eHealth Summit 2014

Aggregating physiological sensors network data

Frederic Ehrler, PhD
Prof. Paul Albuquerque
Florent Gluck, PhD
Saurabh Raina, PhD
David Issom
Prof. Christian Lovis, MD MPH
Chronic diseases: multidimensional problems

The Whole Person: The Web of Chronic Disease

- Tobacco use
- Alcohol use
- High cholesterol
- High blood pressure
- Diet
- Physical inactivity
- Obesity

CHRONIC DISEASES

- Cardiovascular Disease
- Cancer
- Chronic Lung Disease
- Diabetes

2 AK BRFSS (2009-2011)

Among Alaska Adults with Cardiovascular Disease:
- 23% smoke
- 35% are inactive
- 42% are obese
- 25% have diabetes

Among Alaska Adults with Cancer:
- 20% smoke
- 30% are inactive
- 29% are obese
- 16% have a history of cardiovascular disease

Among Alaska Adults with Diabetes:
- 19% smoke
- 30% are inactive
- 59% are obese
- 19% have a history of cardiovascular disease
Managing chronic diseases

Beating Diabetes

Affects of Diabetes
- Eyes: Can cause problems with the eyes, including blindness
- Blood Sugar: Leads to persistently elevated blood sugar levels
- Heart: Can increase susceptibility to heart attacks
- Kidneys: Can cause damage to the kidneys
- Nerves: Can cause nerve damage making the hands and feet to hurt, tingle, or feel numb

How to Avoid Diabetes
- Exercise: Exercise helps keep a healthy blood sugar level, maintain a healthy weight, manage stress, and improve sleep
- Eat Healthy: Eat a balanced diet low in saturated fats and sugars in order to maintain a healthy weight and blood sugar level

How to Manage Your Diabetes
- Don’t Skip Medication: Follow your doctor’s recommendations and do not skip a dosage, even if you feel fine
- Don’t Stress: Stress can complicate diabetes so speak to someone if you ever need support
- Don’t Smoke: In addition to its many other dangers, smoking can harm your circulatory system

- Keep Teeth Healthy: Higher blood sugar levels lead to an increased risk of tooth decay and gum disease
- Check Blood Glucose: Check your blood sugar levels to stay in control of your diabetes
- Check Your Feet: Keep track of your blood sugar levels to stay in control of your diabetes

Sources

 ostatistically designed by Ava Falls from the Human Project
## Explosion of health sensors

<table>
<thead>
<tr>
<th>Pedometers</th>
<th>Peak Flow Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood Pressure Cuffs</td>
<td>Wireless Pill Bottles</td>
</tr>
<tr>
<td>Pulse Oximeters</td>
<td>Blood Glucose Meters</td>
</tr>
<tr>
<td>Weight Scales</td>
<td>Heart Rate Monitors</td>
</tr>
<tr>
<td>Thermometers</td>
<td>Maternal Monitors</td>
</tr>
</tbody>
</table>

---
Platforms are flourishing
Managing interoperability at the sensors / communication level

Continua Interfaces & Standards Architecture

Personal Device

- Thermometer
- Pulse Oximeter
- Pulse / Blood Pressure
- Weight Scale
- Glucose Meter
- Cardio / Strength
- Independent Living Activity
- Peak Flow
- Adherence Monitor
- Physical Activity
- Insulin Pump

Aggregation Manager

- ISO
- IEEE
- ZigBee
- Bluetooth
- USB

Local Area Network (LAN) Interface

Personal Area Network (PAN) Interface

Wide Area Network (WAN) Interface

Health Record Network (HRN) Interface

Telehealth Service Center

Health Records

EHR

PHR
ISO/IEEE 11073

<table>
<thead>
<tr>
<th>Device Category</th>
<th>IEEE Standards (ISO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermometer</td>
<td>11073-10404</td>
</tr>
<tr>
<td>Pulse Oximeter</td>
<td>11073-10406</td>
</tr>
<tr>
<td>Pulse / Blood Pressure</td>
<td>11073-10407</td>
</tr>
<tr>
<td>Weight Scale</td>
<td>11073-10415</td>
</tr>
<tr>
<td>Glucose Meter</td>
<td>11073-10417</td>
</tr>
<tr>
<td>Cardiovascular and Strength Fitness Monitor</td>
<td>11073-10441</td>
</tr>
<tr>
<td>Independent Living Activity</td>
<td>11073-10471</td>
</tr>
<tr>
<td>Medication Adherence</td>
<td>11073-20601</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measurements</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse / Heart Rate</td>
<td></td>
</tr>
<tr>
<td>Blood Pressure</td>
<td></td>
</tr>
<tr>
<td>Thermometer</td>
<td></td>
</tr>
<tr>
<td>Weighing Scale</td>
<td></td>
</tr>
<tr>
<td>Glucose</td>
<td></td>
</tr>
<tr>
<td>Cardiovascular Fitness Monitor</td>
<td></td>
</tr>
<tr>
<td>Strength Fitness Equipment</td>
<td></td>
</tr>
<tr>
<td>Independent Living Activity</td>
<td></td>
</tr>
<tr>
<td>Medication Monitor</td>
<td></td>
</tr>
<tr>
<td>Base Framework Protocol</td>
<td></td>
</tr>
</tbody>
</table>

Transport Independent

Personal Health Device Class Specification

Medical Device Profile Specification

PC

Personal Health System

Cell Phone

Set Top Box

Aggregator

출처에서 편집: Continua Health Alliance
Why not Continua

Percentage of device continua compatible

- Scale
- Glucometer
- Tensiometer
- Oxymeter
- Heart rate
- Thermometer
Managing interoperability at the software level

The inner circle of the new mHealth app eco-system

- **App users**
  - Smartphone users
  - Patients
  - Payers
  - HCPs

**Connected Elite**

- **App Stores**
  - €

- **Apps**
  - ₹

**Enabling Layer**

- **API Aggregators**
  - Human API
  - **VALIDIC**

- **Connected Apps**
  - [App Icons]

- **Connected Sensors**
  - Withings
  - Polar
  - fitbit

**API Managed Services**

- happtique
- apigee
- QUALCOMM LIFE

**Health Database**
- Food
- Medicine
- Disease

**Health Insurance Database**

**Universities, Medical Institutions**

Source: research2guidance
What about a integrated transversal solution?

- Connecting heterogeneous sensors
- Communicating the signals
- Synchronizing and aggregating signals
- Enhancing decision support
Use case: The Arduino platform
Architecture overview
Connectivity

- Plug and Play architecture
- Detectors identify sensors
Communication

- Need to understand each other

“How do you send text messages?”
Signal analysis

- Synchronization
- Noise cleaning
- Trend computation
Visualization

Comparaison

Evolution du patient
Mr Mohamed El Guelou

Glycémie
Pression
Poids
Activité

155 mg/dl
150 mg/dl
145 mg/dl
140 mg/dl
135 mg/dl
130 mg/dl

90 kg
80 kg
70 kg
60 kg
50 kg
40 kg

12.5 METs
10 METs
7.5 METs
5 METs
2.5 METs
0 METs

Hospitaux Universitaires de Genève
Mixing any types of information
Questions & Answers