Using Health Information Technology to Connect the Healthcare System and Improve Patient Care

Submitted by: Korea
Using Health IT to Connect the Healthcare System and Improve Patient Care

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Definition of u-Health

- u-Health provides medical & health promotion services (prevention, diagnosis, treatment, post control and so on) using ubiquitous IT
- Medical Treatment Using IT Network
- Transmission of Medical Information, Remote Healthcare
- Medical & Healthcare Services through Internet
- Joint Use of Medical Information, Remote Healthcare
- Medical & Healthcare Services Using u-IT (Sensor Network)
- Intelligent Healthcare Services

Source: Myoungho Lee, 2010 ICOST Smart Homes and Health Telematics, Seoul, Korea
### Historical Transition of u-Health

<table>
<thead>
<tr>
<th>Year Range</th>
<th>Description</th>
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<tbody>
<tr>
<td>1970~1990</td>
<td>Telemedicine</td>
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<tr>
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<td>Telehealth</td>
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<td>u-Health</td>
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</tbody>
</table>

#### Key Terms
- **Telemedicine**: Provision of Healthcare Service
- **Telehealth**: Encompassing Term of Telemedicine
- **Internet-based Health Care Delivery**: Health Informatics
- **Health Telematics Telecare**: Informational, Educational, Commercial Product
- **Integration of Telecommunication System**: Network Internet Mobile
- **Web-based Health Care Delivery**: Informational, Educational, Commercial Product

**Historical Transition**
- **1970~1990**: Telemedicine
- **1990~2000**: Telehealth
- **2000~2008**: e-Health
- **2008 +**: u-Health

**U-Health**

### Changing Health Sector Domain

- **Classical Health Service**
  - Hospital Domain
  - Patient Domain
  - Medical Supplier Domain
  - Pharmacy Domain

- **Future Health Service**
  - Clinician Domain
  - Medical Supplier Domain
  - Consumer Domain
  - Pharmacy Domain

**U-Health**

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*M.H. Lee, 2009 WCID Conference, Beijing, China*
2012 APEC Health Working Group
Health Policy Dialogue (HWG-PD)

**u-Health is Worldwide**: e-Health is Worldwide Developed by Constructing e-Health Portal and Adopting National 'e' Policy in each economy.

- **e-Europe 2005**
- **EU-CAN e-Health**
- **e-Canada**

#### Configuration of u-Healthcare Service System

- **Sensing**
  - Measuring biological signals

- **Monitoring**
  - Measured Data
  - Filtered & Analyzed Data Display

- **Analyzing**
  - Long-term Data storage
  - Trend analysis

- **Feedback**
  - Behavior modification
  - Emergency Alert
  - Feedback-Action
    - Prescription, exercise, etc.

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Medical Electronics & Information Laboratory
u-Health Medical Sensors

1. Glucose
2. Blood Pressure
3. Body Temperature
4. Respiration
5. ECG, EEG, EMG
6. HRV, PPG
7. SPO2
8. EtCO2

u-Health Medical Devices are based on Ubiquitous IT

Body Sensors, BAN

Body sensors, BAN
Ubiquitous Personal Monitoring Systems

- Intelligent wireless sensors communicate with each other and the personal server

- Integrate information from different sensors
- Communicate with the upper layer of the organized m-Health system

Personal Server

BAN: Body Area Network
PAN: Personal Area Network
LAN: Local Area Network
Micro/Nano applied to Medical Devices

The catheter is inserted into an artery (usually the femoral artery) and guided to the blood clot.

Saline jets dissolve the clot by creating a vacuum within the artery. The clot is pulled apart and sucked out of the body via the catheter and into the pump set.

Taken from: www.heartcenteronline.com
Micro/Nano applied to Medical Devices

An implantable blood pressure sensor developed by CardioMEMS

Surgical microgripper actuated by SMA


Patient Friendly (u-Health) Sensing

Diagnostics
- Bioelectrical and physiological measurements
  (ECG, arrhythmia, other heart symptoms, EEG, EMG, blood pressure, ...)
- Biochemical assays (blood sugar, infarct markers, ...)

Safety
- Monitoring of chronically ill patients (heart diseases, diabetes, epileptic events), alarms
- Monitoring at home and in nursing homes (elderly and demented people)

Sport, physical exercise, training
- Monitoring of physical condition and efficiency
- Control and feedback in training

Ambient intelligence, smart devices, security
- Environment senses, recognizes and reacts (home, office, car)
- Smart user interfaces (telephone, PC, multimedia devices, digital-TV, games)
ECG Sensing

- Most widely used ECG measurement setup in clinical environment
- Signal is measured non-invasively with 9 electrodes
- Lots of measurement data and international reference databases
- Well-known measurement and diagnosis practices
- This particular method was adopted due to historical reasons, now it is already rather obsolete

1. Einthoven leads: I, II & III
2. Goldberger augmented leads: V_L, V_R & V_{p}
3. Precordial leads: V_1-V_6

![Patient Monitor 12Ch-ECG](image)

![Wearable ECG Sensor](image)

Blood Pressure Sensing

- **Blood pressure (BP)** is the pressure exerted by circulating blood on the walls of blood vessels, and is one of the principal vital signs.
- During each heartbeat, BP varies between a maximum (systolic) and a minimum (diastolic) pressure.
- The mean BP decreases as the circulating blood moves away from the heart through arteries, has its greatest decrease in the small arteries and arterioles,
- has its greatest decrease in the small arteries and arterioles, and continues to decrease as the blood moves through the capillaries and back to the heart through veins

![Continuous Non-Invasive Blood Pressure Measurement Method](image)

![Source: H.Jerry ASADA, Journal of wearable technology “Mobile Monitoring with Wearable Photoplethysmographic Biosensors”](image)
Photo-Plethysmogram (PPG) Sensing

- A photoplethysmograph (PPG) is an optically obtained plethysmograph, a volumetric measurement of an organ.
- A PPG is often obtained by using a pulse oximeter which illuminates the skin and measures changes in light absorption (Shelley and Shelley, 2001).
- A conventional pulse oximeter monitors the perfusion of blood to the dermis and subcutaneous tissue of the skin.

SpO2 Sensing

Saturation of peripheral oxygen (SpO₂) tells the observer or clinician how much oxygen is dissolved in the blood of the subject under observation. And SpO₂ is of vital interest as it can alert medical professionals to conditions underlying illness or disease in a patient.

The normal range result of a pulse oximeter is 95% to 100%. Anything lower than that means there’s not enough oxygen getting to your body.
**Body Temperature Sensing**

Contact or Noncontact Measurement

- Sensing Chip

**Application**

2.45GHz Active RFID Temperature Sensor Tag

**Patient Friendly Sensing Systems**

- Sensor physics and new sensing materials
- Modelling and simulation
- *Focus in* microsensors, biosensors and *wireless sensors*
- Applications of *commercial sensors*
UWB Radar Sensor for u-Health Service System

**What is the UWB?**

1. **Ultra-Wide-Band** spread transmitting energy across a wide spectrum of frequency, such that the energy in any frequency band is below the noise floor.
2. **Short duration pulses** in the picoseconds or subnanosecond range resulting in several GHz bandwidth.
3. The UWB signal can be transmitted with no carrier with a low power.
4. **Promising technology** for many aspects of biomedical applications.

**Medical Application of UWB**

1) Breathing Detecting
2) Noninvasive Glucose detecting
3) Fetal monitoring
4) Straight forward hearts and breath activities Monitoring
Examples of u-Health Products

Infineon: Electronic Textile Sensors

Wearable Electronics: Infineon provides basic technologies for smart clothes

Examples of u-Health Products

Sensatex – Smart Shirt: Electronic Textile Sensors

Sensatex™ Smart Shirt

- Wearables used as emergency medical devices
- Monitors heart rate and respiration
- Uses flexible electronics and textiles
- Can be integrated into clothing

Other Applications
- Rehabilitation and physical therapy
- Monitoring athletes
- Personalized health monitoring

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Examples of u-Health Products

Vivometrics: Life Shirt

Phillips: Electronic Textile Sensors

Towards ambulatory fetal monitoring

- Wearable at home
- Sleep in the normal bed
- Shopping, in clothing
- Lightweight
- Long battery life
- Rechargeable
- Simple status indicator

ECG measurement through clothing

New Wearable Packages and Hardware Modules
Examples of u-Health Products

Phillips: Electronic Textile Sensors

- Context aware mobile phone
- Textile electronics
- Body area networks

Textile Electronics

- Intelligent capsules
- woven into fabric
- self-regulating networks of cells
- able to monitor F, p, or vibrations

Body area networks

- Mobile, wearable
- Multi parameter
- Electroencephalogram sensors
- Cardiographic
- Wearable and active in cable
- Safe, reliable operation
- Integrated patient identification

Examples of u-Health Products

Polar/Adidas: Electronic Textile Sensors

- Polar Electro and Adidas, one of the world’s leading sports brands, have formed a partnership to introduce the world’s first completely integrated training system called “Project Fusion” (August 10, 2005) which integrates Polar heart rate and speed and distance monitoring equipment into Adidas apparel and footwear.
- The system integrates the Adidas “AdiStar” Fusion range of apparel (T-shirts, long sleeve shirts, bras, women’s tops), the Adidas AdiStar Fusion shoe, Polar’s 63 Stride Sensor, The Polar WearLink transmitter and The Polar RS800 Running Computer into one complete system that simplifies use and increases comfort for the athlete.
- Purchasing the entire kit will be around 640 Euros/880 Dollars (available as separate pieces as well, and available in spring of 2006).

The Adidas AdiStar Fusion range of apparel includes T-shirts, long sleeve shirts, bras and women’s tops.

The Polar WearLink transmitter and the heart monitoring bra.

The Polar RS800 Running Computer.
Examples of u-Health Products

Phillips : Electronic Textile Sensors

Philips Research has developed a wearable, wireless monitoring system that can warn patients with underlying health problems. The system uses dry-electrode technology that can be built into common items of clothing like bras, shorts or waist belts.

Examples of u-Health Products

Phillips : HeartCare Telemedicine Services

Transmission and comparative analysis of ECGs
Examples of u-Health Products

**Phillips: Cardiac Telemonitoring System**

*Integrated Care of Cardiac Patients*

- Telemedicine:
  - Integrated part of a Total Care System
  - Ensures the best possible care for Post Event Cardiac Patients

**Monitor Center**

365 Days / 24 Hours

Medical Specialists and Monitor Center Professionals (MCP)

**Card Guard Health Mobile Phones (Israel)**

- 1 and 12-lead ECG event recorder
- Blood pressure
- Glucometer
- Thermometer
- Spirometer
- SpO₂

**HUMANA**

*Guidance when you need it most*
Examples of u-Health Products

CardioNet: Mobile Cardiac Telemetry

**Description:**
CardioNet’s mission is to help clinicians prevent morbidity, mortality and disability with rapid diagnostic and treatment, initially focusing their efforts on patients with cardiovascular disease. CardioNet’s main product focuses on real-time arrhythmia analysis (see below for what is an arrhythmia).

![CardioNet images](image1.png)

Qualcomm’s Personal Health MVNO, LifeComm

Qualcomm is prepping to launch a mobile virtual network operator (MVNO) company called LifeComm, which is centered on healthcare but with a broader appeal to consumers interested in wellness, fitness and health maintenance (the 2nd half of 2008).

- **Target demographic:** women ages 40 to 65
- **Potential services:** fitness, weight management, diabetes management as well as monitoring services for heart health, hypertension and congestive heart disease.

![LifeComm images](image2.png)
Examples of u-Health Products

Debiotech: Subcutaneous Infusion of Insulin for Diabetes

- R&D Organization which integrates today’s best industrial skills and numerous collaborations with industrial groups (Currently under development).
- Debiotech performs research and development on medical devices based on breakthrough discoveries in microtechnology, micromechanics and microelectronics.
- Debiotech’s main objective is to improve drug tolerance and therapeutic efficacy through innovative and cost-effective drug delivery systems where high-tech disappears in end-user simplicity.

Chronojet: A novel miniaturized pump for insulin delivery.

A new concept for diabetes therapy

Gulucose Sensing Contact Lenses

Non-invasive monitoring of physiological glucose

- Contact lenses which sense the glucose levels in the tear fluid of the wearer’s eye, which may be linked to the concentration of glucose in the blood (fluorescent sensor spots which change color in response to tear glucose levels, which track blood levels with a 30 minute lag time).
- Changes in the glucose level in the tear fluid alter the wavelength of light reflected by the ‘sensor hologram’ in the contact lens.
- Detected by a small device held up to the eye to give an accurate reading of the wearer’s glucose level.

— Smart Holograms (in Cambridge)
: developing the sensors
: supervised by Dr Tony James and Dr Steve Hall of the University of Bath’s Department of Chemistry.

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Examples of u-Health Products

Pendragon Medical System
Solution for continuous non-invasive glucose monitoring

- Benefits
  - Improves the compliance for a tighter control of diabetes
  - Helps to simplify the therapy management of diabetes - acute and long term
  - Reduction of diabetes complications by continuous monitoring and management of hypo- and hyperglycemic conditions
  - Storage capacity of 1 month for glucose and alarm history data
  - 80/DS User Software to manage patient data

Electromagnetic field is interacting with tissue and blood

Variations of glucose level and movement of glucose through the cell membrane such as erythrocytes lead to a charge in the electrolyte concentrations and hence to an alteration in the interfacial polarization of the cell membrane - conductivity and permittivity variations e.g. of erythrocytes.

These effects cause changes in the electromagnetic properties of the human skin and underlying tissue, which are measured by the device.

Public/Private Health Sectors Innovation

3.1 EHR Construction

Severance Hospital
Cooperate with IT company

Samsung Hospital
Apply to EHR of Inpatient
Apply to EHR of Outpatient

Seoul St. Mary’s Hospital
Apply to EHR of Inpatient
Apply to EHR of Outpatient

Samsung/LG/TeleCom
Unified of the HIS of Grand Hospital
Cooperate with Hospital Market

Asan Hyundai Hospital
Cooperate with IT Company

Seoul Nat’l Hospital
Slipless
Filmless
Paperless
Chartless

Inha Hospital
EHR of Outpatient
the EHR of Outpatient is extending more

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Conclusions

- **New wireless technology** (ambulatory or implantable wireless sensors) will **dramatically change** the way we understand healthcare today.
- This development provides the enabling technology for **real long term monitoring** of physiological functions in sports, home health care as well as in hospital environment.
- **The healthcare system** will become more mobile, demand driven, efficient, and person/patient friendly.
- **New wireless sensors and measurement systems** have a huge market potential.
Thank you for your attention!!