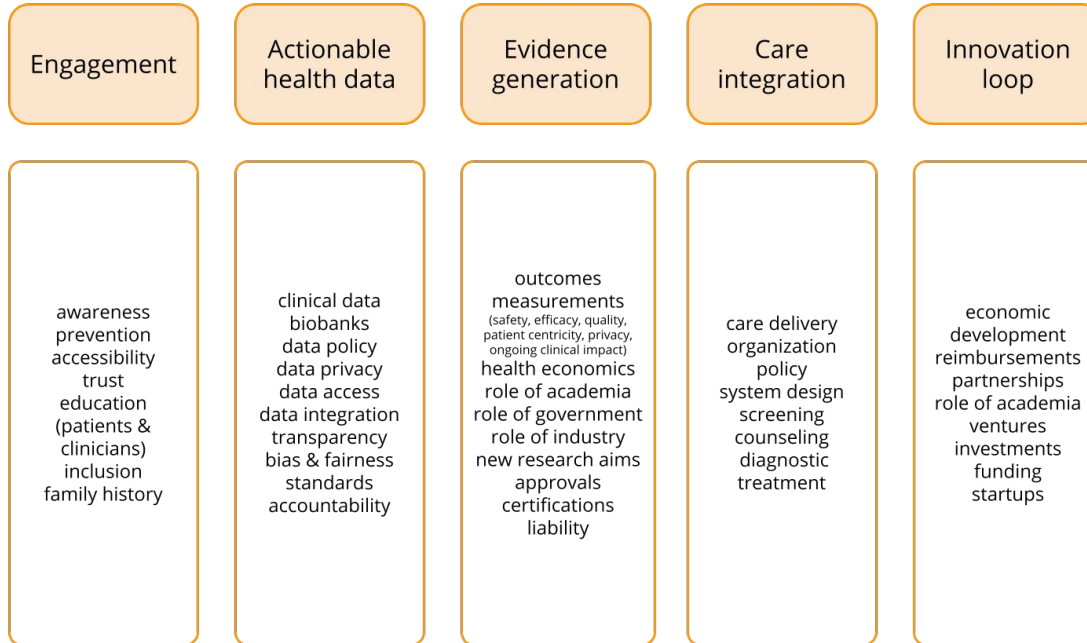
To
**Behaviour
Testing**

pharmacogenomics



Computer is getting ready to assist,
are we ready?





Foundational elements (enablers):
health systems; insurance / financial models; inclusion; regulatory / government oversight; IT infrastructure; general infrastructure; social determinants

Back to

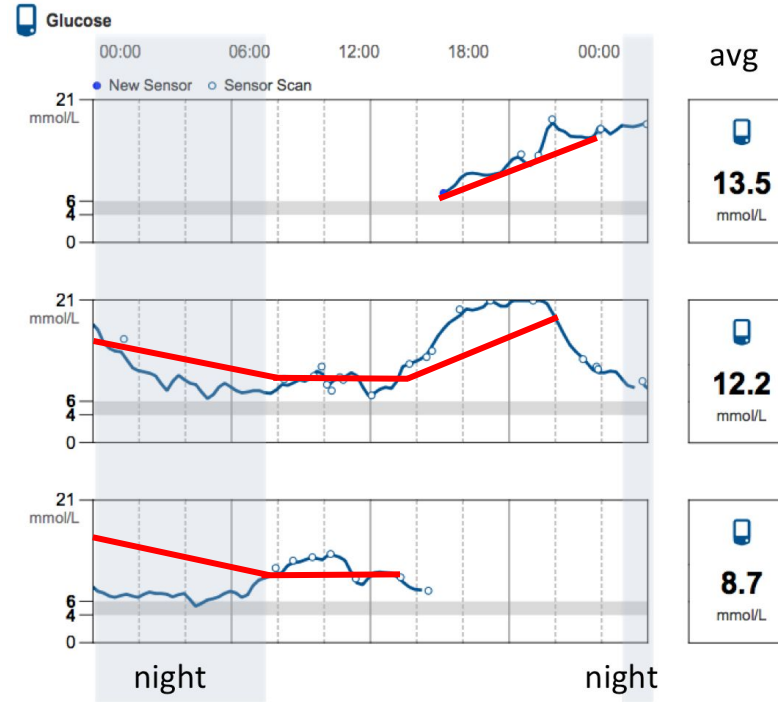
The Small Picture



What about my Mom?



Freestyle Libre



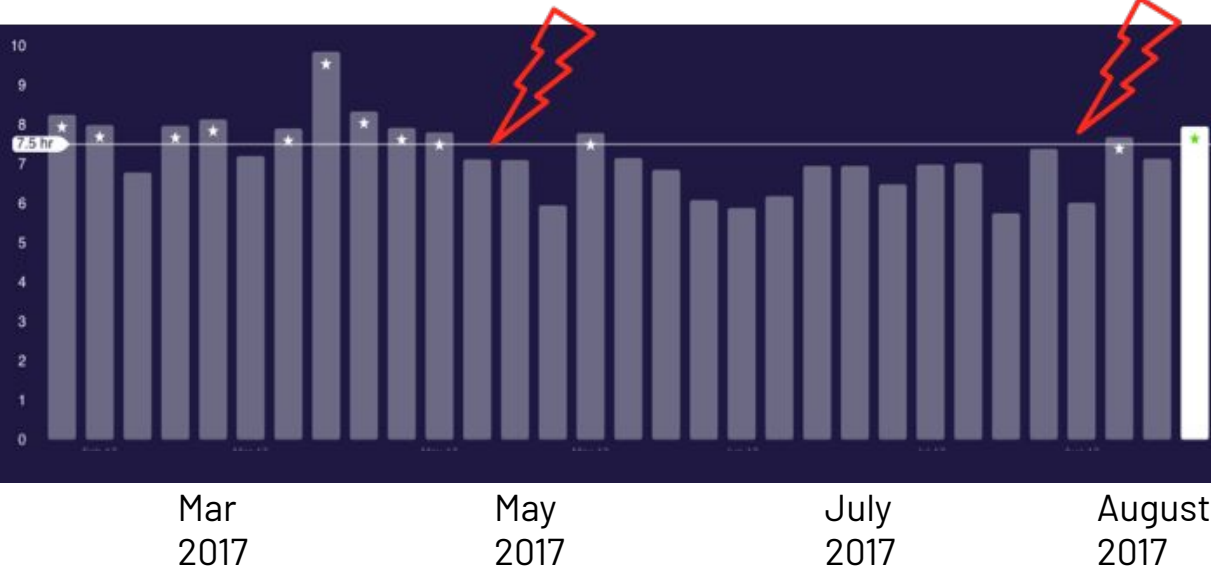
Red: infrequent finger pricks, 3 / day

What about my Mom?

New medication → worse sleep...



Change back to old meds



Exponential Technologies

'Take Home' Messages

Change patients (4E)

- experts in own health, equipped, enabled, engaged, empowered

Change health care (4P)

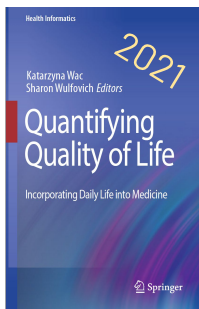
- personalized, predictive, preventative, participatory

Challenges are numerous, 'systemic' approach is needed

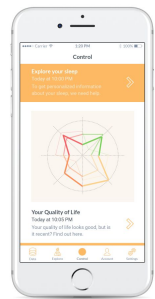
Future focus: behaviome & digital biomarkers



Quality of Life Technologies Lab
www.qol.unige.ch



Thank You



Prof. Katarzyna Wac and the QoL Team

Quality of Life, Center for Informatics, University of Geneva, Switzerland

katarzyna.wac@unige.ch

Images: unsplash.com and icons8.com

