m.Health: The Emergence of a New Ecosystem for Healthcare Delivery, Global Public Health and National Security

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Healthcare: Major Unmet Needs and Unsustainable Systems

- infinite demand versus finite resources
- unsustainable costs and massive inefficiencies
- escalating global threats/instabilities

- prospering in an era of escalating economic constraints
- managing the limit(s) of society’s willingness and ability to pay for innovation
- global health: risk mitigation, economic productivity, equity
The Economic, Social and Clinical Benefits of Proactive Mitigation of Disease Risk and Chronic Disease Co-Morbidities (G8:OECD)

Health Status

20% of the Population Generate 80% Cost

- Healthy/Low Risk
- At-Risk
- High Risk

20% of the Population Generate 80% Cost

- End-of-life care
- Chronic disease progression
- Chronic disease early stage
- Acute disease

Value → Cost
The Challenge of Cost Reduction and Improved Quality-of-Life

- **Home Care and Medical Home**
  - healthy, independent
  - local MD
  - community clinic
  - chronic disease mgmt.

- **Residential Care**
  - assisted living
  - skilled nursing care
  - hospice
  - long term care

- **Acute Care**
  - specialty clinic
  - community hospital
  - ICU

<table>
<thead>
<tr>
<th>Quality-of-Life</th>
<th>Cost Per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>high</td>
<td>$100 - $10,000</td>
</tr>
<tr>
<td>low</td>
<td>$100 - $10,000</td>
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</tbody>
</table>

- **Notes:**
  - ICU: Intensive Care Unit
  - MGmt: Management

- **Comparison:**
  - Home Care and Medical Home: Low cost, high quality.
  - Residential Care: Moderate cost, moderate quality.
  - Acute Care: High cost, low quality.
From Healthcare Delivery to Health (Wellness) Systems and Services
Reframing the Healthcare Debate: Reimaging Healthcare as a Designed Service

- high quality and affordable care
- the wellness imperative
- major redesign of the way:
  - healthcare services are organized and delivered
  - medical knowledge is disseminated and measured to ensure best practices
  - accountability of consumers/patients for self-management
- commitment to improved global public health
The Key Strategic Elements in the Evolution of Healthcare

- Molecular medicine
- Health status monitoring
- Risk management
- Optimized decisions
The Key Strategic Elements in the Evolution of Healthcare

- Molecular diagnostics for disease prediction, prevention, earlier detection
- Biomarkers for health status profiling
- Molecular medicine
- Risk management
- Health status monitoring
- Optimized decisions
- E.Care: EMR, PHR integrated care and wellness
- M.health
- Prevention
- Disease subtyping and Rx choice
- Compliance
- M.health
The Future of Mobile Communications: A Global Cooperation for the Advancement of Mobile Health and Wellness

- empower individuals to manage their health
- extend health services to people at all economic levels
- evidence collection for best practices and promote ROI
- integrate m.health into payment programs
- incentivize government investment in long term programs
- facilitate connectivity between critical infrastructure and health delivery networks
- open ecosystem: interoperability, innovation, competition and consumer choice
The Evolving m. Health Ecosystem
The Evolving m.Health Ecosystem

- technology
- regulation
- legal
- financial

- incentives
- behavior change
- metrics

- new services
- new business models
- new organizational relationships

DEMONSTRATING VALUE
You, Me and Health in a Networked World

- mobile
- multimedia
- monitored
- measured
- me, and those like me
- multiple markets of one, but primarily ME!
Mobile Services: Universal, Personalized and Indispensable

- 5 billion plus mobile phones, 6 billion projected by 2013
- 3 billion more than any other consumer electronic devices
- 750 + million 3G mobile users, 1.6B projected by 2012
- 7 trillion wireless devices serving 7 billion by 2017
- Projected 1000 wireless devices per person by 2017 (source WWRF)
  - devices, smart homes, intelligent cars, consumer goods and healthcare
Remote Health Monitoring and Chronic Disease Management

Information for Proactive Health Awareness (Wellness)

Lifestyle and Fitness
Mobile Services and Web 2.0
AORTA: Always On, Real Time Access

- collapsing time and space
  - access, analysis and action
- everybody on the net: one world
  - services, surveillance and security
- every body on the net (Qualcomm)
Wireless Integrated Data Systems

- geolocation data (where)
- temporal information (when)
- contextual information (what)
Major Drivers of m.Health

- networked sensor systems
- device miniaturization
- diverse signal capture
- complex signal deconvolution
- broadband wireless
- blended physical and virtual environments
- integrated personal technologies
- embedded intelligence
- intelligent environments
Major Drivers of m.Health

- remote health status monitoring
- real time monitoring of networked sensors
- deconvolution of complex, diverse signals
- mobility and behavior patterns
- social networks
- epidemiological and outcomes data
- continuous, integrated analytics
- large scale database federation
- EHR/PHR uploading
- privacy and security
- health performance metrics (systems and individuals)
Major Drivers of m.Health

- distributed networks and POC monitoring/decisions
- remote health status monitoring
  - patient self-management/accountability
  - Rx compliance
- improved supply chain/care delivery process/resources allocation
- performance and outcomes metrics
- trusted health information services
- increased knowledge symmetry between providers/patients/payors
- social networks and empowerment
- evidence-based decisions and decision-support tools
On-Body: In-Body Sensors (OBIBs) for Health Status Monitoring

- minimally intrusive/invasive
- portable/mobile
- point-of-care (POC)
- multi-parametric
- real-time monitoring and actionable feedback for decisions/recommendations
- extended lifetime and reliability
- accuracy, safety and security
On-Body: In-Body Sensors

- extended lifetime: ultra-low power sources
- sensor processing and transmission cycles
- sensor networks: data aggregation and integration from multiple sensors
- complex signal deconvolution
- data volume and storage
- security and privacy
- passive and active feedback loops
- regulation
“This isn’t a device it’s a service.”

Jeff Bezos
CEO, Amazon
Wearable Technology

Concepts for Flexible Monitoring

Living by NUMBERS

Track your data.
Analyze your results.
Optimize your life.

Plus
The Nike+Apple Experiment:
1 Million Runners and Counting

culture | Jul 2006

62.1 VO2 max
202 Max heart rate
1,890 Metabolic rate
88 Blood Glucose
Gaming for Health:
myFoodPhone

'Take a photo and get advice'

As seen on:
- abc
- CNN
- WSJ
- The Washington Post
- CBC
- CTV
Consumer Behavior and Healthcare Costs

“diabesity” $200 billion

smoking $190 billion
alcohol $20 billion
PressureAlert™ Orthotic System

A pressure sensing Orthotic to alert patients and/or their caregivers when blood flow may have been compromised to the point where serious injury may occur.
# Major Target Markets for Wireless Medicine

<table>
<thead>
<tr>
<th>Disease</th>
<th>*Patients</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alzheimer’s</td>
<td>5 million</td>
<td>vital signs, location, activity, balance</td>
</tr>
<tr>
<td>Asthma</td>
<td>20 million</td>
<td>respiratory rate, FEV, air quality, oximetry, pollen count</td>
</tr>
<tr>
<td>Breast CA</td>
<td>3 million</td>
<td>ultrasound self-exam</td>
</tr>
<tr>
<td>COPD</td>
<td>10 million</td>
<td>respiratory rate, FEV, air quality, oximetry</td>
</tr>
<tr>
<td>Depression</td>
<td>19 million</td>
<td>medication compliance, communication</td>
</tr>
<tr>
<td>Diabetes</td>
<td>21 million</td>
<td>glucose, hemoglobin ATC</td>
</tr>
<tr>
<td>Heart Failure</td>
<td>5 million</td>
<td>cardiac pressures, weight, blood pressure fluid status</td>
</tr>
<tr>
<td>Hypertension</td>
<td>74 million</td>
<td>continuous blood pressure monitoring, medication compliance</td>
</tr>
<tr>
<td>Obesity</td>
<td>80 million</td>
<td>smart scales, caloric in/out, activity</td>
</tr>
<tr>
<td>Sleep Disorders</td>
<td>15 million</td>
<td>sleep phases, quality, apnea, vital signs</td>
</tr>
</tbody>
</table>

From: West Wireless Health Institute, Medtech Insight, August 2009
The Costs of Non-Compliance with Rx Regimens

- $177 billion projected cost
- 20 million workdays/year lost (IHPM)
- 40% of nursing home admissions
- Projected 45-75% non-compliance (WHO)
- 50-60% depressed patients (IHPM)
- 50% chronic care Rx (WHO)
Intelligent Medicine Dispensers for Enhanced Rx Compliance
Patients

- allow for more home-based care (68%)
- perceived reassurance by patients and family (57%)
- more freedom of choice (51%)

Physicians

- estimated 25-40% patients would benefit
The Patient Experience

- most appropriate care and best outcome
  - access to clinical expertise
- much more than the clinical encounter
- "touch points" in a period of vulnerability
  - first and last impressions of myriad non-clinical events
  - efficiency, compassion
  - support for family members
  - transparency

Personalized ("Me")
‘The Medical Home’: Integrated Care Services for Independent Living

Connected Care
Technology-enabled Care at Home

Produced by the Deloitte Center for Health Solutions

State of Technology in Aging Services According to Field Experts and Thought Leaders

By:
Majd Alwan, Ph.D.,
Center for Aging Services Technologies (CAST)
American Association of Homes and Services for the Aging (AAHSA)

and

Jeremy Nobel, M.D., M.P.H.,
Harvard School of Public Health

Report Submitted to: Blue Shield of California Foundation

February 2008
Key Determinants in Adoption of m.Health

**technical**
- standards, inter-operability, scaleability
- integrated multi-sensor feeds
- validation analytics for multiplex biomarker profiles
- dynamic monitoring, dbase integration and facile real-time analytics

**regulatory**
- certification and safety standards for multi-vendor solutions

**financial**
- value-based versus cost-based reimbursement
- new co-pay solutions
- risk of ‘vendor lock-in’ for high CapEx in immature technology domains

**legal**
- error liability, DOS
- security and privacy
If You Build It Will They Pay?
Adoption of Disruptive Innovation

- new technology/service that simplifies a complex/costly problem
- business model that allows market adoption of the simplified solution at low(er) cost
- incentivized supply and demand to networks to reinforce the disruption
“If it isn’t billable – it isn’t going to happen!”

You have a (healthcare) system that traps us into bad performance because it’s the only way you can bill”

Hon. Newt Gingrich
Medical Device Daily (2009) 27 Jan. p8
In-Home Health Connections: Engaging the Elderly
In-Home Health Connections: Engaging the Elderly

- 30 reporting countries
- continued low percentage of use in older age groups
- only USA (42%) and Sweden (41%) exceed 40% use by 65yr or older cohort
technology is only the enabler

emergence of new organizational structures, alliances and business models

engage and educate multiple constituencies with long entrenched behaviors

‘care’ space will be increasingly decentralized
  – from hospital/clinic to ‘personal health space’

from episodic encounters to continuous interactions

new business opportunities in customized health services and health broker/concierge services
Digital Health and New Delivery Pathways

- new organizational/business models
- rapid expansion of e.health/m.health
- social media and promotion/adoption of OTC/wellness/lifestyle products/services
- integration of consumer health product categories with remote health monitoring services
- new ‘infomediaries’ will change balance of power between healthcare professionals and consumer
  - transparency, positive outcomes and performance
  - consumer choice
The Fundamental Drivers of Healthcare Delivery: Implications for Training Physicians and Healthcare Professionals

- molecular medicine
- engineering-based medicine
- information-based medicine
- consumer-centric medicine
- recalibration of the roles/expectations and status of healthcare professionals
Social Networks and Consumer: Patient Empowerment

Source: R&D Directions May 2010
Pharma and Healthcare Social Media Brand Sponsored Patient Communities

- **support community overall disease information and features**
- **people of all ages living with cystic fibrosis.**
- **global, interactive social network for CML community by Novartis Oncology**
- **Arimidex (breast cancer) support and patient story site**
- **Support community for breast cancer supported by Genentech**
- **Support community to share the power of Walk MS experience**
- **Support community for Alli, weight loss product from GSK**
- **Support community for epilepsy by Valeant**
- **Support community Epilepsy by Valeant**
- **Support community Cystic Fibrosis sponsored by Gentech**
- **Support community Depression**
- **Support community for people of all ages living with cystic fibrosis.**
- **Support community Diabetes**
- **Support community hearing implant company**
- **Support community for breast cancer**
- **Support community for hemophilia**
- **Support community for PKU sponsored by Biomarin**
- **Support community collaboration Bayer Healthcare and MS Soc.**
- **Support community Diabetes online wellness program**
- **Support community Depression**
- **Support community Epilepsy**
- **Support community for hearing implant company**
- **Support community Cystic Fibrosis**
- **Support community for breast cancer**
- **Support community for hemophilia sponsored by Bayer Healthcare**
• FDA guidelines to be issued
• need for clear rules of engagement
• content (passive), conversation (active)
• covert eavesdropping on patient sites
• sponsor transparency
• how to adapt presentation of benefits:risks required by DDMAC in new media formats
• level of sponsor responsibilities to monitor and correct misinformation and report claimed AEs
• surveillance against black campaigns to discredit products
Safety

Interference in High Density Medical Device Areas

The Security of Medical Devices is Not a Luxury
Applications of RFID Technology in Healthcare

- patient ID, tracking and status monitoring
- location of equipment and assets
- supply chain management
- surgical QC inventory of instruments/materials
- directed endoscopy and placement of microdevices
- patient support device alarms
- product authentication
- capture of device-generated data and uploading to EHR
Bad Habits

non-sterilizable devices

NEGATIVE EXPOSURE

The use of cell phone cameras inside hospital walls can lead to HIPAA repercussions

PEPPER Reports
A Helpful Financial Condiment

Electronic Document Management Systems
Much More Than Scanning

non-consented ID
The Continued Debate Over Cell Phone Safety
Systems Architecture and Design Guidelines for Inter-Operability in Remote Health and m.Health Applications

- Body Area Network Devices
- Local Area Network Devices
- Application Hosting Device and WAN
- EHR
- PHR

large scale databases and analytics

optimized decisions
A New Healthcare Ecosystem Arising From Technology and Market Convergence

- Dx/Devices
- Rx
- HLx

Integrated Technology Platforms

Data Mining and Integration Services

- passive/active data collection
- analytics and network architecture
- EMR/PMR
- performance and outcomes analysis

Increasingly Targeted Care and Efficient Use of Finite Resources

patients

consumers

services for integrated care
Getting Ready For The PEZ Transition

- Petabyte
- Exabyte
- Zettabyte

- massive datasets
- mining tools
- minds: customized context and formatting for optimum cognitive processing and improved decisions
Managing “Mega-Data”

- volume
- Infrastructure
- global networks

- data heterogeneity/
- spatio-temporal scale
- integration
Key Elements of Healthcare Data Mining and Decision-Support Networks

- real time
- integrated
- customized

Control and Communication Devices

- requisition category
- latency
- bandwidth
- interoperability

Data Network

- professional
- patient
- payor
- epidemiology
- public health
- research

Networked Resources

- shared state management
- scalability
- multi-threaded
- heterogeneity
- failure management

Decision-Support Algorithms

- scalability
- multi-threaded
- heterogeneity
- failure management
mobility and ubiquitous sensor nets demand dynamic reconfiguration

device heterogeneity and diverse connectivity strategies

unreliable wireless
- interference, blocking, fading

7 trillion connected devices will rapidly exhaust available spectrum

current spectrum policy has full allocation but poor utilization

cognitive device platforms and dynamic shifting to unallocated spectra
Integration of Advances in Customized Data Formatting and Visualization Tools for Different User Constituencies

- escalating quantities and diversity of information
- real time decision support systems under conditions of uncertainty
- new multi-modal, multi-sensory high performance human: information interfaces
- representation and comprehensibility of information flows
  - optimize representation (perception and recognition)
  - integrated multi-user interfaces (customized and actionable)
- adoption of advances in cognitive neurobiology in customizing data formats (kinds of minds)
New Services and Business Models

- increasingly customized services for risk mitigation
- automated decision-support
- large scale database curation and mining
  - resources demand modeling and supply chains
  - proficiency metrics
  - CER, guidelines, best practice
  - global surveillance and epidemiology
  - new research platforms
Global Biosecurity: The Broadest Definition of Health
Imagine a health worker in a remote clinic in mountainous Rwanda, who must ensure that HIV/AIDS patients take their daily medication. Whipping out her cell phone, she sends a text message to a national health registry in Rwanda’s capital, Kigali, noting that Patient X, who just came in for a clinical consultation, has been taking his meds and that a new round of antiretrovirals has been dispensed on his behalf.

Minutes later, other workers at the national health ministry take this information and add it into their records of

(Health Affairs February 2010)
m. Health Services for the Global South

- adapt global materials
- content tailored to local settings
- translation into local languages
- content repackaged for specific health needs
- create local content
m. Health Services for the Global South: Verification of Product Authenticty

- malaria medication
- acetaminophen syrup
- glucophage

Bloomberg Businessweek May 17-23, 2010
Geo-demographic Information Systems (GIS): Real-Time, Front Line, Ground Zero Data from Field Sampling and Sentinels
Global Disease Surveillance

EMERGEncy ID NET

Public Health Department's Surveillance

U.S. Influenza Sentinel Provider Surveillance Network

Quarantine Activity Reporting System (QARS).

GeoSentinel
The Global Surveillance Network of the ISTM and CDC
a worldwide communications & data collection network of travel/tropical medicine clinics
Geo-demographic Information Systems: Mapping Disease Patterns and Modeling Trends

Anomaly Detection and Early Alert

Disease Progression

Satellite Surveillance and Predictive Modeling of Disease Trends
Traceability

Salmonella Saintpaul Outbreak Traceback & Distribution
Partial view of the traceback & distribution of peppers from Mexico: July 16 - July 22, 2008

Food & Agriculture Commodity Flow System Labor Inputs Input/Process/Output Diagram

Source of the positive sample

Positive product and environmental sample found
Wireless Sensors and Systems for Improved Agricultural Productivity
“For most of us design is invisible until it fails”
Bruce Mau
Use of GIS and Wireless Devices for Tracking Population Movement, Healthcare Resources and Supply Chains in Large Scale Disasters
m. Health as a Disruptive Change

- multidimensional impact on broad range of healthcare technologies/delivery processes
  - individual wellness to global public health

- information is power
  - redress medical paternalism and information asymmetry in healthcare decisions
  - consumer:patient empowerment
  - increased consumer:patient accountability for mitigation compliance risk

- key element in evolution of decentralized healthcare services
  - point-of-care diagnostics
  - treatment compliance
  - remote health status monitoring
  - emergency response
Healthcare Delivery

- MD/payor-centric
- controlled information
- medical paternalism
- patient:consumer dependency
- reactive, episodic interaction/intervention
- fragmented care and information silos
- system-constraints on PC-centric services
- system-shielded from economic competitiveness and outcomes metrics

Health Systems and Services

- patient:consumer (PC)-centric
- transparency
- active PC participation in care decisions
- health literacy and accountability
- proactive, integrated care continuum
- PHR + ERH + mobility and ambient intelligence
- options + choice
- performance metrics/emergence of a real market
Major Challenges in m.Health and the Redesign of Health Systems and Services

- governmental commitments and resolve
  - sustainable, long-term investments
- infrastructure, investment and ROI
- policies for cross-domain integration
  - education
  - control of communicable diseases
  - safe water and food security
  - environmental sustainability
  - trade
  - national security
Healthcare: The Long Overdue Need for Radical Redesign

- demand and debt (unsustainable)
- demographics (aging societies)
- divisiveness (public expectancy and political populism)
- digital (connectivity networks)
- data (lottabyte world)
- decision support (precision and improved outcomes)
- decentralization (point-of-care)
- distance disappears (remote monitoring)
- devolution (MD-centric to patient centric care)
- disparities (equity in global health)

DEMONSTRATING VALUE: DISRUPTIVE TECHNOLOGIES AND NEW BUSINESS MODELS
Health Matters!