Motivation for Biosensors as a Tool in the Pursuit of Wellness

- State of complete physical, mental and social well-being
- Health results from primarily positive perspectives and choices by which to live
- Diagnostics can provide information that facilitates positive choices
Wellness Support

- Growing need for new sources of data, and data interpretation
- Integration of multiple diagnostic sources (lifestyle, self testing, doctor’s office testing)
- Integrated wellness and health record
- Ongoing information support for maintaining healthy lifestyles

Diagnostic Wellness Technologies

- Biomarkers
- Nutrition
- Exercise
- Biometrics
- Pain
- Stress
- Sleep
- Mood

Wellness Support

- Food coaching
- Rewards
  - Exercise
  - Nutrition
  - Therapeutic compliance
- Consequence reporting
- Consequence forecasting

Overcome vicarious goal fulfillment or, “exhaustion of self-control”
Home Health IT

- New revenue sources: Medical Cloud coaching and Interpretations

Technologies will be needed to measure the spectrum of health

Wellness → Disease

Wellness Tools
- Accelerometer based
- Various models for data delivery
- Basic physiologic measurements

Information Week

BodyMedia
FitBit
Shine
Misfit
Scanadu
Tricorder
Zephyr

Implantable Continuous Glucose Monitoring

Dexcom
Challenges With Implantable Sensors

- Negative tissue response
- Poor sensor temporal responses
- Sensor fouling
- Implantation trauma
- Implantation infections
- Aesthetics

Portable Diagnostics

- iPhone based portable ultrasound
- EKG
- Otoscope
- Dermatoscope
- Microscope

Cell Scope™

- Dermatoscope – iPhone clip-on
  - Transmits high quality magnified pictures of skin blemishes
- "Smart Otoscope" – iPhone ear drum microscope
  - Transmits pictures of videos of the ear canal and ear drum
  - Looks at progression or regression of disease
Otoscope Images

Normal Ear Drum  Ear Infection  Ruptured ear drum

Cloud Based Diagnosis of Parkinson's

- Non-invasive phone based
- Accurate (98%)
- Remote, non-expert
- Low Cost
- Rapid diagnosis
- Scalable to large populations

Max Little - Parkinson’s Voice Initiative TED Conference 2012

Wearable Cancer Detection

- First Warning Systems™ heat distribution sensing sports bra
**iPhone Body Fluid Diagnostics**

- Biosense Technologies
  - uCheck
- TouChb

**KNOWS**
- You and what is around you

**LEARNs**
- What you like

**DISCOVERS**
- Things relevant to you

**FILTERS**
- Out the irrelevant

**SENSING**
- Local content & services discovery

**SEEING**
- Augmented reality UI: Map, 3D, in building navigation

**INTERACTING**
- Connection manager (WAN, Wi-Fi)

Source: Jarrin (Qualcomm)
PASSIVE WELLNESS MONITORING

The Passive In-Home Health Monitoring Project

- Create a model where the impact of chronic disease is delayed or avoided
- Provide opportunity for medical intervention before a crisis occurs
- Minimize impact of chronic disease on the healthcare system
- Develop a platform on which passive biosensor technologies may be deployed

Passive Remote Sensing

- Wireless Sensor Array (WSA) – gathers data on daily activities and physiology
- Data Manager (DM) – transmits data to data analysis servers
- Capture Analysis & Reporting Engine (CARE) – captures potential problems and alerts caregiver
Vibration
Proximity
Vibration

Passive Proximity and Gait Sensors

Pulse and breathing sensors embedded

Passive Proximity and Gait Sensors

Mattress pad to measure:
- Sleep quality
- Pulse (and HRV)
- Breathing
- Movement/restlessness
- Bed exit
- Subject position/turning
- Body temperature
- Blood Pressure

Passive Vital Sign Bed Monitor
Automated Triage

- Real time assessment of participant health status/well being
- Ability to drill down to specifics
- Built in automated optimized dispatching
- Manual override of dispatch event or downstream processes
One Click Trending

- Health
- Socialization
- System utilization

Telehome Monitoring Decreases Costs by 74%

N=21 in each group. P<0.05; Telemed J E Health, 2007 13(3):279-85

PASSIVE BIOMARKER SENSORS
Passive Wellness Monitoring

- Vital Sensor
  - Body temperature
  - Pulse
  - Blood Pressure
  - Body fat percentage

Data management PC

- Urine analyzer
- Urine protein
- Urine glucose

Healthcare providers

Network

Passive Automated Pharmaceuticals

- iPill (Philips) Networked pills (Proteus Biomedical)
  - Instrumented Pills
  - Cost < $0.01
  - Measure and send physiologic signals through body electrically
  - Receiver is a patch worn on the body that also logs respiration, heart rate and body movement, sleep patterns

The Eye as the Window to Health

- UCSD

Preventive Science Inc.

Univ. of MD, Baltimore
MeyeChem, LLC: Lachrylmal Canaliculus Tear Based Chemistry Lab

- Measures tear chemistry continuously
- Reports values to cell phone

Manufacturing Process

Simulated Tear Glucose Standard Curve

Amperometric detection of 20-200 μM glucose using a 1232A CH Instruments Electrochemical Analyzer, then filtering the data to smooth out the noise using an 8th ordered Low Pass Filter with the MATLAB software.
Long Term Stability of Glucose Measurements

MeyeChem, LLC
- Real time glucose monitoring
- Alerts for low or high glucose concentrations
- Trend analysis and prediction
- Food coaching via tele-nutritional-mentoring

Summary
- Ubiquitous computing will enable portable health
- Sensors will be inserted, implanted, worn, and passive
- Interpretation will be automated
- Motivation for wellness will be self directed or coached by a wide variety of providers
Medical Automation.org

A non-profit educational organization improving healthcare quality and efficiency through teaching automation principles and their application in health systems

http://medicalautomation.org

TagLine - BioMedical reality

http://medicalautomation.org