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How can the Internet of Things help in overcoming current challenges … and make healthcare sustainable

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Abstract

Context & Challenges

- **Several changes in the healthcare systems** starting from an ageing population to a growing demand for more advanced and better healthcare solutions, leading to:
  - an **increase of healthcare costs**
  - a **need for better and more efficient outcomes**

Objective

- **Bring some preliminary evidence** that the Internet of Things can improve the quality of healthcare and/or reduce the cost of it

Methodology

- **Review of 5 recent Internet of Things solutions** from monitoring cardiac arrhythmia and congestion in heart failure, to management of diabetes and obesity prevention

Findings

- **The Internet of Things has a significant potential to contribute to the overall decrease of healthcare costs while increasing the outcomes** if it enables:
  - the system management of a particular disease
  - the mindset and behavioural changes of the stakeholders

Context: Internet of things as a catalyst

The IoT (The Internet of Things) definition:

- A "**dynamic global network infrastructure** with self configuring capabilities (…) where physical and virtual things have identities, physical attributes, virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network". These things will have the **capability of directly interacting with each other and exchange information** (SUNDMAEKER *et al* 2010, RELLERMEYER *et al* 2008)
- **Potential to generate benefits for the patients, health systems and society at large** by shifting from "anytime, anyplace connectivity for anyone" to " **connecting for anything**" (ITU 2005)

Current opportunities and unlocked values in the healthcare system:

- **Lack of systemic management of the healthcare system**
- **Difficulty of permanently changing people mindset and behaviours** (doctors, patients, etc.)

Thesis and methodology

Thesis

- The **value generated by the IoT is greater than the intrinsic value of any specific IoT solution** as it will trigger a systemic effect either enhancing the outcome or reducing the cost (or both) of one or many of the components which build the total value of a healthcare system

- This **statement will prove true if the two propositions are verified:**

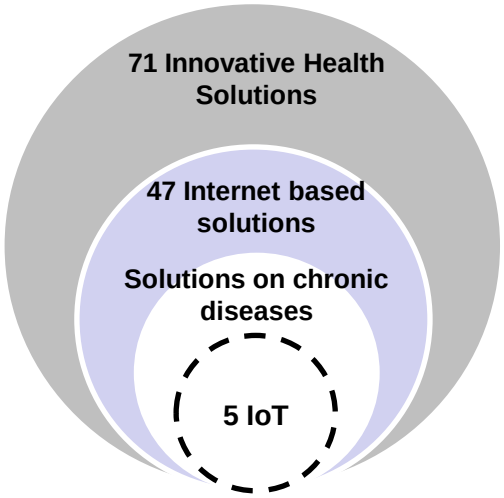
Proposition 1

- IoT solutions enable the system management (disease pathway) bringing transparency of responsibility of impact and effort of each activity involved in the disease management

Proposition 2

- IoT solutions enable mindset and behavioural changes of the stakeholders in the system

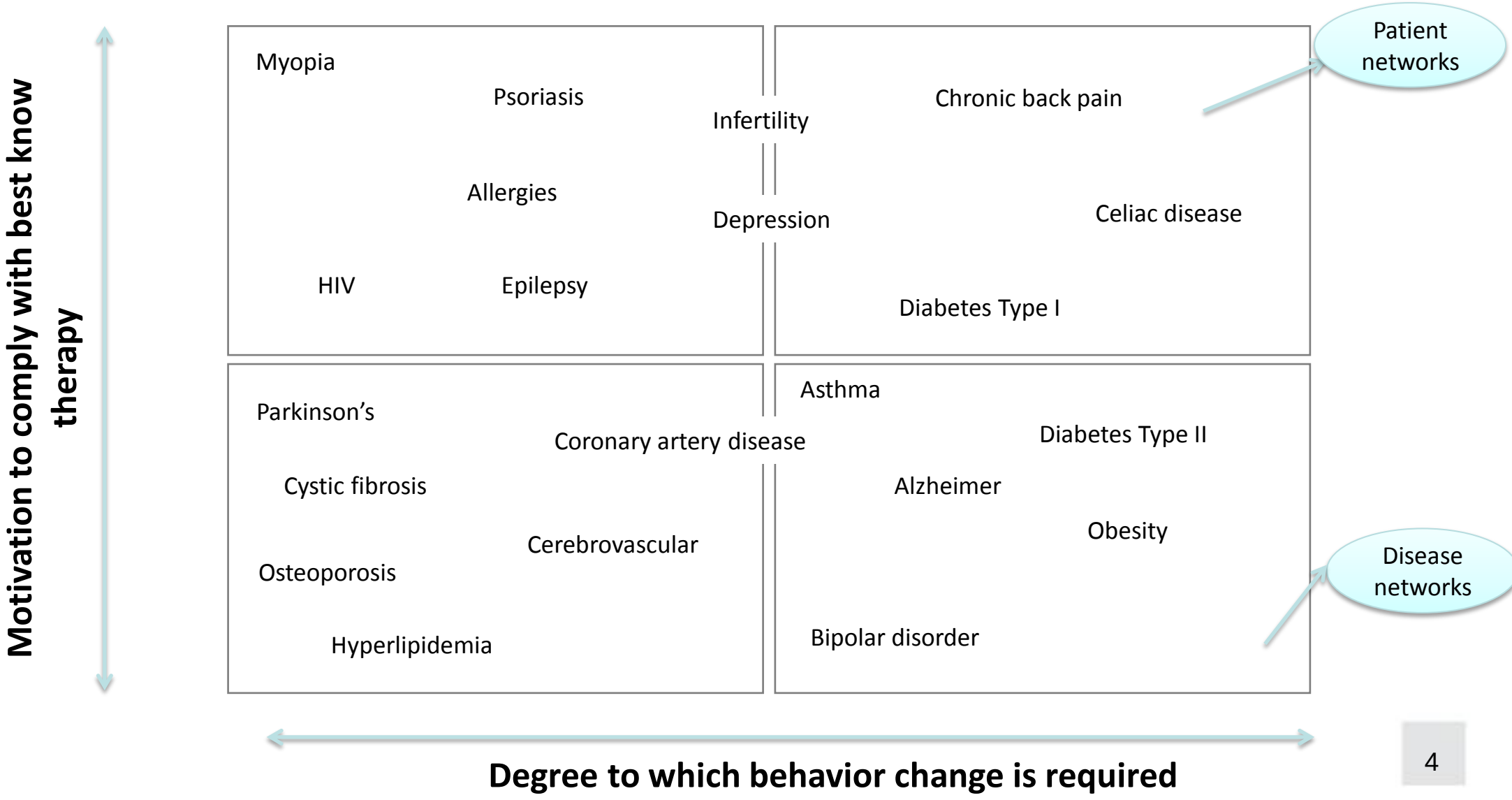
Selection of the 5 IoT



Methodology of analysis: a structured three-phased approach

Disease analysis → **Related IoT analysis** → **IoT impacts**

Any Solutions proposed shall take in account two key contraints



C1&C2: Cardiac arrhythmia monitoring services

Cardiac arrhythmia definition:

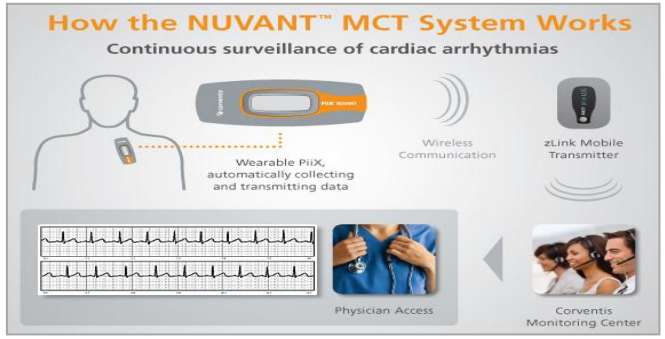
- Abnormality of the heart's rhythm
- Can lead to loss of consciousness and death
- Possible treatments can be implantable devices (pacemaker, cardioverter-defibrillator) or surgical procedures like coronary by-pass surgery

1. Mobile Cardiac Outpatient Telemetry (MCOT) by CardioNet

- Monitors patients 24hours a day via a small sensor and transmit patient activity to the company's monitoring center

2. NUVANT Mobile Cardiac Telemetry system (MCT) by Corventis

- Sensor attached to the chest recording and transmitting physiological information via wireless connection to a central server



Benefits

- Transmit data when it is available
- Reduce time of diagnosis, hospitalization costs and readmissions
- Make the whole clinical pathway more efficient

Challenges of implementation

- Patient privacy issues
- Risks on information accuracy
- Patient behaviour as a key driver in the adoption of the solution
- Expensive

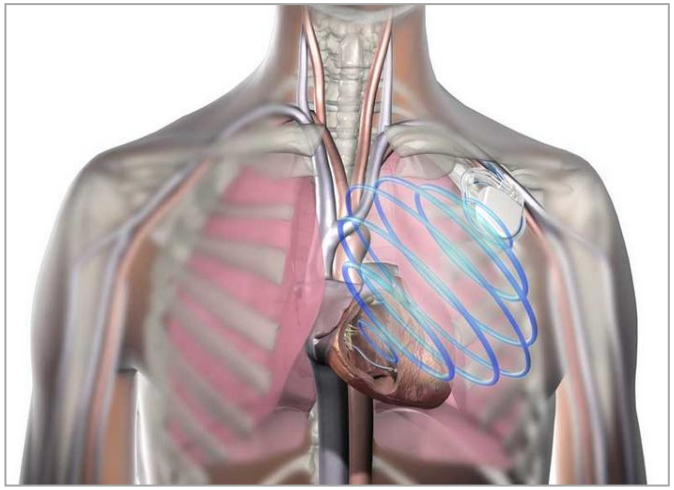
C3: Monitoring congestion in heart failure

Heart failure definition:

- Heart can not longer pump enough blood and blood may back up in the lungs, liver, arms and legs
- Causes are coronary artery disease, heart problems
- A significant proportion of patients are not receiving treatment with guideline-recommended, evidence-based therapies

3. OptiVol Fluid Status monitoring device by Medtronic

- Implemented in the patient's heart to detect any fluid build-up in the thoracic cavity
- Connected to the patient's physician through the company's network system,
- When a patient crosses the fluid threshold, diet and medication are immediately adjusted to get him back on track



Benefits

- Better disease management
- Quick reactivity to worsening heart failure issues
- Helps the patient to comply with his treatment routine

Challenges of implementation

- Need for more evidence of efficacy to conclude to major improvement in clinical outcomes

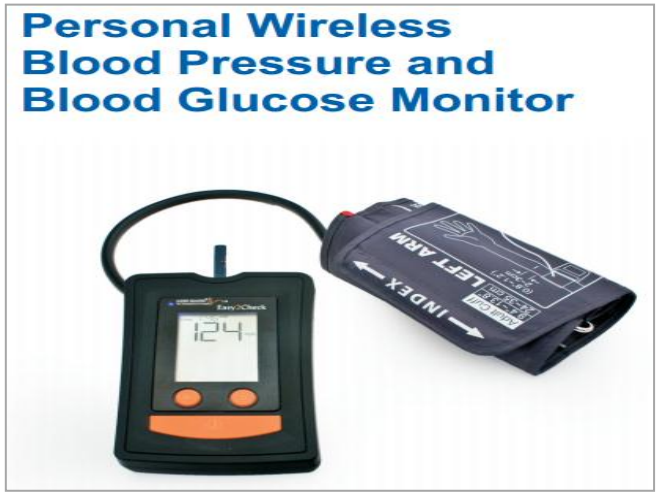
C4: Diabetes management systems

Diabetes definition:

- Condition where the pancreas produces little (Type 1) or no insulin (Type 2)
- In most cases treatments involve taking insulin injections for life and monitoring the level of blood sugar
- Oral or other medications can be administrated and in some cases a pancreas transplant or bariatric surgery is recommended

4. PMP4 Easy2Check monitoring device by LifeWatch

- Uses blood pressure and glucose monitor to give accurate test results
- Communicates via Bluetooth to a smart screen, PC or cellular / or land line phone, transmitting data to a web-enabled server
- Data is stored, reviewed and interpreted by the patient's doctor



Benefits

- Easy to implement
- Immediate access to data
- Direct feedback on the treatment efficacy
- Improves the efficacy of the overall clinical pathway

Challenges of implementation

- No reimbursement for non face-to-face services
- Medical legal issues related to timeliness of provider response
- Patient privacy issue
- Expensive

C5: Obesity prevention

Obesity definition:

- Excessive body fat for a given height and gender, with BMI>30
- Consequences on cholesterol, diabetes, blood pressure, heart disease, cancer, sexual health issues
- Possible treatments can be diets, exercising plans, even medication and surgical treatments

5. Fitbit Ultra Wireless Tracker by FITBIT

- Wireless-enabled fitness tracker, with a 3D motion sensor tracking:
  - calories burned
  - steps taken
  - distances travelled
  - sleep quality
- Data collected uploaded on Internet every time the tracker is within 15 feet of a base station

Benefits

- Contributes to obesity prevention by providing data on people's activity levels
- Patient take control of their own health

Challenges of implementation

- People's lack of diet and lifestyle adherence
- Constraint to wear it permanently

Synthesis of findings

Impact of the IoT solutions and their fulfilment of the propositions

IoT Solution	Impact on value	Proposition 1	Proposition 2
Mobile Cardiac outpatient Telemetry **Cardiac arrhythmia monitoring patch** **Fluid status monitoring device** **Blood pressure and glucose monitor** **Fitness tracker**	1) **Enhanced outcome of medical care** by enabling real-time transmission of time sensitive data 2) **Enhance outcome of drug/treatment efficacy** by increasing compliance 3) **Reduced cost of medical care and healthcare infrastructure** by limiting unnecessary hospitalisation and readmissions 4) **Reduced cost of medical care** by decreasing demand on medical staff	The solution **enhance system management** in at least two ways: • **Generating new information** that contributes to improved health outcomes • **Interconnecting patients, doctors and technicians** for timely adjustment on medication	The solution gives **immediate feedback loops** (real time evidence of efficacy of treatment and life-style changes) that **drive behavioural change of various stakeholders** through: • Close monitoring of patient's lifestyle and **permanent link to doctors** • Better **management of treatment compliance** • **Patients taking control of their health** (5th IoT solution)

Conclusion and next steps

Conclusion:

- IoT solutions can address important challenges by **improving healthcare outcomes and helping better manage costs**
- However, **some challenges/barriers need to be overcome** for a widespread diffusion

Further investigations:

- **Gathering quantitative evidence** on those IoT solutions
- **Performing in depth case studies** in the healthcare units were thay have been implemented