Selected Topics Communications and Mobile Computing (Smart Health)

TU Graz

University of Notre Dame

Course Overview

- Instructor
  - Christian Poellabauer
  - cpoellab@nd.edu
  - Office location & hours:
    - TBD

Course Overview

- Time & Location
  - Mondays 10am-12pm
  - HS i4 (MDEG160G)

- Website: http://www3.nd.edu/~cpoellab/teaching/smarthealth

- Slides, papers, links, etc. will be posted in TU Graz online resources once I have access!

- Vorlesung + Uebung

Course Overview

- Student requirements
  - Reading assignments for each lecture; submit summary before lecture
    - If I can figure out online system, then we use that
    - Else: email to cpoellab@nd.edu (Subject: Smart Health Assignment)
  - Select topic of your choice; 3-5 papers; written report (~5 pages) and brief presentation
    - Depending on class size, teams can be formed
      - Class size < 10: individual
      - Class size 10-19: up to 2 members per team
      - Class size 20+: up to 3 members per team
  - Brief final exam (in-class)

Course Overview

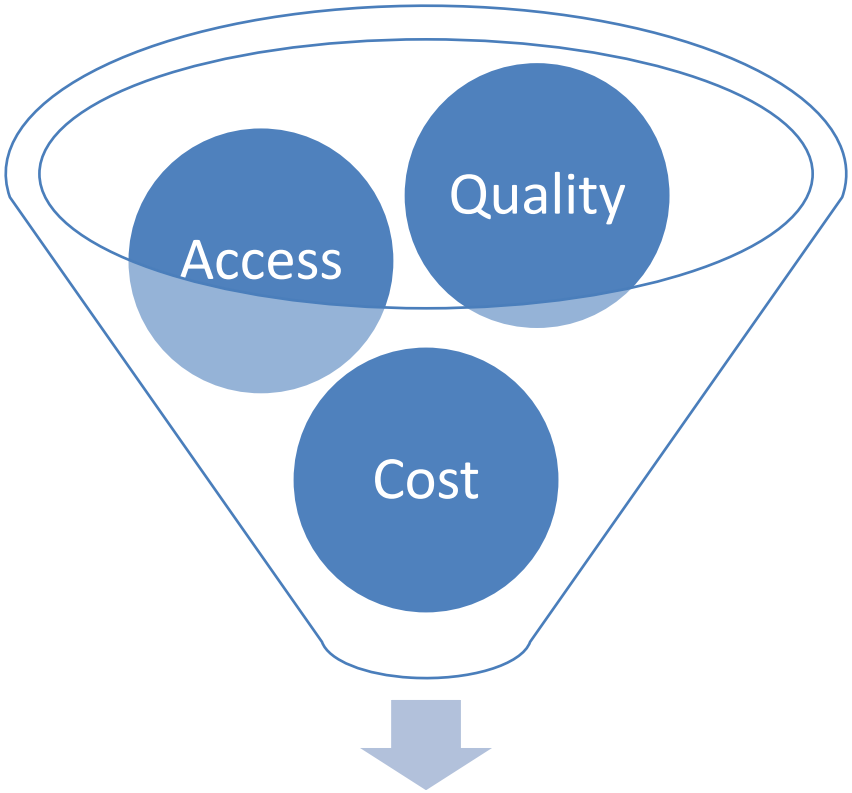
- Class dates (tentatively):
  - March 4, 11, 18, 25
  - April 1, 29
  - May 6, 13, 20
  - June 3, 17, **24**

Bloomberg Health Ranking

Bloomberg 2019 Healthiest Country Index

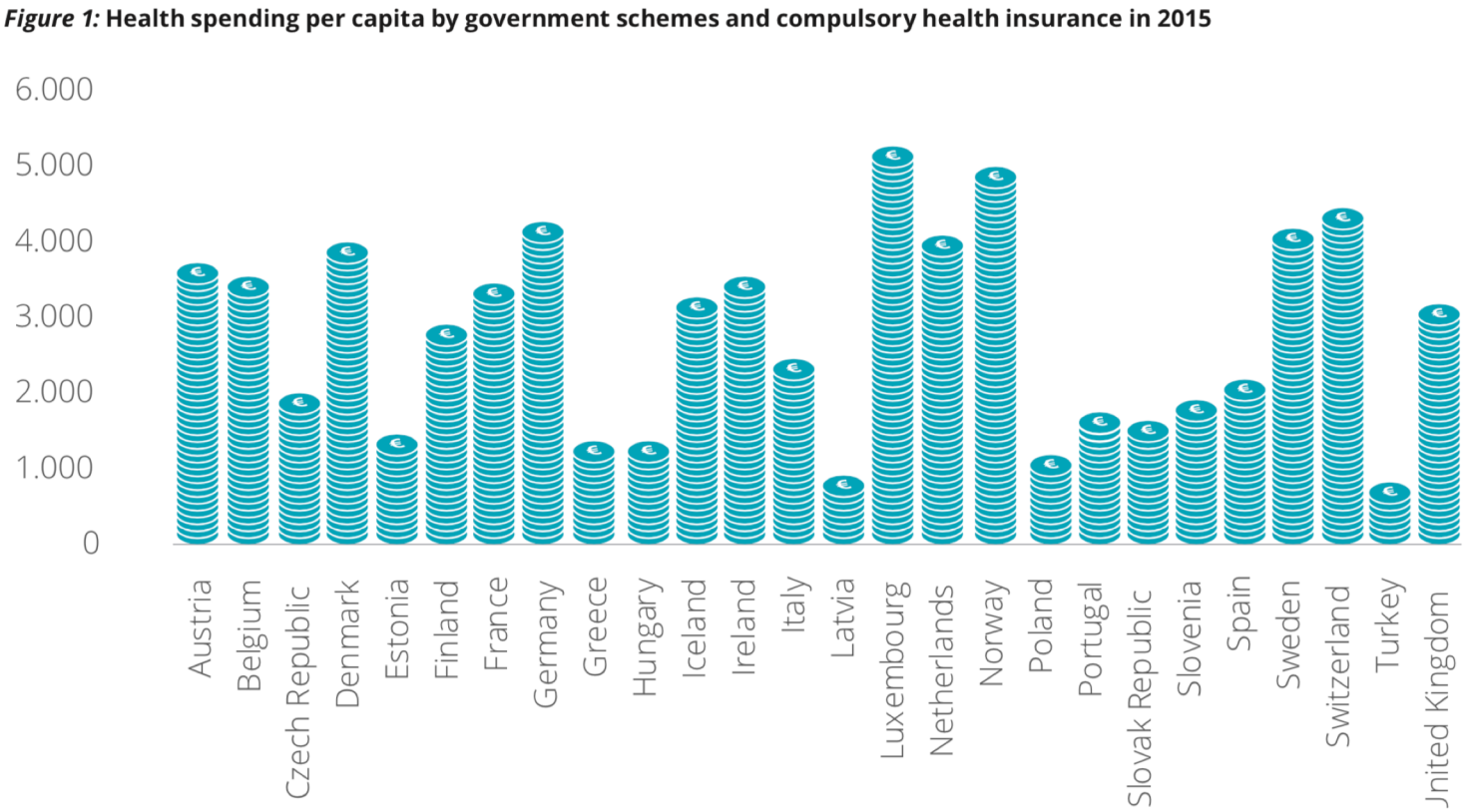
2019 Rank	2017 Rank	Change	Economy	Health Grade	Health Score	Health Risk Penalties
1	6	+5	Spain	**92.75**	96.56	-3.81
2	1	-1	Italy	**91.59**	95.83	-4.24
3	2	-1	Iceland	**91.44**	96.11	-4.67
4	7	+3	Japan	**91.38**	95.59	-4.21
5	3	-2	Switzerland	**90.93**	94.71	-3.78
6	8	+2	Sweden	**90.24**	94.13	-3.89
7	5	-2	Australia	**89.75**	93.96	-4.21
8	4	-4	Singapore	**89.29**	93.19	-3.90
9	11	+2	Norway	**89.09**	93.25	-4.16
10	9	-1	Israel	**88.15**	92.01	-3.86
11	10	-1	Luxembourg	**87.39**	92.03	-4.64
12	14	+2	France	**86.94**	91.70	-4.76
13	12	-1	Austria	**86.30**	90.81	-4.51
14	15	+1	Finland	**85.89**	90.18	-4.29
15	13	-2	Netherlands	**85.86**	90.07	-4.21
16	17	+1	Canada	**85.70**	90.31	-4.61
17	24	+7	S. Korea	**85.41**	89.48	-4.07
18	19	+1	New Zealand	**85.06**	89.68	-4.62
19	23	+4	U.K.	**84.28**	88.74	-4.46
20	22	+2	Ireland	**84.06**	89.57	-5.51

Goals of Healthcare Delivery System



(Often) competing goals

Challenge/Goal: Cost



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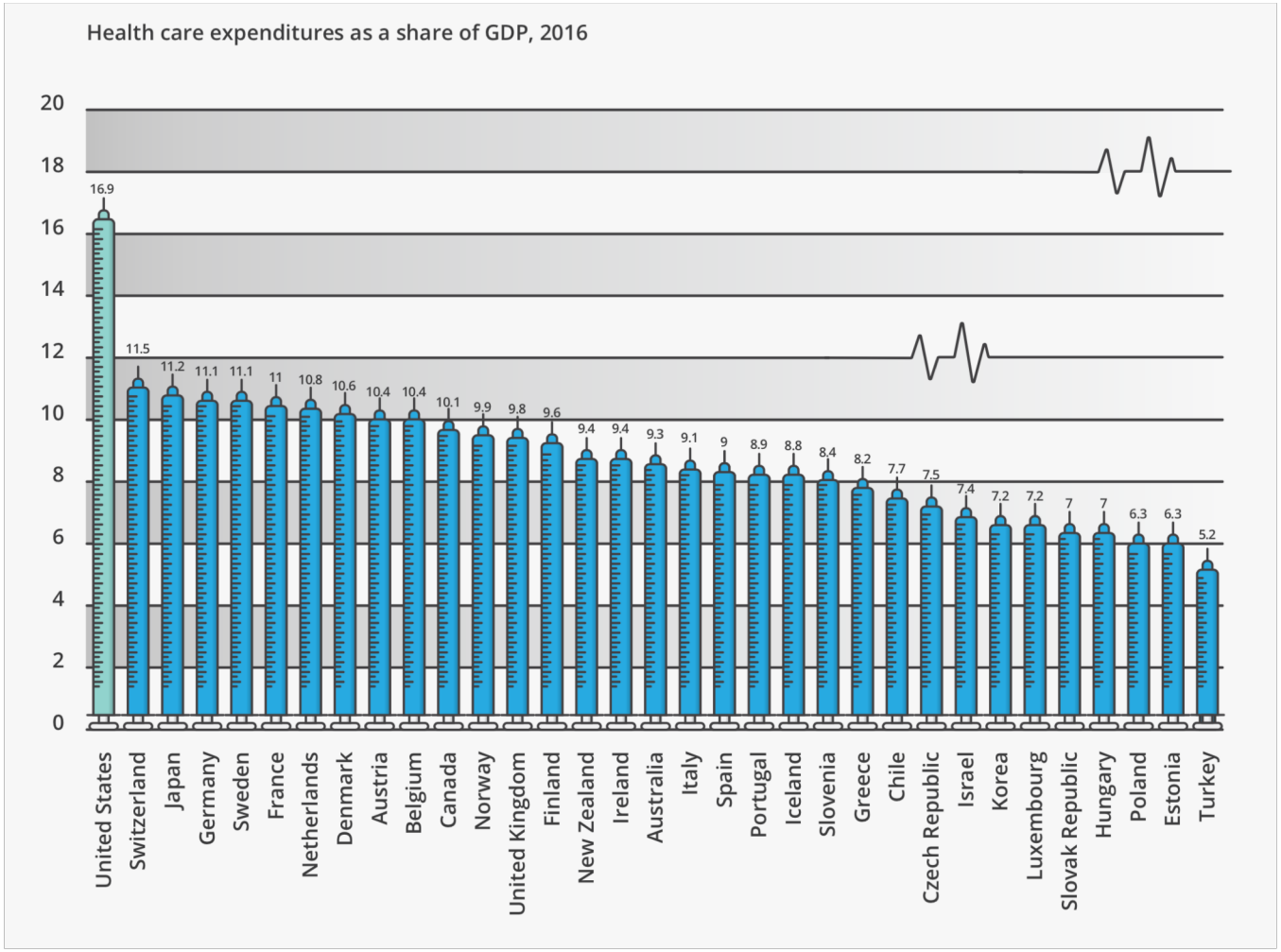

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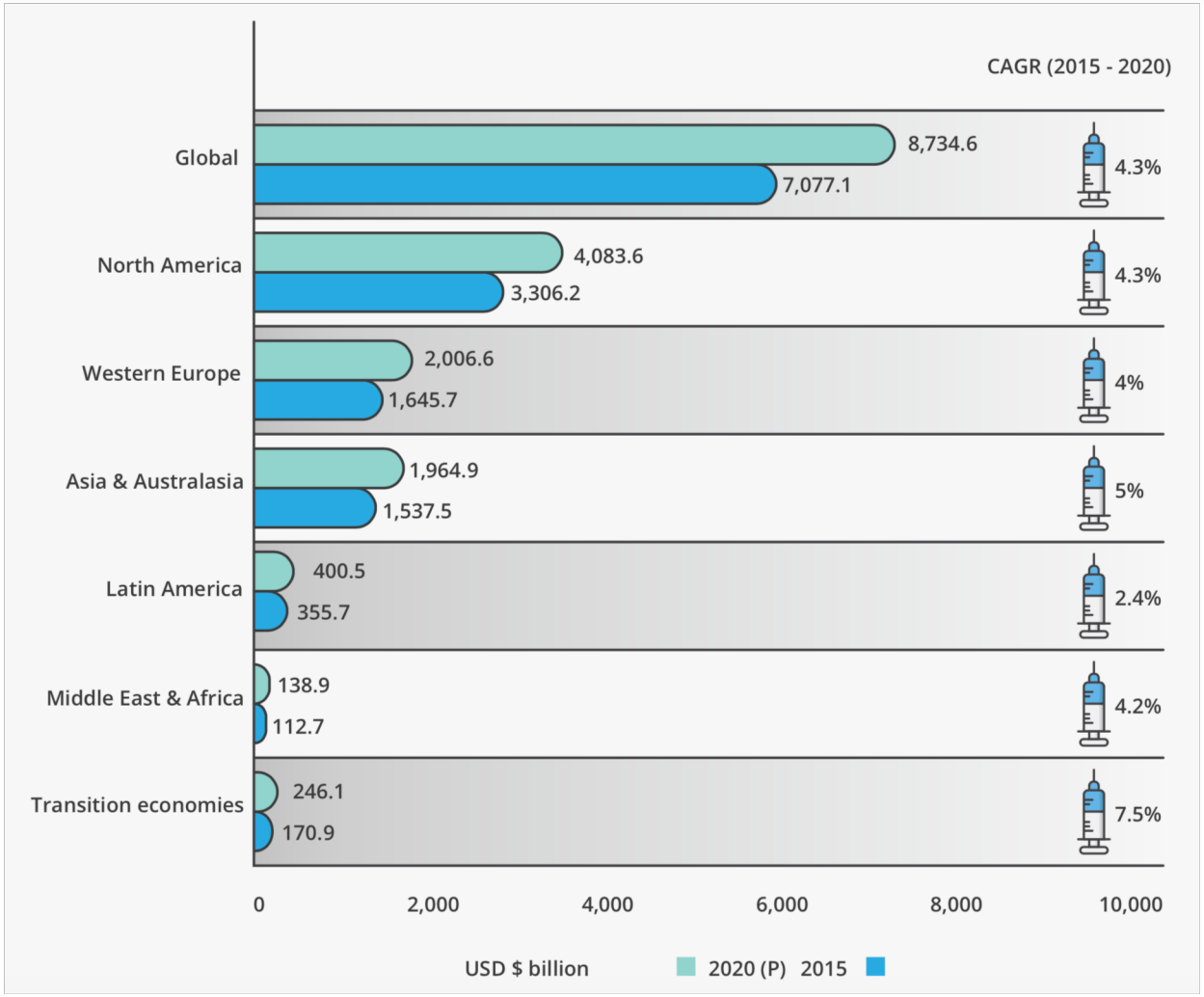
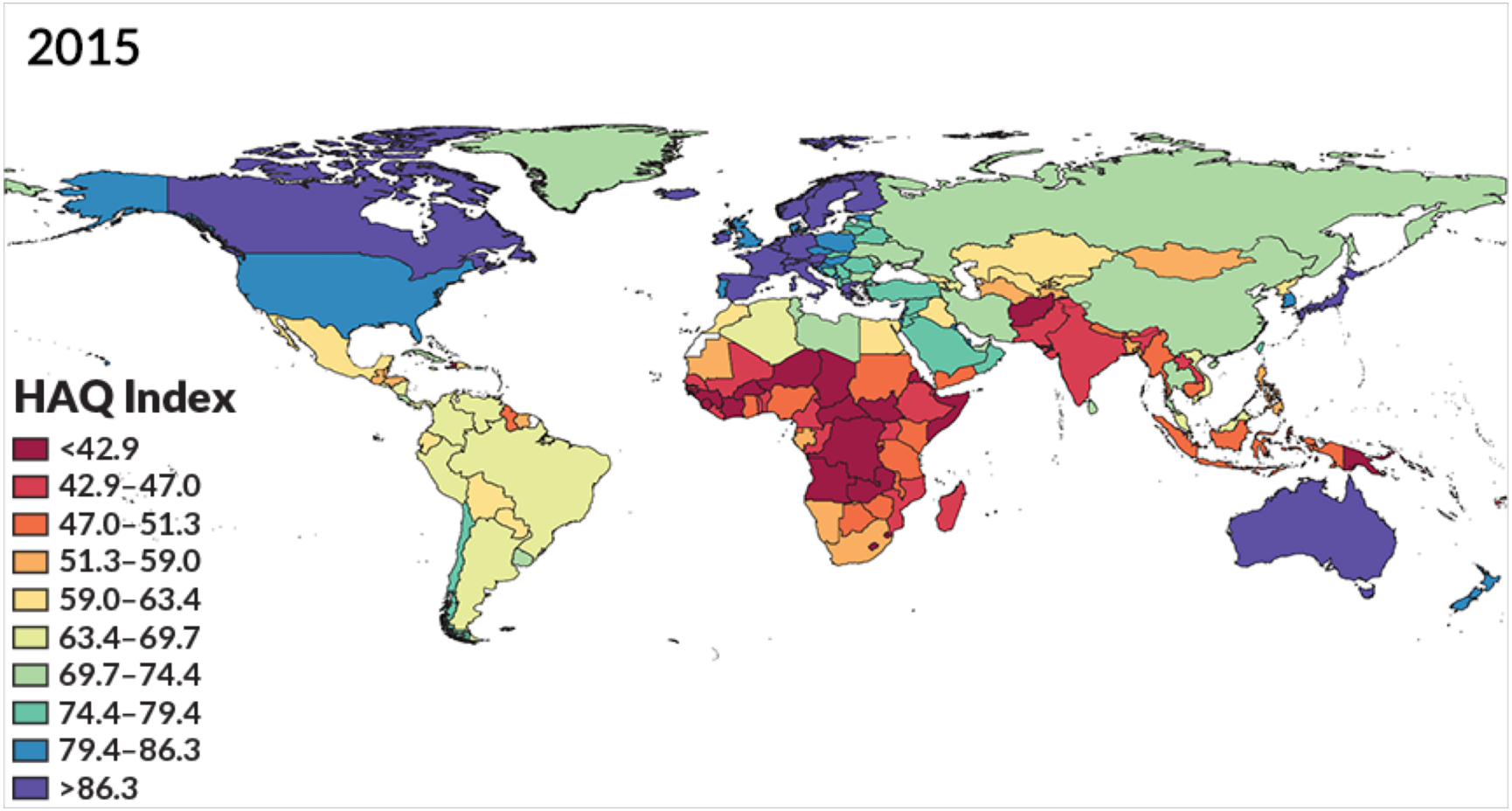


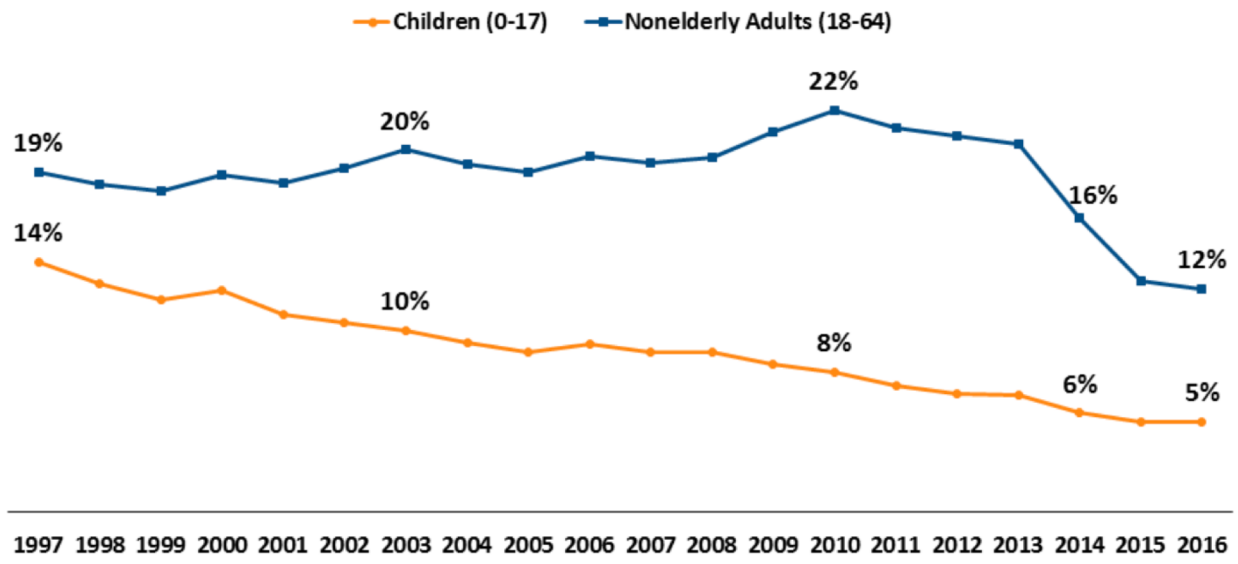
Challenge/Goal: Access



Challenge/Goal: Access

Figure 1

Uninsured Rates Among Nonelderly Adults and Children, 1997-2016

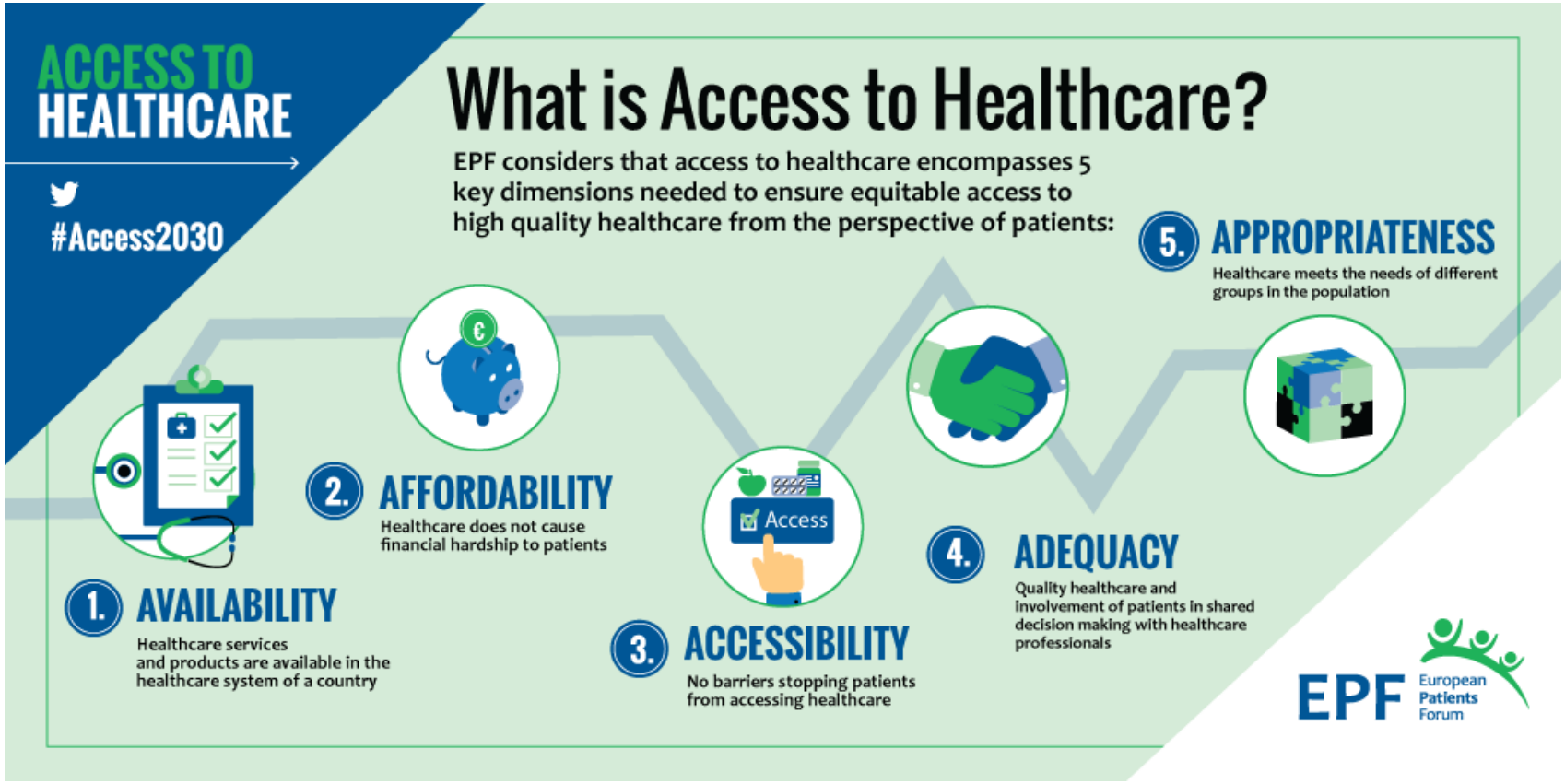


NOTE: Children includes all individuals under age 18. Uninsured rates for 2016 are as of June 2016.
SOURCE: Brian W Ward, Tainya C Clarke and Jeannine S Schliler, *Early Release of Selected Estimates Based on Data form the January-June 2016 National Health Interview Survey*, (Atlanta, GA: National Center for Health Statistics, CDC, November 2016), https://www.cdc.gov/nchs/data/nhis/earlyrelease/earlyrelease201611.pdf.

THE HENRY J. KAISER FAMILY FOUNDATION

Figure 1: Uninsured Rates Among Nonelderly Adults and Children, 1997-2016

Challenge/Goal: Access



Challenge/Goal: Quality

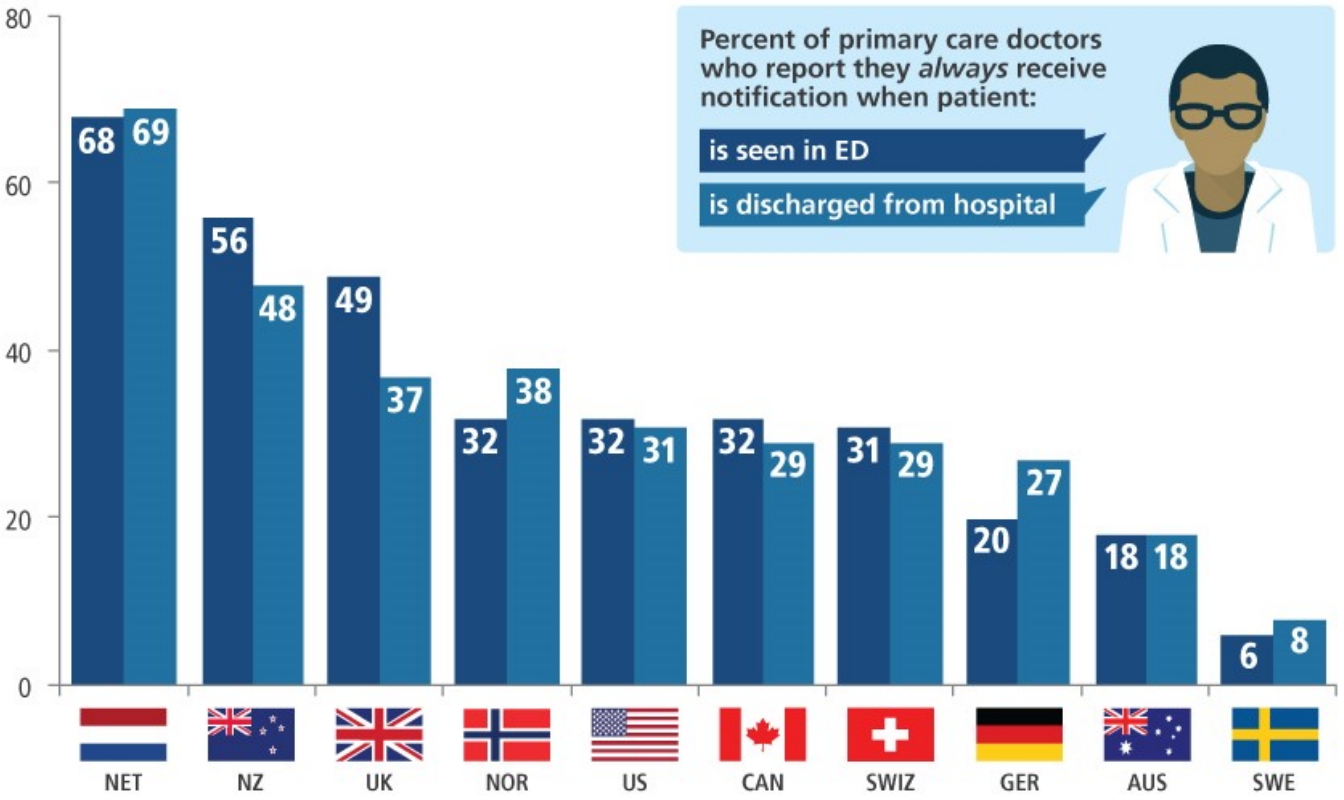
Overall Score 64%

"D"

Challenge/Goal: Quality

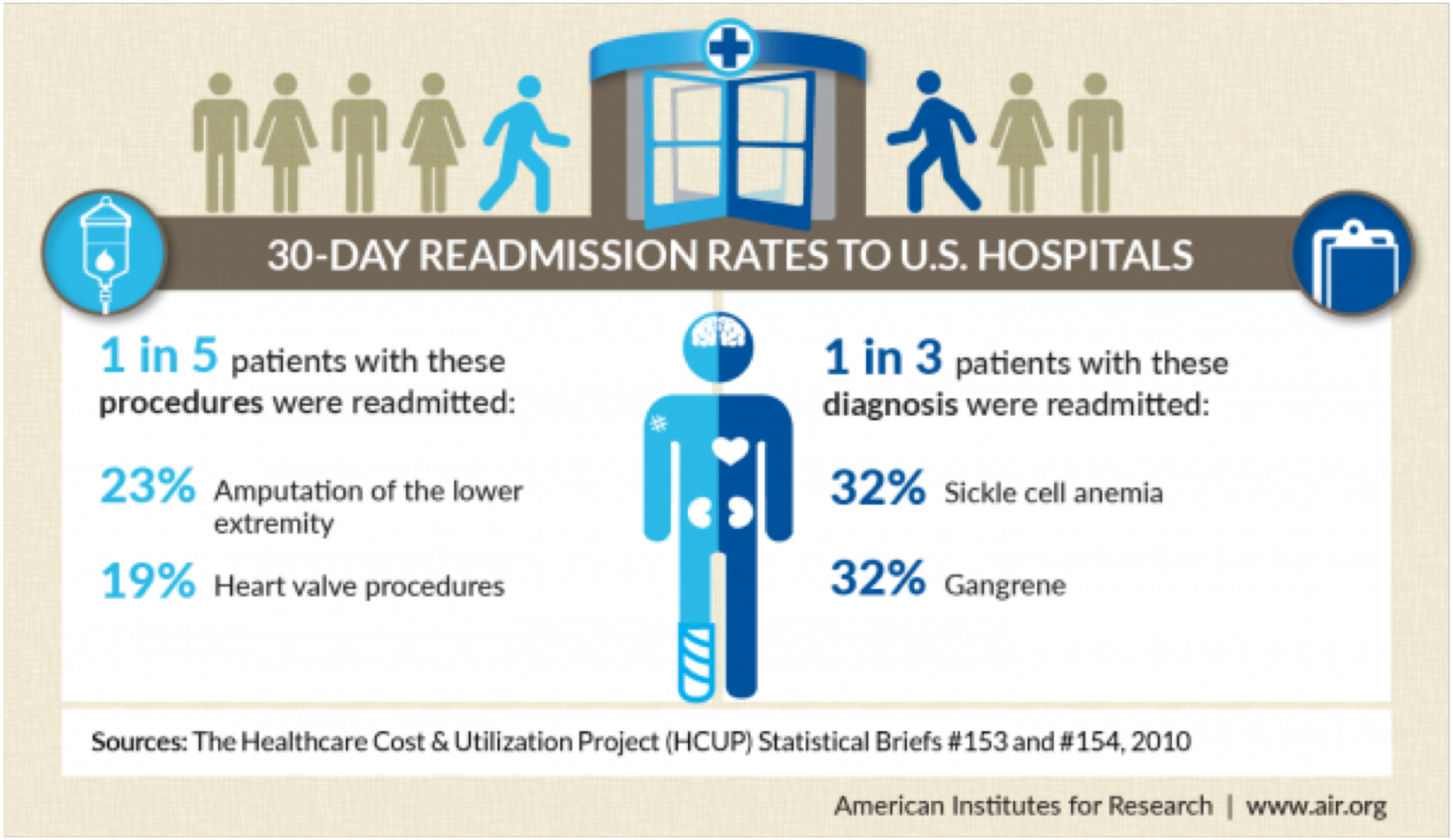
All Nations Face Challenges Coordinating Care

Doctors in every country in a 10-nation survey reported that their practices struggled to coordinate care and communicate with other health providers, which is key to managing patients with complex care needs.



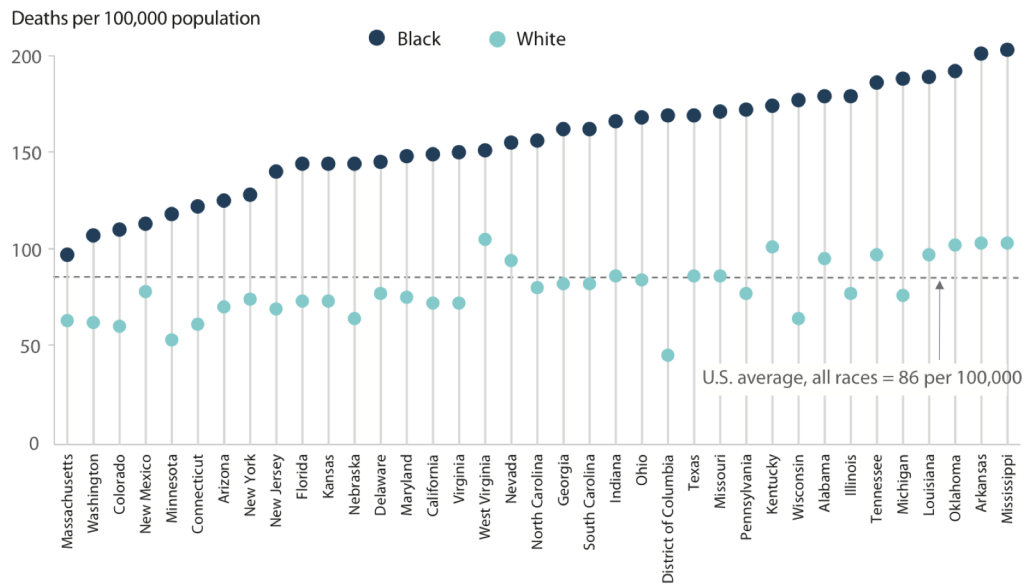
Source: 2015 Commonwealth Fund International Health Policy Survey of Primary Care Physicians.

Challenge/Goal: Quality



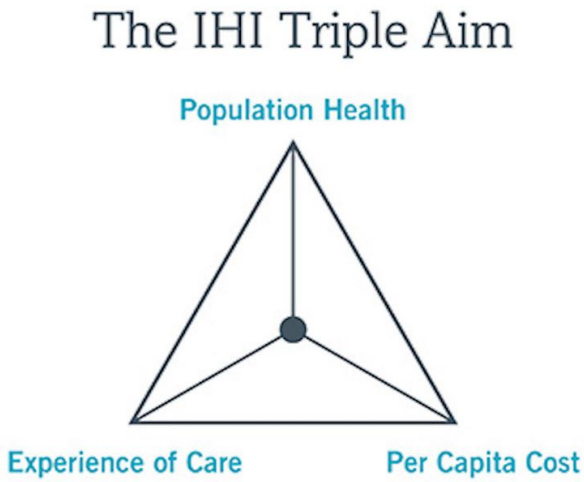
Other Challenges

- Disparities
- Malpractice
- Unnecessary Care
- Health Literacy
- Lack of collaboration
- Big data
- Cybersecurity



Notes: Data for Black population are not available for Alaska, Hawaii, Idaho, Iowa, Maine, Montana, New Hampshire, North Dakota, Oregon, Rhode Island, South Dakota, Utah, Vermont, or Wyoming. States are arranged in rank order based on black mortality.
Data: 2004–05 and 2009–10 National Vital Statistics System (NVSS) mortality all-county micro data files.
Source: Commonwealth Fund Scorecard on State Health System Performance, 2014.

The IHI Triple Aim



- Improve the **health** of the population
- Enhance the **patient experience** of care
- Reduce the **per capita cost** of care

A Patient-Centric Ecosystem

Informed

Involved

A Patient-Centric Ecosystem

- Patients are key stakeholders in their care journeys
- Update patients about their health at all times
- Educate patients ("health-literacy")

- "Loose weight" -> Coaching
  - Personalized information (which exercises might work best)
  - Technology (videos, apps)
  - Self-management (apps)

“eHealth”

- A relatively recent term for healthcare practice supported by **electronic processes and communication**, dating back to at least 1999

- **World Health Organization**: “*…eHealth is the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including healthcare services, health surveillance, health literature, and health education, knowledge and research…*”

- **European Commission**: *“…the use of modern information and communication technologies to meet needs of citizens, patients, healthcare professionals, healthcare providers, and policymakers…”*

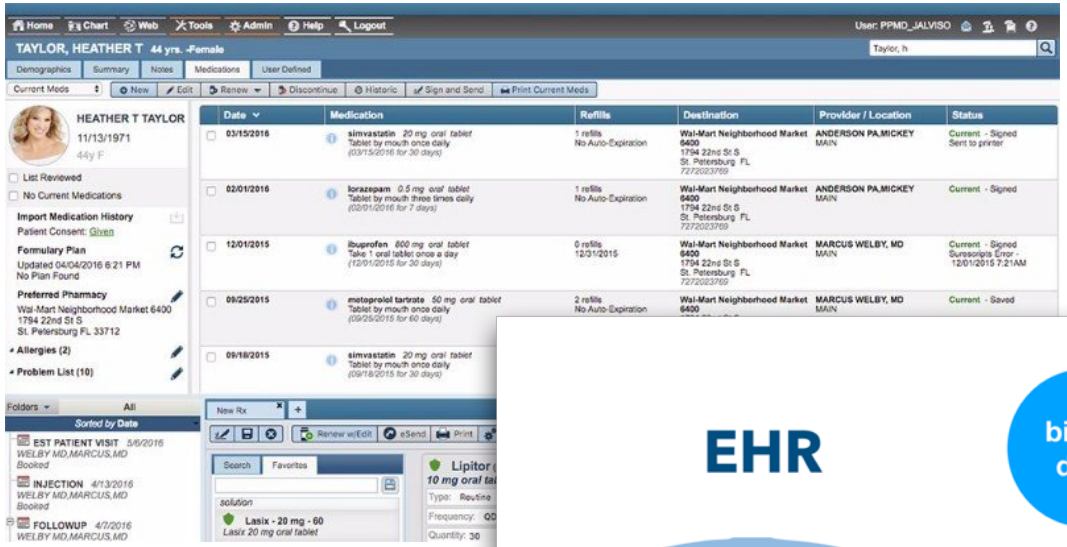
eHealth

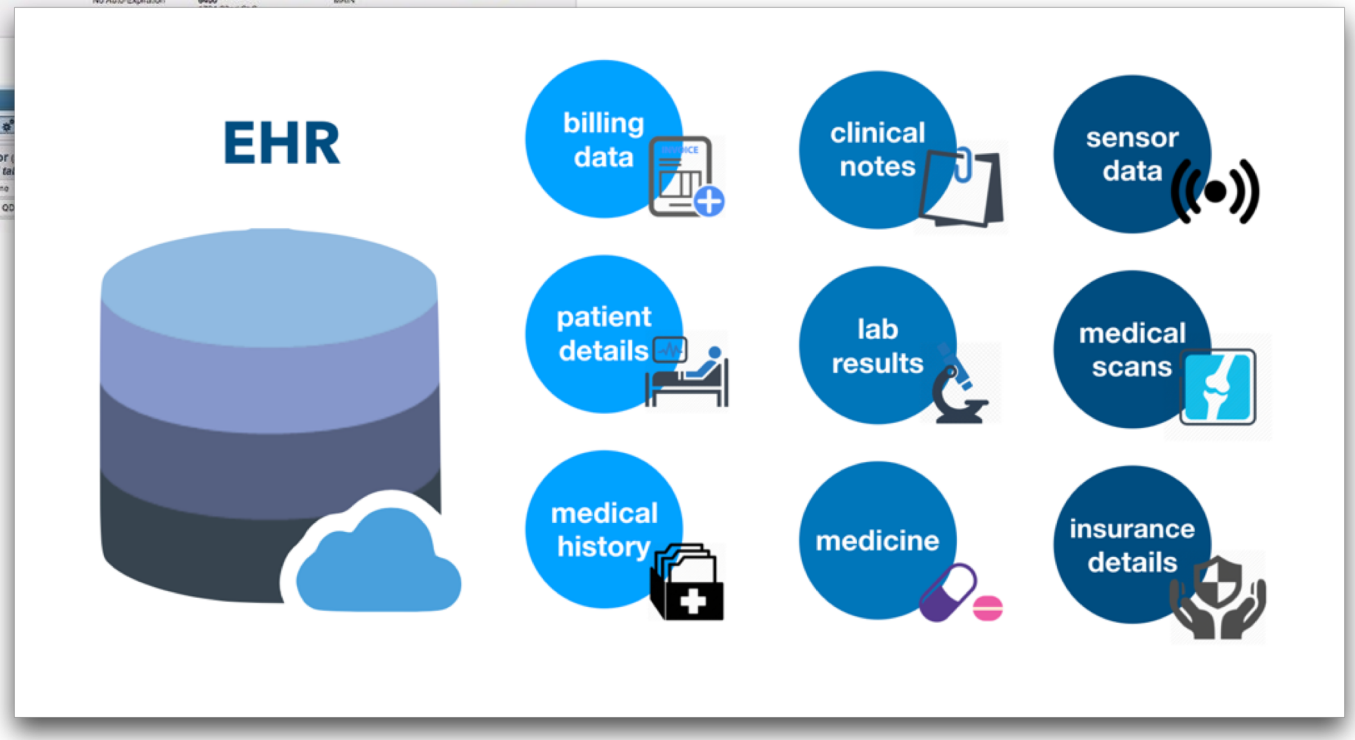
- **Electronic health record** (**EHR**) or **electronic medical record** (**EMR**): systematized collection of patient and population health data in a digital format that is electronically-stored

- **Clinical decision support system (CDSS):** ICT solution designed to provide health professionals with clinical decision support (CDS) such as assistance with clinical decision-making tasks

- **Telemedicine:** physical and psychological diagnosis and treatments at a distance, including tele-monitoring of patient functions

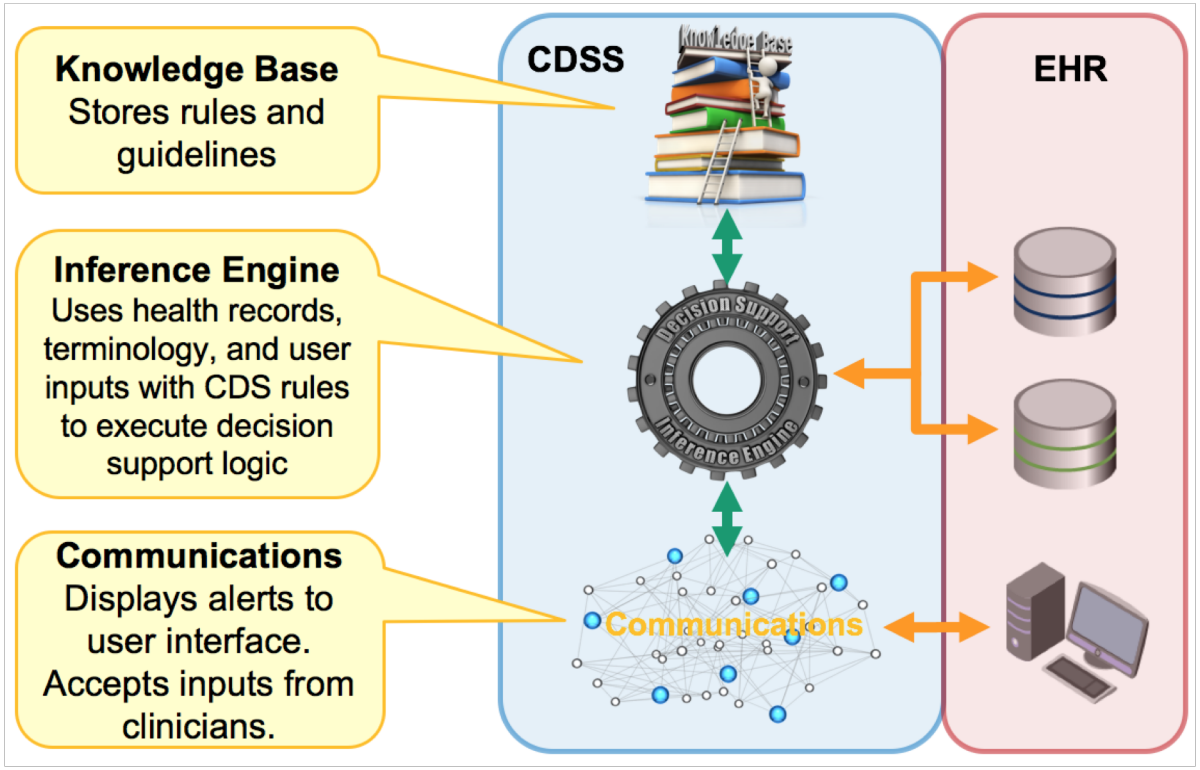
Electronic Health Records





CDSS

- Patient-specific prompts
- Screening recommendations
- Warnings
- Treatment guidelines
- Medication dosing
- Overdue tests



eHealth in LMICs

- In many low- and middle-income countries (LMICs), health system challenges relating to weak governance, health workforce shortages, and geographic and economic barriers to care impede effective delivery of health services to those in need

- Information and communication technology (ICT) offers the potential for addressing some of these challenges with innovative solutions, especially if offered at scale

- LMICs account for three-quarters of the rapidly expanding Internet and mobile cellular subscriptions globally, thus creating opportunities for innovative and cost-effective health services through the use of ICT

mHealth

- **Foundation for the National Institutes of Health (FNIH):** *"…the delivery of healthcare services via mobile communication devices…"*
- **NIH Consensus Group:** *"…mHealth is the use of mobile and wireless devices to improve health outcomes, healthcare services and health research…"*
- **mHealth Alliance:** *"…mHealth stands for mobile-based or mobile-enhanced solutions that deliver health. The ubiquity of mobile devices in the developed or developing world presents the opportunity to improve health outcomes through the delivery of innovative medical and health services with information and communication technologies to the farthest reaches of the globe…"*
- **World Health Organization (WHO):** *"…Mobile Health (mHealth) is an area of electronic health (eHealth) and it is the provision of health services and information via mobile technologies such as mobile phones and Personal Digital Assistants (PDAs)…"*

mHealth Applications

- Rapid collection/sharing of current data via mobile phones
- Public health and lifestyle messages over mobile phones
- Medication alerts using mobile phones
- E-prescribing for repeat prescriptions via mobile phones
- Tele-monitoring to transmit patient results to clinicians
- Transmission of test results to patients via SMS messages
- Online electronic health records via computer or phone
- Clinical emergency care for accidents, natural disasters
- Patient appointment booking and alerts via wireless e-mail (continuity of care)

mHealth – From Simple to Complex

Single use mHealth
Focuses on a single purpose for a single user, typically consumer initiated:
- smartphone apps and wearable tech products that support the user to record data which may be communicated to others
- consumer driven, focus on wellness, diet and exercise.

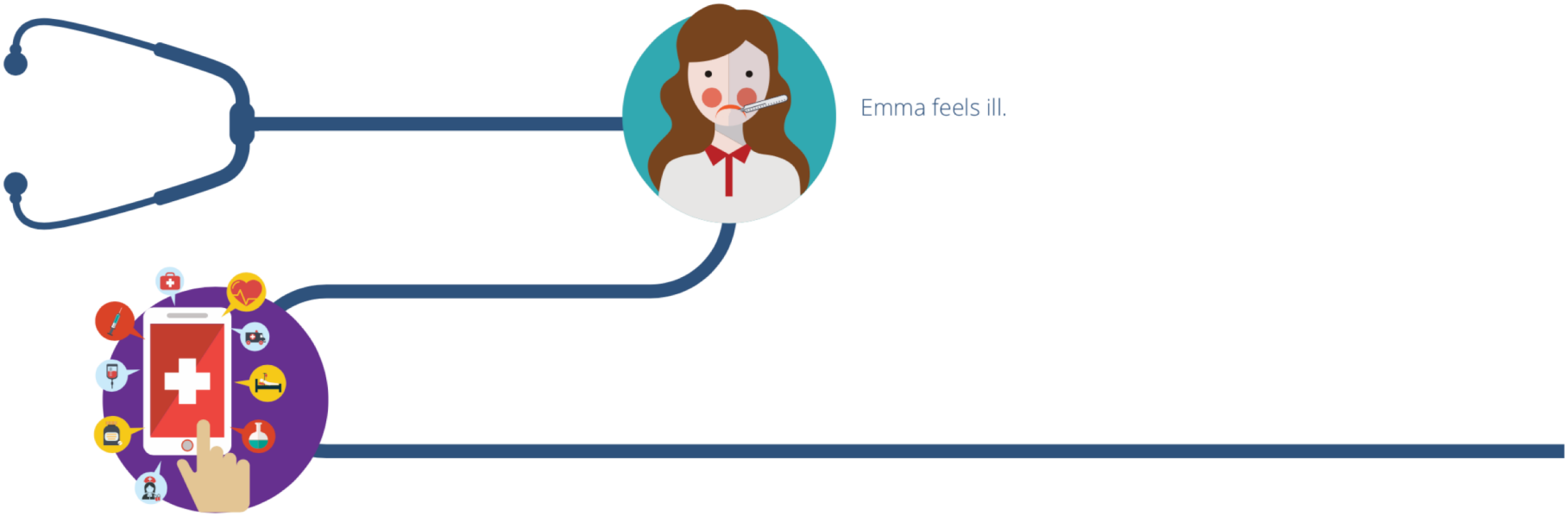
Social mHealth
Drawns upon the support and encouragement provided through social networks:
- gamification and competition based apps which encourage users to meet goals
- consumers likely to pursue activities independently.

Integrated mHealth
Links apps and devices with the formal healthcare system:
- mobile technology linking patients and HCPs
- tailored to multiple end users: consumers, physicians and administrators.

Complex mHealth
Leverages advanced, integrated analytics for decision support:
- predictive analytics applied to complex data generated through mHealth applications
- focus on achieving optimal management of a specific disease.

Source: Four Dimensions of Effective mHealth, Deloitte US Center for Health Solutions, 2014

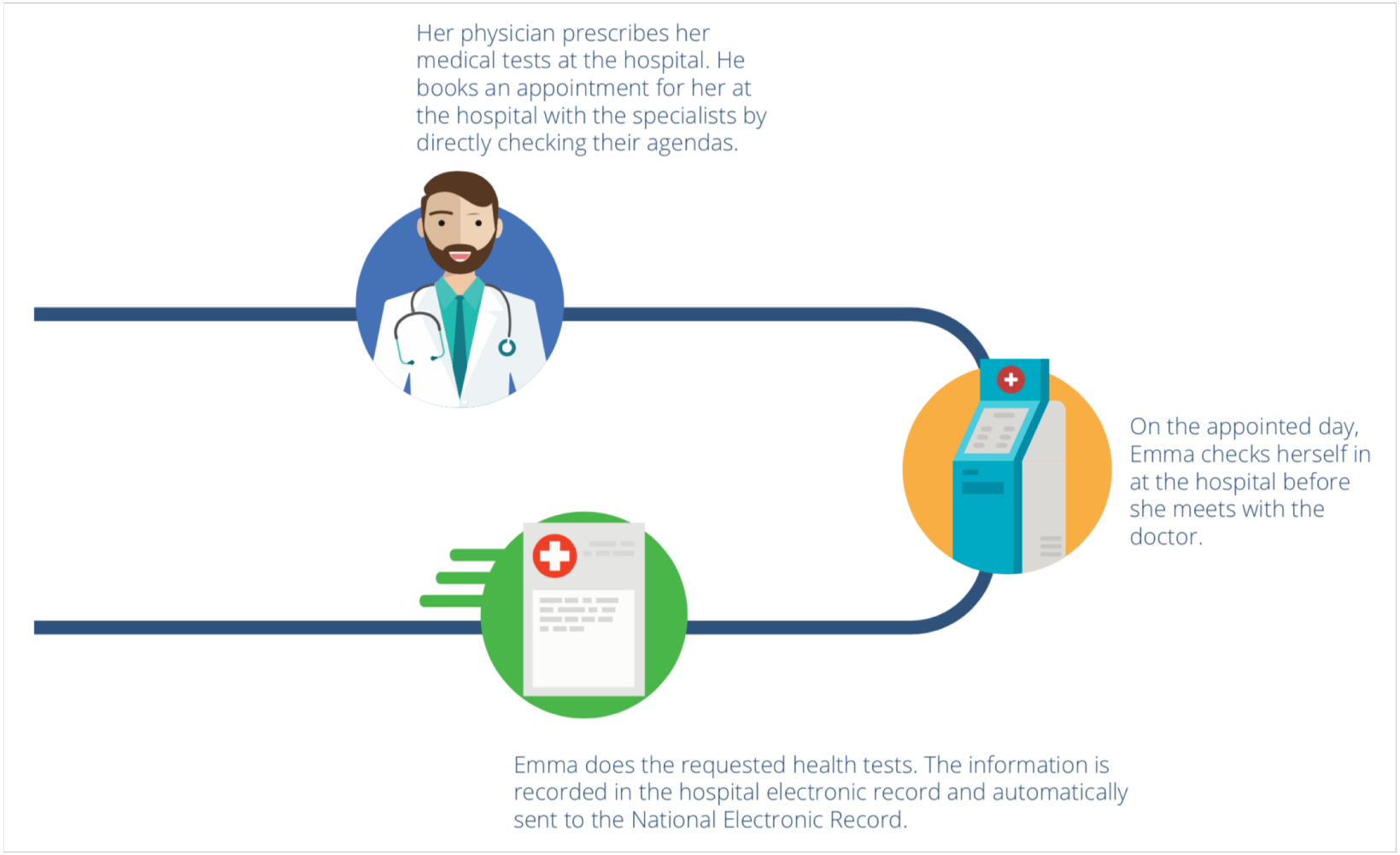
Emma’s Journey Towards Smart Health



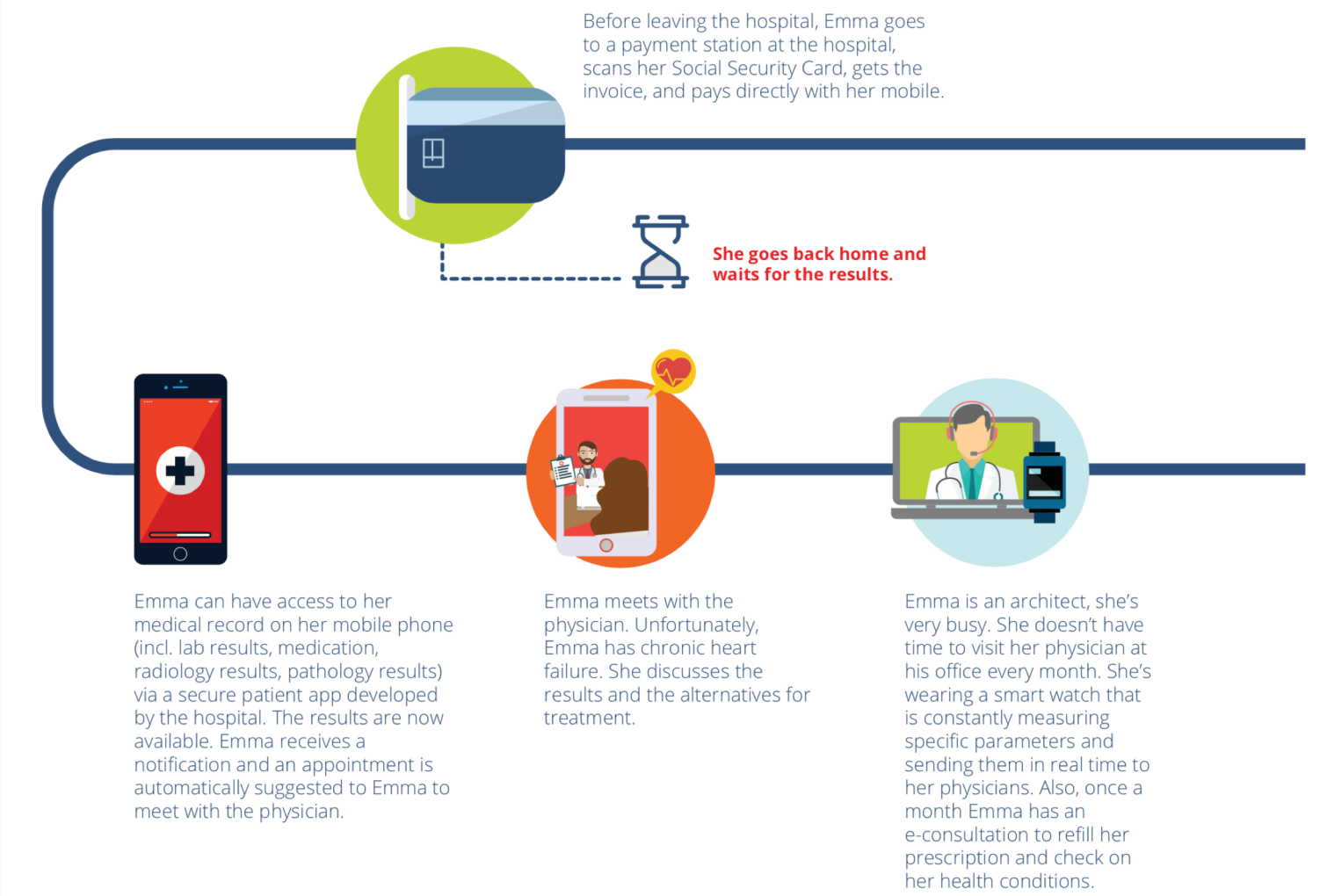
Emma feels ill.

She books an appointment online
with her physician.

Emma's Journey Towards Smart Health



Emma's Journey Towards Smart Health



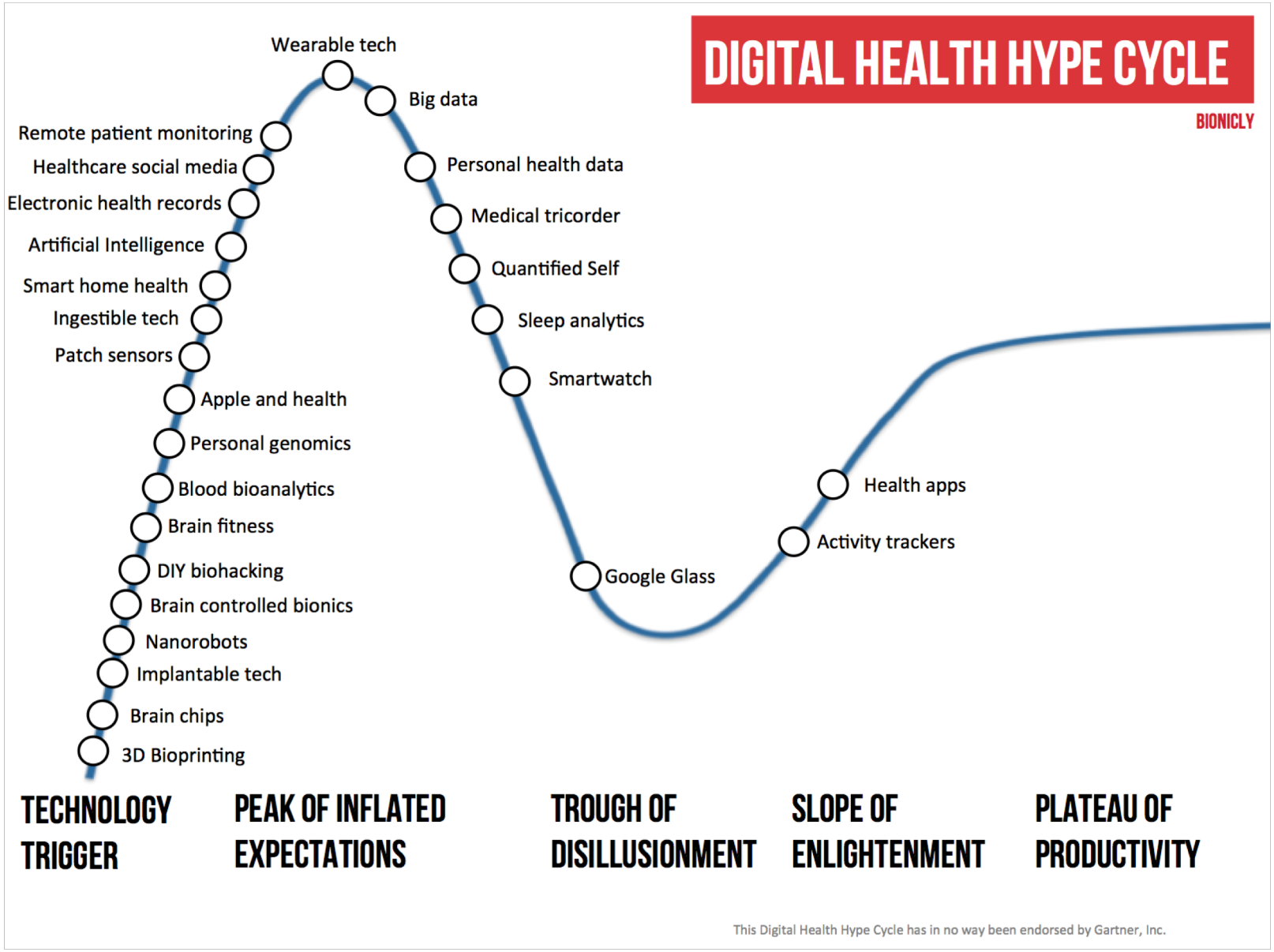
Emma's Journey Towards Smart Health

Emma connects with other patients suffering from heart failure on a patient network (sharing data on their health conditions, treatments, etc.)

Emma wants to support the development of research in chronic heart failure. She agrees to participate in a clinical trial for a new medical connected device. Her data is collected and analyzed to assess the accuracy and efficiency of the device.

“Smart X”

Source: The Future of Digital Health by Ranjan Karthik, Electronic Design, 2017



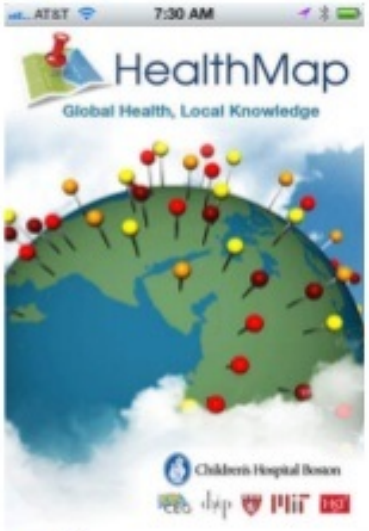
See BIONIC.LY, Digital Health, The Digital Health Hype Cycle, December 29, 2014, Which emerging digital health technologies are hype or here?, http://bionic.ly/digital-health-hype-cycle/

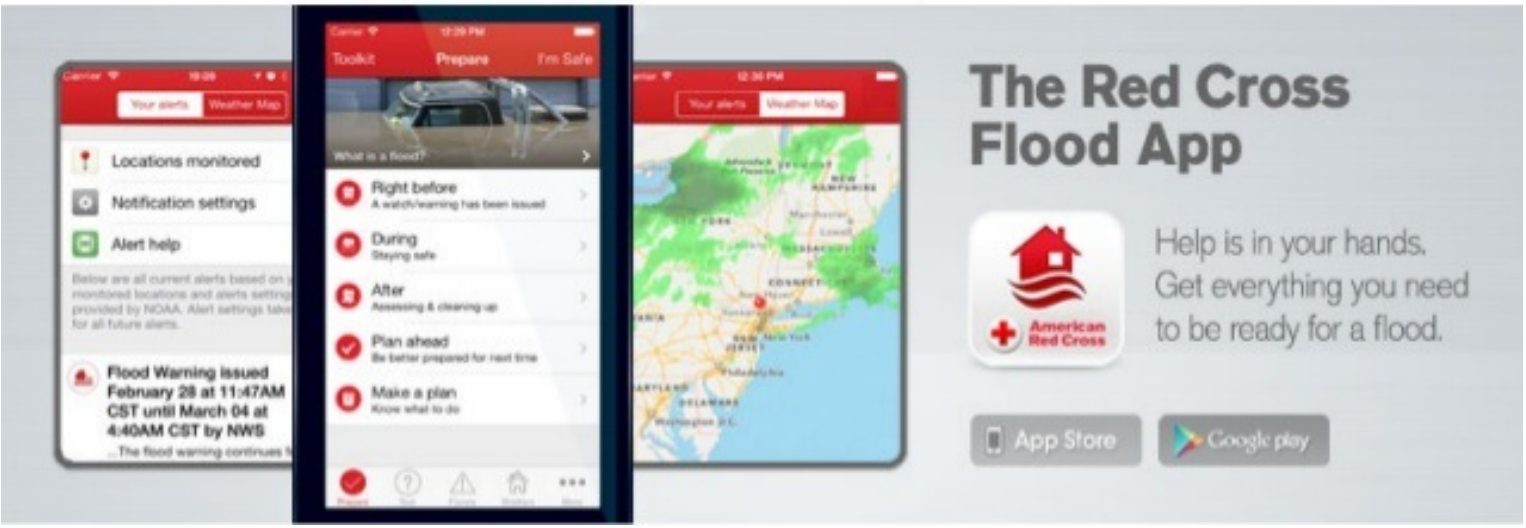
Summary: Smart Health

- **eHealth**: use *information and communication technologies* to improve access, quality, and cost of healthcare
- **mHealth**: use *mobile/wireless* information and communication technologies to improve access, quality, and cost of healthcare
- **Smart Health**: use devices/solutions that have built-in *intelligence*

- Foundation for healthcare that is:
  - **Precise (Personalized):** customization of healthcare
  - **Persuasive**: behavior change
  - **Predictive**: prevention & early intervention
  - **Participatory**: engage patients
  - **Preventative**: as opposed to treatment

HealthMap: Outbreaks Near Me





Making high quality eye care portable, cost effective and intuitive;
Leveraging mobile phone technology to extend the availability of a full range of ophthalmic diagnostic tests outside of high income hospital departments to anywhere in the world: hospital wards, GP surgeries, patient homes and we're even being tested in the Antarctic!

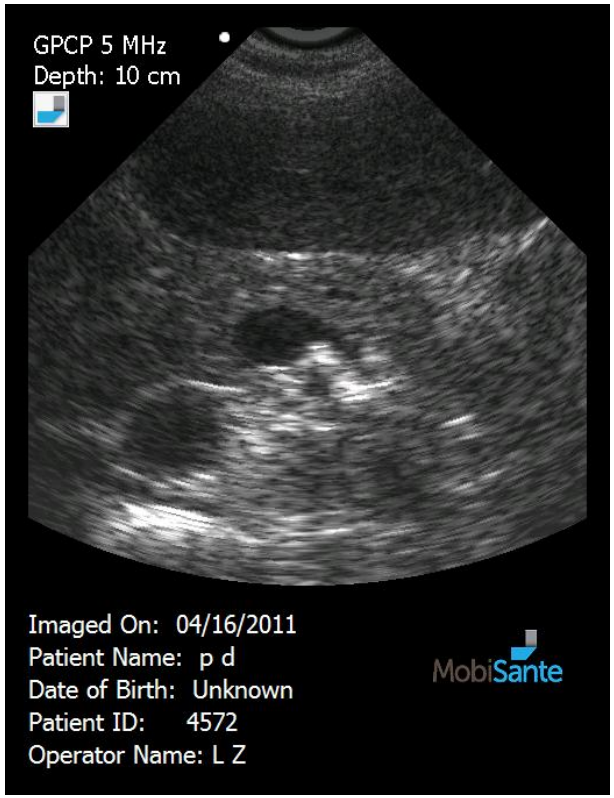
iHealth Mobile Products

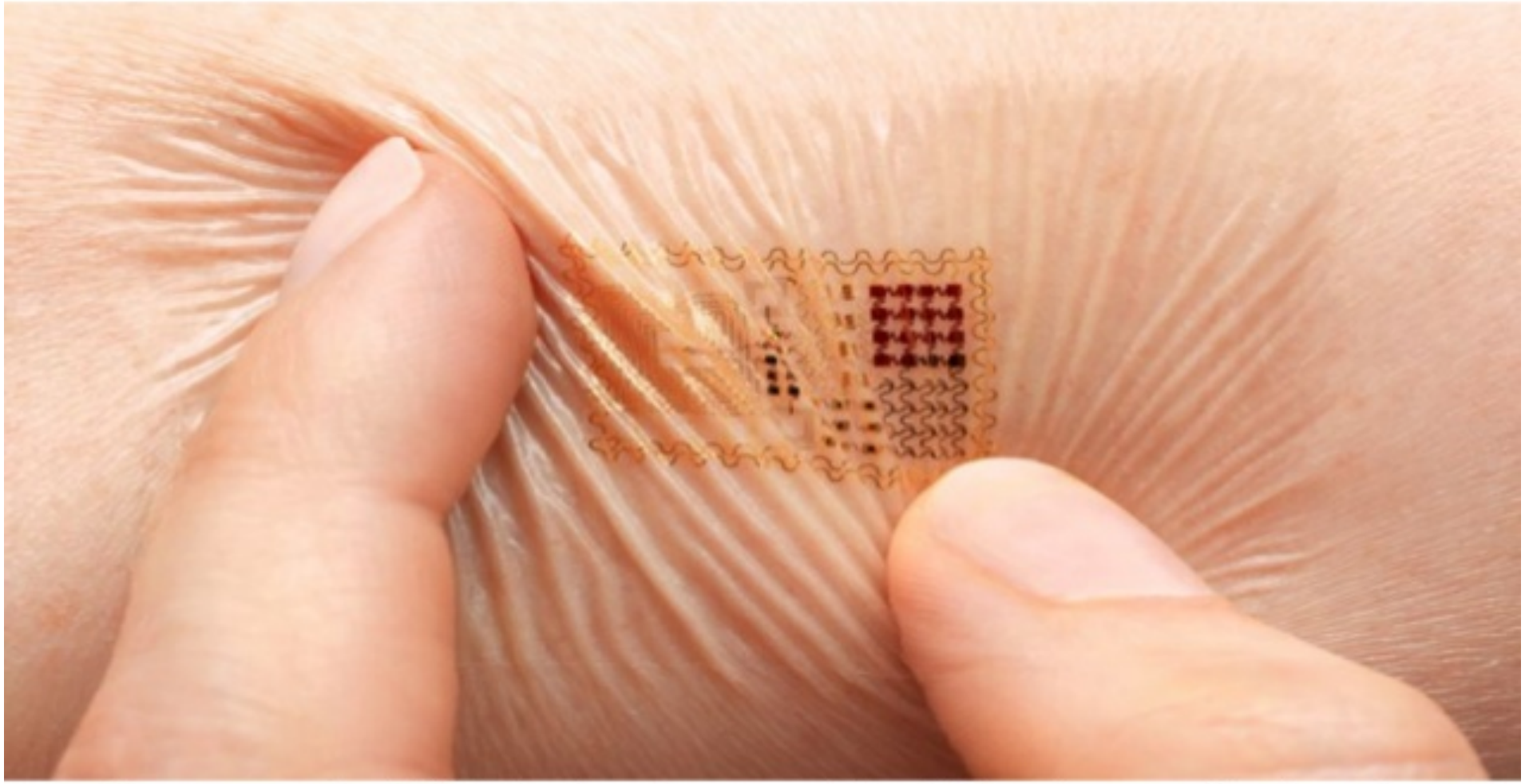
THE ONE-STOP SHOP FOR TRACKING YOUR PERSONAL HEALTH
Weight. Blood pressure. Diet. Physical activities. They're all aspects of your personal health and they're all interconnected.


CardioSleeve™ v1.0
Bring your stethoscope
into the digital age.
AT&T
8:34 AM
51 %
Close
1/2 X
Aortic
Lock
Thompson , Joe
DOB 4/11/80
HS
ECG

MobiUS

- FDA-approved MobiUS is the first ultrasound imaging system to work on smartphones. The software, made by MobiSante, could be used for a slew of clinical applications, including confirming and tracking pregnancies and assessing kidney disorders. The images and video can be shared over email or through a standard USB connection





Biostamp by MC10, via dezeen: Flexible electronic circuits that stick directly to the skin like temporary tattoos and monitor the wearer's health. Potentially these could be used in healthcare to monitor patients in their normal environment and without tethering them to large machinery. **#Biotech #Biostamp**

DermoScreen Cancer Screening App

developed at the University of Houston

DermoScreen, **can detect skin cancer 85 percent** of the time. That's the same accuracy rate as at the dermatologist's office and is more accurate than a primary care physician's diagnosis, according to engineering technology Professor George Zouridakis, who started working on the project in 2005. *Len is $500

Finding Veins

- Vein visualization technology uses non-invasive infra-red technology to project an image of the donor's veins onto the skin's surface.

ReSound Hearing Aid & App

Say hello to the world's smartest hearing aid

ReSound LiNXTM offers a superior sound experience, setting new standards for hearing aid performance.

This Made for iPhone® hearing aid provides direct sound streaming, personalized to your every need.

3D bioprinting, which uses the same process, but instead of printing plastic, can print **human body parts**, vaccinations and living cells. 3D bioprinting will produce tissues such as blood vessels and organs such as the lungs, kidneys and heart muscles. Bioprinted organs and tissues could be made from a patient's own cells which would eradicate the risk of rejection like you would have if receiving from a third-party donor.

John Redfield is testing a prosthesis that he can adjust using an app on his smartphone, instead of a wrench at a doctor's office.

MATTHEW HEALEY FOR THE WALL STREET JOURNAL

iSWIMBAND

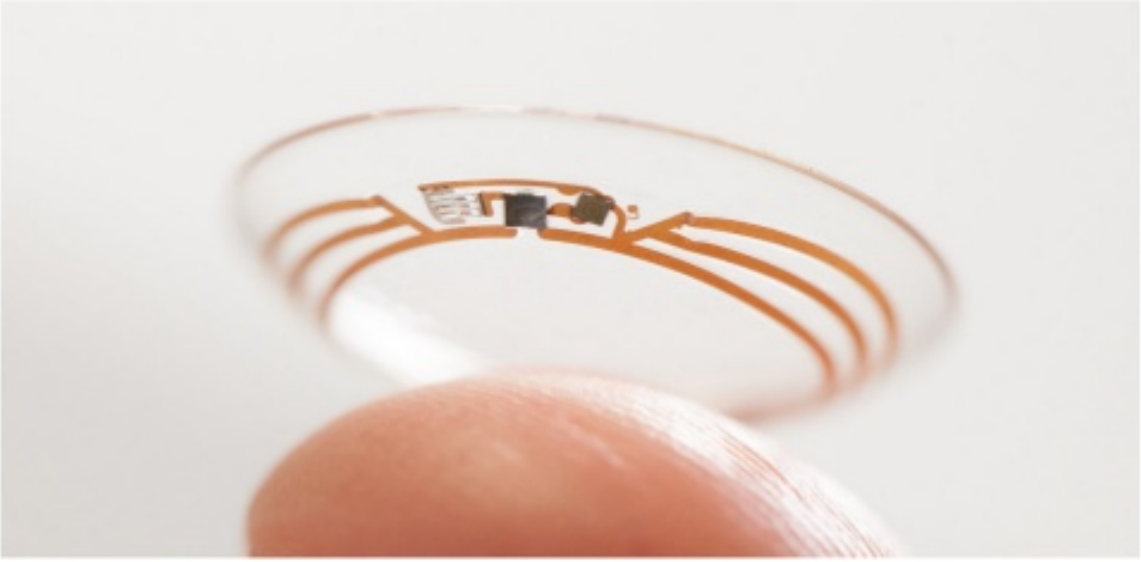
Revolutionary Drowning Detection.

iSwimband is a wearable appcessory which will alert your Bluetooth-enabled phone, tablet, or music player if a swimmer has been submerged beyond a preset time limit, or if a non-swimmer (such as a toddler) enters the water.

Google Glass for Medical Use

By Tracking Sugar In Tears, Contact Lens Offers Hope For Diabetics

The latest project from **Google X is a smart contact lens**, a tiny, flexible computer capable of monitoring glucose levels in tears. Researchers at Google are hopeful that one day this technology might be used to help diabetes patients better control their disease.



‘Smart’ Bed Tracks Patient Vitals, Activity

- The medical device company received approval from the United States Food and Drug Administration in February to market its flagship product, the LG1 Intelligent Medical Vigilance System, a patient safety technology that tracks heart rate, breathing rate and whether a patient is in bed or trying to get out of bed without hooking the patient up to electrodes or any other wiring system. The monitoring sensors are present in a pad-like device, or mattress coverlet, that can be sat on or lain upon. The sensors respond to physiological stimuli and are able to measure patient information through clothing, hospital gowns and sheets.


Healthcare of the Future
Whole Hospital Optimization
Hospital of the Future
Do More & Better With Less
Smart Patient Room
Patient Safety Forecaster

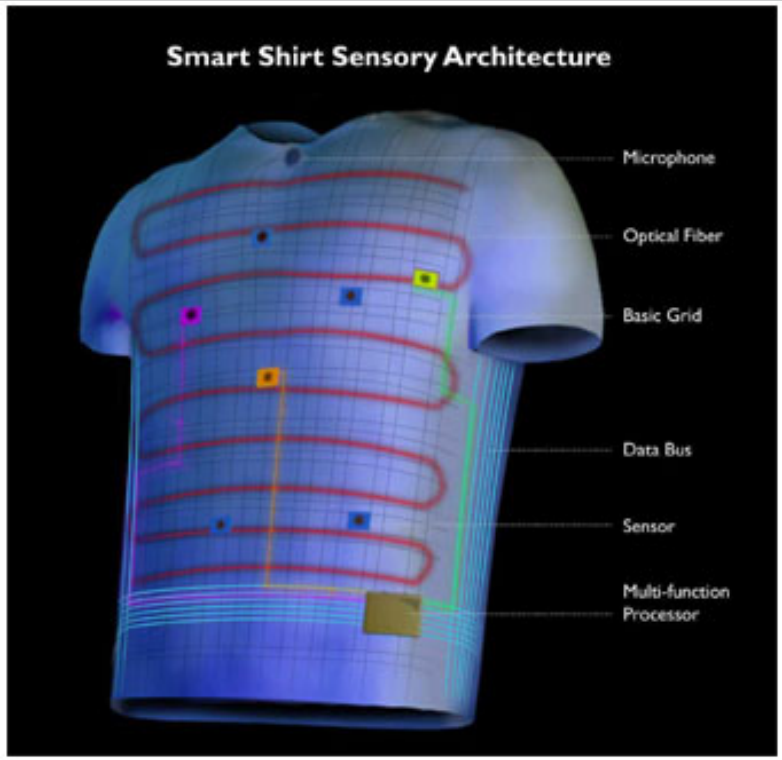
Smart Toilets: Doctors in Your Bathroom

Toto's new Intelligence Toilet II monitors weight, blood sugar levels, and other vital signs, transferring data to your computer for analysis via WiFi.

Smart Shoes

- Created by Ducere Technologies Pvt, the shoe hooks up with an app that syncs with Google Maps, tracks your steps, and counts your calories burned.

GoBe is the first and only wearable device that automatically **measures the calories you consume and burn, through your skin.**



- *Patient monitoring technology, such as "smart shirts," coupled with device apps and consumer technologies will result in more effective healthcare for patients and a much greater level of data for medical professionals with which to diagnosis potential concerns.*

BodyMedia FIT Armband

- BodyMedia FIT armband is a 3D activity monitor that uses sophisticated skin sensors to detect how many calories you are burning by measuring changes in skin temperature as well as perspiration. Its wireless Internet connectivity lets you upload your progress and share that information with friends and colleagues.