Emerging Technologies in Health Care

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Largest private integrated health care system in the U.S.

9M members
17K physicians
173K employees
37 hospitals
611 clinics
37M office visits a year
3K clinical research studies
$50B revenues

EHR Largest, most advanced deployment

PHR Nearly 6M members signed up
Innovation & Advanced Technology

- National HIT future sensing group (2006)
  - Clinicians, analysts, IT staff, software developers
- Three-part mission:
  - Communications
  - Social networking
  - External networks
  - Innovation exchanges
  - Media coverage

- Create innovation
- Scan and evaluate new technologies entering market in 2-5+ years

- Innovation Fund for Technology
- Innovator workshops
Garfield Innovation Center

- Opened 2006 near OAK
- 37,000 sq ft warehouse
- Space design, workflow simulation, technology testing
- Full-scale hospital ward, L&D, OR, ED, NICU
- Home environment
- Patient Rm of the Future
- Open prototyping space
- 50,000+ visitors from over 42 countries
Hospital Ward
Operating Room of the Future
Home Environment
Health Care in Crisis

↑ Demand  ↓ Worker shortages
↑ Costs  × Wrong incentives
↓ Reimbursements
Current Approaches

- Automate best practices
- Integrate health care across care delivery ecosystem
- Use data-driven analytics
- Move care to less expensive venues
- Move care to lower-tier workers
- Engage and empower consumers
- Create new incentives for consumers and providers
- Develop technology-enabled care delivery models
Gartner Telemedicine Hype Cycle

Source: Gartner (July 2012)
Telemedicine and Telehealth

Virtual Health Care
What Do Virtual Models Require?

Care Coordination
Shared Practice Standards
EHRs & Health Info Exchange
Accountability Framework
Reimbursement Structure
Reporting Mechanisms

- Hospitals
- Clinics
- Ancillary Services
- Payers
- Doctors
- Nurses
- Regulators
- Pharmacies
- Suppliers
- Labs
Four Virtual Care Models

**Live Video Consultation**
- Synchronous
- Saves travel time
- Improves access
- Convenient
- Everyone has to show up at the same time

**Store & Forward**
- Asynchronous, send photo or video
- Saves travel time *and* more efficient
- Improves access
- Convenient
- Impersonal

**Remote Monitoring**
- Monitor data
- Early intervention
- Saves travel time *and* more efficient
- Convenient
- Intrusive
- Requires engagement

**Guided Self Service**
- Personalized education and guidance
- Social networks
- Automated rules-based supervision
- Requires engagement

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Telemonitoring Hubs and Sensors

1. iPhone glucometer © IBGStar
2. Home hub © Health Buddy
3. Clip-on pediatric otoscope © CellScope
4. Skin glucometer © Dexcom
5. Wireless pulse oximeter © iHealth Labs

- HR, motion, skin temp, sweat © Basis
- Galvanic skin response (GSR) Q Sensor © Affectiva
- Skin temperature, sweat © Basis
- Mobile ultrasound © Mobisante
- Weight, body fat, BMI © Withings
- Care Innovations Guide © Care Innovations
- Cell hub © Tunstall
- Home hub © Honeywell

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Kiosks
Motivating Wellness

- Survey of 800 large and mid-sized employers\(^1\)
  - 56% require employees to join wellness program
  - 83% offer employee incentives
    - 24% offer incentives for progress toward acceptable ranges for BP, BMI, blood sugar, or cholesterol
    - 34% are interested in tying incentives to a program that progressively increases activity over time
    - 22% are interested in gaming methodologies
  - 5% offer disincentives (penalties)
    - 58% plan to penalize employees who do not take actions to improve their health
  - 16% offer both incentives and disincentives

- What works: financial incentives (mixed results)

\(^1\) Aon Hewitt survey, March 2013
Behavioral Tools

1. Video fitness classes © Navafit

2. Fitness gaming © Mango Health

3. Fitness gaming for kids © Zamzee / Hope Labs

4. Keas

5. Team contests © Keas

6. VR fitness club © Club One Island

Sleep, diet, activity sensors and apps © Lark

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Behavior Change is Complicated
Mobile Search
Mobile Browsing
Mobile Voice Calls
Mobile Messaging
Mobile Video Conferencing
Mobile Location-Based Services
Mobile Context-Aware Services
Mobile Office
Mobile Music & Book Library
Mobile Banking
Mobile Commerce
Mobile Payment

Mobile Health
Mobile Social Networking
Mobile Gaming
Mobile Image Recognition
Why the Mobile Market?

- Market penetration nearly universal
  - Convenient, personalized, always connected
- Medical apps among the most popular
  - Consumer
    - Health education, diet and exercise, self-diagnosis
    - Search, engagement, motivation, reminders
    - Collaboration, social networking, and support
  - Health care practitioner
    - Diagnosis, treatment, reference, decision support
    - Imaging, monitoring, tracking, care coordination
- New types of relationship with consumers
  - Trusted health advisor vs. crisis care provider
20,000+ Consumer Medical Apps

OneHealth
MyDiabetes
Pillboxie
RunKeeper
JEFIT
Depression Connect
Med Helper Pro
HealthPrize
EyeChart
MyNetDiary

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And A Few Mystery Apps

- After you do 30 squats, app tells you whether you can play sports
- iPhone light cures acne
- iPhone light cures Seasonal Affective Disorder (SAD)
- Sounds of nature relieve toothaches and insomnia
- Low frequency sound cures ringing in the ears
- Hearing a baby cry on your phone enlarges the size of your breasts
- Choose your baby’s sex

Courtesy of The Washington Post
Professional Apps

1. AirStrip Cardiology
2. Visible Body
3. WellDoc Diabetes Manager
4. Mobisante
5. MedCalc
6. Epocrates
7. VisualDx
8. Isabel
9. DrawMD
10. iSpineOperations

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KP Apps

- Mobile Patient Health Record
  - See your lab results
  - Exchange messages with your personal physician
  - Refill your prescriptions
  - Book an appointment
- Portfolio of mobile apps
- Mobile app development group
Big Data and Analytics
Big Data, Big Numbers

Yottabyte (YB) = 10^{24} \text{ B}

Zettabyte (ZB) = 10^{21} \text{ B}

Exabyte (EB) = 10^{18} \text{ B}

Petabyte (PB) = 10^{15} \text{ B}

Terabyte (TB) = 10^{12} \text{ B}

Gigabyte (GB) = 10^{9} \text{ B}

Today’s Limit: \sim 3 \text{ PB}
Big Data Defined

- Datasets too large for standard data tools
  - What used to be big… is not so big today

- The 4 V’s (Gartner)
  - **Volume**: exceeds limits of cost-effective storage and vertical scalability
  - **Velocity**: rapidly changing business scenarios with short decision windows overwhelm conventional data systems
  - **Variety**: multiple data formats make integration expensive
  - **Variability**: data structure variability makes analysis hard
  - 5th V… **Value**? intrinsic value refractory to standard tools
Case Studies

- **Google search engine queries**
  - Detects influenza outbreaks 1-2 weeks sooner with 97% accuracy

- **Vioxx recall (2004)**
  - Arthritis medication approved 1999
  - 2004 study of 1.4M KP patients, drug recalled
  - 27,000 heart attacks, 140,000 cases of heart disease

- **Population genomics**
  - KP Division of Research study with UCSF
  - Over 100,000 health plan members opted in
  - New findings discovered
Nature of Health Care Data

- **20% Structured**
  - Traditional business intelligence analytics

- **80%+ Unstructured**
  - Clinical notes, monitoring data, imaging, surveys, email, phone calls, photos, videos, location, context

- **Highly complex**
  - Multiple regulated silos, lexicons, differences in accuracy, integrity, availability, reliability, usability
## Use Cases

### Care Delivery
- Decision support
- Real-time monitoring in hospital and home
- Personalized medicine
- Comparative effectiveness research
- Workflow optimization
- Cost and quality analytics
- Predictive analytics

### Operations
- Business analytics
- Marketing and supply chain analytics
- Fraud and breach detection
- Payment and pricing models
- Health economics research

### Public Health
- National and regional patient registries
- Biosurveillance
- Preventive health analytics
- Data mining for new multimodal approaches to major public health issues

### Research
- Biomedical research literature
- Clinical trial analytics
- Predictive modeling for drugs and devices
- Genomics, biodata
- Analysis of disease patterns to plan future R&D investments
Extending the Envelope
Environmental Computing

1. VS sensing at a distance © Kai Medical
2. SleepClock © Renew
3. Car drowsiness sensor © Nissan
4. Buttocks ID - Adv. Inst. of Industrial Tech (Japan)
5. Under-mattress activity and VS sensing © EarlySense
6. imPulse EKG monitor © Plessey (UK)
7. Interactive glass mirror display © Corning
**Wearable Sensors**

1. BodyMedia FIT activity sensors © KP
2. Activity sensor © Fitbit
3. Sensor patches © Proteus / Avery Dennison
4. Earbud sensor for VS © Valencell
5. Pendant personal emergency response system © Philips Healthcare
6. Fabric sensors detect movement, HR, T, moisture © Exmovere
7. Wireless activity sensor stickers © Green Goose
8. Nike+ shoe with embedded sensors © Nike

Products not endorsed by KP
Medication Adherence

1. Med reminder watch © Cadex
2. Med adherence app © Pill Phone
3. Xhale SMART tracer system © Xhale

GlowCap pill bottle cap © Vitality
Proteus Raisin microchip pill © Proteus

Pill dispenser © MedReady
Pill dispenser © SentiCare
MagneTrace necklace © MagneTrace

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Robots

1. Hector the robot © CompanionAble
2. Autom weight loss coach © Intuitive Automata
   mPower 100 © Myomo
3. Paro baby seal
4. Legally blind driver in self-driving car © Google
5. Hector the robot © CompanionAble
6. © iRobot
7. Telepresence robots © VGo
8. eLEGS by Berkeley Bionics © Zimbio

Products not endorsed by KP
Natural Interfaces

1. Kinect MIDI interface © Microsoft
2. Nintendo Wii © Nintendo
3. Wii casualty © PrimeSense
4. Tobii eye gaze tracking system © engadget
5. Gaze tracking © Tommy Strandvall
6. Electrical signal speech recognition © NASA
Augmented and Virtual Reality

1. Vuzix AR Smart Glasses © engadget
2. Golden-I AR glasses © Motorola
3. Molecular drug modeling © Roche
4. Burn surgery under VR anesthesia © Univ. Washington
5. Google Glass © Google
6. Real-time sign translation © Word Lens
7. VR multi-user simulation training © Forterra

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Next-Gen Technologies

1. Wristband interface © NEC
2. EEG interface © Neurosky
3. Brain-car interface, Emotiv EEG © Free University of Berlin
4. Skinput © Microsoft
5. Tongue drive © Georgia Tech
6. MIT bio-electronic ocular implant © engadget

Stretchable skin sensor © MC10

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Challenges

- Strategic prioritization and planning are critical
- Clinician does not physically touch patient
- Limited or no reimbursement
- Lack of outcomes research, practice standards
- Business model not yet well understood
- Significant workflow and care model disruption
- Disagreement on metrics
- Scalability and EHR integration issues
- Privacy/security, regulatory, legal issues
- Health care consumer must be willing and able to engage
THE WORLD OF MEDICINE AS WE KNOW IT WILL END SOON

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