Wireless Technology in Global Health: Moving towards a new paradigm in medicine

Enrique Saldivar, MD, MSBME, PhD.
Director, Wireless Health Program
Abstract: The healthcare challenges imposed by a continuously changing population, in both industrialized and under-developed countries, will continue to increase as we observe a growth in the underserved segments of the population. On the one hand, industrialized countries face a growth of their elder population where the problem of healthcare delivery will worsen with time, because people tend to live longer. On the other hand, under-developed communities experience a growth based on the survival of their young, due to improved sanitation. It is expected that this tendency will continue and survival will improve even more in the future. Further complications in healthcare delivery arise when low and middle income countries transition to urbanization of the population, as they face a combination of pathological conditions known as the double burden of disease. However, it can be expected that a paradigm shift in healthcare delivery can help to ameliorate the problems in both ends of the spectrum. It is postulated that the adoption of Wireless Health solutions will provide a paradigm shift in the structure of the healthcare delivery systems at the global scale. It is expected that the nature of this new healthcare delivery system will be patient centric, ubiquitous, and preventive. The implementation of Wireless Health depends on product development and technology deployment, and is a continuously and rapidly evolving field in a highly competitive and complex environment. The high level of competition is due to Wireless Health being the next “Gold Rush” and the complexity is due to a highly regulated industry that converges in high-tech, clinical, and health management. The successful deployment of Wireless Health solutions require a complex skillset seldom found in an individual. A structured ad-hoc educational program can prevent the potential high cost of the traditional deployment path of “learn-it-as-you-go”.
• The challenge
• Examining the current global healthcare landscape
  • Industrialized Countries (US example)
  • Emerging Economies
• Shift in paradigm in global healthcare
  • Framework
  • Pragmatic aspects
• The importance of focused educational programs in Wireless Health in facilitating the shift in paradigm in global healthcare
• The challenge
• Examining the current global healthcare landscape
  • Industrialized Countries (US example)
  • Emerging Economies
• Shift in paradigm in global healthcare
  • Framework
  • Pragmatic aspects
• The importance of focused educational programs in Wireless Health in facilitating the shift in paradigm in global healthcare
• There is an unmet need to provide healthcare in the aging population in industrialized countries as the medians of their population are expected to further increase

• There is an unmet need to provide healthcare in the growing population of emerging economies

• There is an unmet need to provide healthcare in the newly urbanized populations in developing economies facing the double burden of disease
• The challenge
• Examining the current global healthcare landscape
  • Industrialized Countries (US example)
  • Emerging Economies
• Shift in paradigm in global healthcare
  • Framework
  • Pragmatic aspects
• The importance of focused educational programs in Wireless Health in facilitating the shift in paradigm in global healthcare
The problem: Total Health Expenditures, 2008


The problem: How big is it?

National Health Expenditures, $2.6 Trillion in 2010

Centers for Medicare & Medicaid Services, Office of the Actuary.
Age and poverty distribution

Source: www.CensusScope.org
• The challenge
• Examining the current global healthcare landscape
  • Industrialized Countries (US example)
  • Emerging Economies

• Shift in paradigm in global healthcare
  • Framework
  • Pragmatic aspects

• The importance of focused educational programs in Wireless Health in facilitating the shift in paradigm in global healthcare
The global population

GDP per capita- purchasing power parity

Life expectancy at birth

Source: World Bank; CIA World Factbook
The double burden of disease

Modified from:
The challenge
Examining the current global healthcare landscape
  - Industrialized Countries (US example)
  - Emerging Economies

Shift in paradigm in global healthcare
  - Framework
  - Pragmatic aspects

The importance of focused educational programs in Wireless Health in facilitating the shift in paradigm in global healthcare
When a major transformation in the environment results in an improvement of community health there is a shift in the medical paradigm.
Wireless technologies have:
- Rapid adoption rates
- Quasi-universal connectivity (global information transfer)

Good candidate to provide the next paradigm shift in healthcare
Applications of Wireless Technology in Healthcare

• Education and Awareness
• Remote data collection (lab and population studies)
• Remote monitoring (telemetry)
• Communication and training for healthcare workers
• Disease and Epidemic Outbreak Tracking
• Diagnostic and treatment support

Classification of wireless networks

• Wireless personal area networks
  • Small area communications.
  • Low power radios
• Wireless local area networks –
  • Interconnectivity to the internet (WiFi)
• Wireless metropolitan area networks
  • Interconnection of several WLANs
• Wireless wide area networks –
  • Cities and suburban areas
• Mobile device networks –
  • Based on cellular towers.
  • Cover large geographical areas
• Wireless body area network –
  • Interconnect wearable devices with a central unit
Proposed functional classification of wireless infrastructures

- Basic wireless infrastructure
  - fundamental communications
  - Emergency situations.
  - Education.
  - Disease outbreaks.
- Supporting wireless infrastructure
  - administrative functions.
  - Vaccine tracking.
  - Inventory.
- Development wireless infrastructure
  - development framework for innovation in healthcare

“From a public health perspective, an effective clinical system has five essential characteristics: consistency, patient-centeredness, team-based care, registry-based information systems, and continuous improvement in treatments and delivery”


Wireless Health offering: patient centric, ubiquitous, and preventive.
• The challenge
• Examining the current global healthcare landscape
  • Industrialized Countries (US example)
  • Emerging Economies

• Shift in paradigm in global healthcare
  • Framework
  • Pragmatic aspects

• The importance of focused educational programs in Wireless Health in facilitating the shift in paradigm in global healthcare
Enhancing quality
Targeted care, at the right time, based on collection and/or communication of relevant health data and information. New care possibilities that are enabled through continuous monitoring, wireless communication and/or rich new databases of disease conditions.

Improving convenience
By the mobility to patients and healthcare providers.

Extending reach
Possibilities in diagnosis, therapy and monitoring at a distance and/or in places otherwise difficult to reach.

Reducing cost
Keeping patients out of care facilities through preventative care solutions and timely diagnosis. Reducing errors and amplifying the productivity of the health care providers.

Technology availability
The extent and richness of solutions possible to a wide range of health problems.

Acquisition and ownership cost
Costs associated with purchasing the solutions and operating/maintaining them, respectively.

Regulatory efficiency
The time and cost associated with obtaining approval for specific solutions to particular health problems.

Reimbursement policy
Covering the cost of utilizing wireless health solutions, including when used for prevention, which is a great application opportunity for wireless health but not reimbursable for the most part today.

Technology availability = Sensor dev opportunity
The extent and richness of solutions possible to a wide range of health problems.

Acquisition and ownership cost
Costs associated with purchasing the solutions and operating/maintaining them, respectively.

Regulatory efficiency
The time and cost associated with obtaining approval for specific solutions to particular health problems.

Reimbursement policy
Covering the cost of utilizing wireless health solutions, including when used for prevention, which is a great application opportunity for wireless health but not reimbursable for the most part today.

Sensor applications in healthcare
### Top chronic diseases and related sensors

<table>
<thead>
<tr>
<th>Chronic Disease</th>
<th># in U.S.</th>
<th>Sensor Types Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alzheimer’s</td>
<td>5 M</td>
<td>Vital signs, location, activity, balance</td>
</tr>
<tr>
<td>Asthma</td>
<td>23 M</td>
<td>RR, FEV1, air quality, oximetry, pollen count</td>
</tr>
<tr>
<td>Breast cancer</td>
<td>3 M</td>
<td>Ultrasound self-exam</td>
</tr>
<tr>
<td>COPD</td>
<td>10 M</td>
<td>RR, FEV1, air quality, oximetry</td>
</tr>
<tr>
<td>Depression/ Mood Disorders</td>
<td>21 M</td>
<td>Med compliance, activity, communication</td>
</tr>
<tr>
<td>Diabetes</td>
<td>24 M</td>
<td>Glucose, hemoglobin A1C</td>
</tr>
<tr>
<td>Heart Failure</td>
<td>5 M</td>
<td>Cardiac pressures, weight, BP, fluid status</td>
</tr>
<tr>
<td>Hypertension</td>
<td>74 M</td>
<td>Continuous BP, med compliance</td>
</tr>
<tr>
<td>Obesity</td>
<td>80 M</td>
<td>Smart scales, caloric in/out, activity</td>
</tr>
<tr>
<td>Sleep Disorders</td>
<td>40 M</td>
<td>Sleep phases, quality, apnea, vital signs</td>
</tr>
</tbody>
</table>

Changing landscape: The role of sensors

(Accessed at http://www.frogdesign.com/)
A Cheap, Portable Way to Monitor Unborn Babies

A nonprofit creates a new heart monitoring machine employing wireless technology.

WEDNESDAY, APRIL 20, 2011  |  BY EMILY SINGER

Maternal monitoring: A device designed by the West Wireless Health Institute measures fetal heart rate via an ultrasound monitor (lower belt) and maternal contractions via another sensor (higher belt), and then transmits the data via Bluetooth to a tablet (left). Credit: West Wireless Health Institute

An inexpensive portable device could make it easy to monitor fetal health in remote locations, and it might also provide an alternative more expensive machines currently used in doctors’ offices in the developed world.
• The challenge
• Examining the current global healthcare landscape
  • Industrialized Countries (US example)
  • Emerging Economies

• Shift in paradigm in global healthcare
  • Framework
  • Pragmatic aspects

• The importance of focused educational programs in Wireless Health in facilitating the shift in paradigm in global healthcare
Geo-economical landscape in Southern California
• Biomedical engineering (BME) is the application of engineering principles and design concepts to medicine and biology for healthcare purposes (e.g. diagnostic or therapeutic)
• California leads the nation in biomedical firms, jobs, output, federal grants and patents
• BME is one of the fastest growing professions today. The Bureau of Labor Statistics forecasts a 62% growth in BME jobs from 2010 to 2020.
SoCal Biomedical Industry

- Differentiated by emerging convergence of opportunities at intersections of wireless, biotech and medical devices—also leading positions in each
- San Diego and Orange Counties together employ ~80,000 in the biomedical industry, versus ~63,000 for Bay Area. LA County ~$52,000

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bay Area*</td>
<td>62,603</td>
</tr>
<tr>
<td>Los Angeles County</td>
<td>52,071</td>
</tr>
<tr>
<td>Orange County</td>
<td>41,809</td>
</tr>
<tr>
<td>San Diego County</td>
<td>37,697</td>
</tr>
<tr>
<td>Riverside and San Bernardino counties</td>
<td>14,060</td>
</tr>
<tr>
<td>Ventura and Santa Barbara counties</td>
<td>11,093</td>
</tr>
<tr>
<td>Northern California**</td>
<td>10,572</td>
</tr>
<tr>
<td>Sacramento County</td>
<td>3,777</td>
</tr>
<tr>
<td>TOTAL</td>
<td>267,000</td>
</tr>
</tbody>
</table>
• 2nd only to Computer and Peripherals Equipment manufacturing
• Wireless Health and Wearable Computing are at the intersection of electronics and BME
• They expand your opportunities in a unique way
• **University NIH Funding:** UC San Diego ($358M), TSRI ($198M) and UC Irvine ($121M) together $677M, versus $1,007M for UC San Francisco ($487M), Stanford ($339M) and UC Davis ($180M) together. Add in UCLA ($331M), USC ($181M) and CalTech ($57M), SoCal’s exceeds Bay Area

• **Angel network:** Tech Coast Angels, the largest angel investment organization in the US, features over 300 members covering all of Southern California and leads all angel groups in network strength

• **VC investing in US:** San Diego ($1,134M, ranked #6) and LA ($1,677M, ranked #5) together surpass NY City ($2,269M, ranked #4) and are close to Boston ($3,101M, ranked #3)

• **Incubator example EvoNexus founded in San Diego (2009), expanded to Irvine (2014):** $594M raised, 1,000 jobs created, 9 acquisition, 41 currently incubating, 846 total applications, 81 portfolio companies with 81% still active
How to proceed?
How to navigate the current landscape?

Patentability  De Novo
User experience  Class I, II, III
FDA  FCC
HIPAA  QC
PMA  Usability
IRB  QA
CMS
Business model  Reimbursement
FTO  510(k)  Funding
Product design
How to navigate the current landscape?

- Patentability
- De Novo
- User experience
- Class I, II, III
- FDA
- FCC
- HIPAA
- QC
- PMA
- Usability
- IRB
- QA
- CMS
- Reimbursement
- Business model
- 510(k)
- FTO
- Product design
- You
MS DEGREES

Wireless Health in BME

- **480A**: Intro to Wireless Health
- **480B**: The Human Body
- **480C**: Biomedical Sensing
- **480D**: Health Care Delivery Ecosyst
- **480E**: Wireless Communications
- **480F**: Physicians and Hospitals
- **480Q**: Regulatory Policy and Reqs
- **480R**: User Experience Engr
- **480S**: WH Product Development

Wearable Computing in EECS

- **480T**: Design
- **480U**: Technology
- **480W**: Manufacturing
- **480X**: Computing
- **480Y**: Embedded Systems
- **480Z**: Applications Development
- **480G**: Cryptography
- **480H**: Software Security
- **480K**: Hardware Security
In addition to helping turn concepts into knowledge, our course assignments, projects and faculty interactions are designed to teach:

• Critical analysis
• Problem solving
• Reduction to practice
• Technical communication
• Teamwork

All surveys show that these skills are highly valued by employers and critical to the individual's success in the 21st Century landscape.
Abstract:
The healthcare challenges imposed by a continuously changing population, in both industrialized and under-developed countries, will continue to increase as we observe a growth in the underserved segments of the population. On the one hand, industrialized countries face a growth of their elder population where the problem of healthcare delivery will worsen with time, because people tend to live longer. On the other hand, under-developed communities experience a growth based on the survival of their young, due to improved sanitation. It is expected that this tendency will continue and survival will improve even more in the future. Further complications in healthcare delivery arise when low and middle income countries transition to urbanization of the population, as they face a combination of pathological conditions known as the double burden of disease. However, it can be expected that a paradigm shift in healthcare delivery can help to ameliorate the problems in both ends of the spectrum. It is postulated that the adoption of Wireless Health solutions will provide a paradigm shift in the structure of the healthcare delivery systems at the global scale. It is expected that the nature of this new healthcare delivery system will be patient centric, ubiquitous, and preventive. The implementation of Wireless Health depends on product development and technology deployment, and is a continuously and rapidly evolving field in a highly competitive and complex environment. The high level of competition is due to Wireless Health being the next “Gold Rush” and the complexity is due to a highly regulated industry that converges in high-tech, clinical, and health management. The successful deployment of Wireless Health solutions require a complex skillset seldom found in an individual. A structured ad-hoc educational program can prevent the potential high cost of the traditional deployment path of “learn-it-as-you-go”.

Concluding remarks
Many thanks!

http://engineering.case.edu/sandiego/

enrique@case.edu

@RainmakerTech