mHealth: Enabling the Re-engineering of Healthcare

Steven R. Steinhubl, MD  December 1, 2015
What is mHealth?

“mHealth (or mobile health) is the use of mobile or wireless devices to improve health outcomes, healthcare services and health research.”

- NIH Consensus group
mHealth: Enabling the Re-Engineering of Healthcare

1. Technology progress, in perspective.
2. Where can mHealth make a difference?
3. The changing landscape of healthcare.
4. Challenges to adoption.
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ASCI Red

- World’s fastest super-computer in 1996 – 1.8 teraflops/sec (1.8 trillion operations/sec)
- $55 million to develop.
- Occupied 1,600 square feet of floor space.
- Used 800 KW/hr (~800 homes)

- 2006 – 1.8 teraflops/ sec
- $500
- 200 watts
- 64 million units sold
May, 1997
IBM’s Deep Blue beat World Chess Champion Garry Kasparov.
Watson is now “…the size of three pizza boxes stacked up. It's also 24 times faster and has seen a 2,400 percent improvement in performance.”

I.B.M.’s Watson Goes to Medical School

By STEVE LOHR

Next up for Watson, I.B.M.'s clever question-answering computer? A stint as a medical student at the Cleveland Clinic Lerner College of Medicine of Case Western Reserve University.

The collaboration, announced on Tuesday, includes a bit of controlled crowdsourcing, with the Cleveland clinicians and medical school students answering Watson’s questions and correcting its mistakes.
In the US, 91% of adults own a mobile phone, with the majority of them (61%) being smartphones.

194 minutes a day looking at smartphone or tablet screen. 147 looking at TV, 103 at laptop or PC.

Projected Worldwide Growth in Mobile & Smartphones

9.2 BILLION
mobile subscriptions by the end of 2019

>80%
of mobile subscriptions will be for mobile broadband by the end of 2019

Ericsson Mobility Report June 2014
A Historical (and Present Day) Look at Our Tools for a Patient’s Office Visit

Blood Pressure

- Sphygmomanometer invented 1881.
- Popularized by Harvey Cushing 1901

ECG

- Willem Einthoven 1901.
- Precordial leads introduced 1944

Physical Exam/Auscultation

- Laënnec 1816.
- Binaural stethoscope 1851

House Calls

- In 1930’s ~40% of all patient encounters were in their home.

Unwin BK. Am Fam Physician 2011
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The Near Future of Wearable Sensor Data

1. Activity
2. Pulse
3. Sleep stages
4. Blood pressure
6. ECG
7. Stress
8. HRV
9. EDA
10. Respiration rate
11. Oxygen saturation
12. CO2 levels
13. Temperature
14. Hydration
15. Glucose (?)
Oura Ring

**Measures:**
- Heart rate
- Respiration rate
- Body temperature
- Movement.

Algorithms interpreting sleep cycles closely match analysis done at sleep laboratories.
Predicted Growth in Wearables

Global Connected Wearable Devices Traffic
Global Connected Wearables Traffic will Grow 18-Fold from 2014-2019

Source: Compass Intelligence, 2015
Gartner's 2014 Hype Cycle for All Emerging Technologies

http://www.gartner.com/newsroom/id/2819918
Permanente Medical Group CEO: Video, big data are the future. Wearables, not so much.

By: Jonah Comstock | Oct 29, 2015

Tags: big data | Kaiser Permanente | Partners Connected Health Symposium | Partners Connected Health Symposium 2015 | Partners Healthcare | video visits | wearables |

Doctors, technologists, and entrepreneurs have a lot of different visions of the future of medicine, and they don’t always line up. Dr. Robert Pearl, the Executive Director and CEO of The Permanente Medical Group, part of Kaiser Permanente, thinks some digital health offerings — like video visits — will revolutionize medicine. Others — like health monitoring wearables — are going nowhere, he told the crowd at Partners HealthCare Connected Health Symposium.

“I don’t think very many of us want to have a thousand continuous traces of the patient’s heart rhythm, and the last place we want it is inside the hip pocket,” Pearl said of wearables. But, he said, video visits are the future. And not necessarily just in medicine. In a talk earlier in the day, Google’s senior vice president of health care, Eric Topol, said it’s not just doctors that will be able to use mobile apps and other tools to diagnose and treat patients with video visits. "People with diabetes who have long-term issues don’t need to visit a doctor when they have something that isn’t a life-threatening issue," he said. "They can go to a doctor with a video."
There Remain Huge Gaps in People-Centered Care Availability

Online survey of 5,014 US adults

### Access to Interactions with Primary Care

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online submission of questions answered by a medical professional</td>
<td>11%</td>
</tr>
<tr>
<td>Email reminders about taking medications and/or other health measurements</td>
<td>6%</td>
</tr>
<tr>
<td>Text reminders about taking medications and/or taking other health measurements</td>
<td>4%</td>
</tr>
<tr>
<td>The ability to submit photos of a condition or symptom to receive phone or email consultation</td>
<td>3%</td>
</tr>
<tr>
<td>Video visits (telemedicine)</td>
<td>2%</td>
</tr>
</tbody>
</table>

Nielsen’s Strategic Health Perspectives June 2015  [http://goo.gl/P0gZYl](http://goo.gl/P0gZYl)
Acute Diagnostics, When and Where They are Needed

More than a million people are searching on Google for information on ear infection at 4:30 a.m. every morning

The Stethoscope as a Relic of the Past

Auscultation skills in 860 providers: Trainees thru Faculty

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic</td>
<td>84%</td>
<td>35%</td>
</tr>
<tr>
<td>Diastolic</td>
<td>49%</td>
<td>67%</td>
</tr>
</tbody>
</table>

Vukanovic-Criley JM. Arch Intern Med. 2006;166(6):610-616
Hypertension Management: Why Important?

1. One of every 3 adults in America has high BP. ¹

2. Nearly $100 billion in total costs are attributed to high BP annually in the US.

3. Nearly 40 million office visits every year in the US have a primary diagnosis of hypertension making it the single most common reason for an office visit.

4. Less than half of all individuals in the US have their blood pressure under control, and only 20% worldwide.

¹ MMWR. Morbidity and mortality weekly report 2011;60(4):103-108.
³ National Ambulatory Medical Care Survey: 2010 Summary Tables.

**Improved Blood Pressure Control with Self-Monitoring and Self-Treatment**

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>6 Month</th>
<th>12 Month</th>
<th>Differenceb</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Systolic Blood Pressure Complete Case</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usual care</td>
<td>230</td>
<td>143.6 (141.9-145.4)</td>
<td>225</td>
<td>138.1 (136.0-140.3)</td>
</tr>
<tr>
<td>Intervention</td>
<td>220</td>
<td>143.1 (141.4-144.9)</td>
<td>215</td>
<td>131.8 (129.6-134.1)</td>
</tr>
<tr>
<td><strong>Diastolic Blood Pressure Complete Case</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usual care</td>
<td>230</td>
<td>79.5 (78.3-80.8)</td>
<td>225</td>
<td>77.2 (75.9-78.5)</td>
</tr>
<tr>
<td>Intervention</td>
<td>220</td>
<td>80.5 (79.2-81.8)</td>
<td>215</td>
<td>75.3 (74.0-76.6)</td>
</tr>
</tbody>
</table>
Simplified and Connected HTN Management

![Image of blood pressure monitor and mobile app interface]

- **Results**
  - **January 27, 2015**
  - **9:07 PM**
  - **Blood Pressure**: 125/79 mmHg
  - **Heart Rate**: 50 bpm
  - **Temperature**: 97.2°F (Out of Range)
  - **SpO2**: 100%

- **Blood Pressure**
  - **120/76** mmHg
  - **sys/dia**
  - **Details**
  - **Scan Details**
    - **JAN 23 - 28**
    - **1 SCAN**
## Healthcare Team

- Physician
- Nurse
- Pharmacist
- Dietician
- Physical Therapist
- IT

## Personalized Predictive Analytics

## Automated Clinical Decision Support

## Learning Healthcare System
Mobile Phone Penetration in Sub-Saharan Africa
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Separating the Wheat from the Chaff When There is Mostly Chaff

Number of Health Related Apps Now >165,000

- 100% increase in the number of iOS apps over last 2 years
- Only 0.02% (36) of all apps account for 50% of downloads.
- Only 2% provide connectivity with provider healthcare systems.

“Patient Adoption of mHealth” IMS Institute for Healthcare Informatics. Sept 2015
Estimated Total Downloads of mHealth Apps (billions)

- 2013: 1.7 billions
- 2014: 2.3 billions (36% increase)
- 2015: 3.0 billions (35% increase)

Copyright research2guidance 2015
Online Consumer Survey of 395 Respondents

- 26% of apps are downloaded and used only once.
- Of the people who confirm using their apps, 74% drop out by the 10th use.
- Also showed that 26% of smartphone apps retain consumer loyalty.

```
Would you be more likely to use an app that can analyze the information you're logging and give you feedback as to how you're doing?

<table>
<thead>
<tr>
<th></th>
<th>Consumers</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>20.1%</td>
</tr>
<tr>
<td>Yes</td>
<td>79.9%</td>
</tr>
</tbody>
</table>
```

Digital Snake Oil

ULTIMEYES®
A simple-to-use interactive game scientifically shown to improve vision.
$5.99 for a limited time

Acne Pwner
by: Andrew Finkel
Download $0.99

AcneApp
Acne therapy without risky medications.

Instructions:
Begin by choosing a light from the tab bar below. Red & Blue is the recommended option.
Rest the iPhone against your skin's acne-prone areas for 2 minutes daily to improve skin health without prescription drugs.
- Blue Light: fights bacteria
- Red Light: promotes healing
Digital Snake Oil

Measure blood pressure using only your iPhone.

No cuff required.
“The $2.8 trillion US healthcare industry is being upended by companies attuned to the needs and desires of empowered consumers.”

pwc. Health Research Institute April 2014. Healthcare’s new entrants: Who will be the industry’s Amazon.com?
• ~1000 locations in 31 states
• Staffed by nurse practitioners and physician assistants
• Over 25 million patient visits since 2002.
• 400 Healthcare Clinic locations across US
• Most used healthcare app
• Already collecting mHealth data remotely in 800,000 individuals with 250,000 connected devices in their for Balanced Rewards for healthy choices loyalty program.
• Primary provider of flu vaccines in the country.
“On-Demand” Channel Growth

Urgent Care: 95M → 129M (7% CAGR)
Retail Care: 7M → 14M (14% CAGR)
Virtual Care: 5M → 22M (34% CAGR)

Becker’s Hospital Review Feb 2014
Do Virtual Visits Impact Care Delivery? UTI Complaints

- No difference in the rate of f/u visits (7% for both) as a proxy for treatment failure.
- Not examining a patient may lead to a more “conservative” treatment approach.

Compared 2855 office visits to 99 “e-visits.”

- Urine culture ordered: 8% of patients (51% for E-visit vs. 44% for Office visit)
- Antibiotic prescribed: 99% (99% for E-visit vs. 44% for Office visit)
- Avg. cost per visit including tests and drug: $74 (74% for E-visit vs. $93 for Office visit)

Mehrotra A. JAMA Intern Med. 2013;173:72-74, Figure from WSJ
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**The Effectiveness of Mobile-Health Technology-Based Health Behaviour Change or Disease Management Interventions for Health Care Consumers: A Systematic Review**

Caroline Free¹, Gemma Phillips², Leandro Galli³, Louise Watson⁴, Lambert Felix⁵, Phil Edwards¹, Vikram Patel⁴, Andy Haines⁴

> “...high quality adequately powered trials of optimised interventions are required to evaluate effects on objective outcomes.”

**The Impact of Mobile Handheld Technology on Hospital Physicians’ Work Practices and Patient Care: A Systematic Review**

Mirela Prgomet, BAppSc(Hons), Andrew Georgiou, PhD, Johanna I. Westbrook, PhD

> “The paucity of evidence calls for much needed future research...”

**The Effectiveness of Mobile-Health Technologies to Improve Health Care Service Delivery Processes: A Systematic Review and Meta-Analysis**

Caroline Free¹, Gemma Phillips², Louise Watson³, Leandro Galli⁴, Lambert Felix⁵, Phil Edwards³, Vikram Patel³, Andy Haines³

> “High quality trials measuring clinical outcomes are needed.”
So How Do We Show True Value?

Productivity Paradox

- In 1900 95% of all factory machines were still steam engine and belt driven (two decades after Edison’s first electric power system started).
- It took ~ 40 years to see meaningful productivity gains as the original group drive system remained in place for much of that time.

So How Do We Show True Value?

Productivity Paradox

Just as systems of manufacturing needed to change to take advantage of transformational technology, systems of care need to be re-engineered around the capabilities that mHealth tools provide.

The mHealth: Enabling the Re-Engineering of Healthcare - Summary

• We are well into a technology revolution of unprecedented computational power & connectivity that we are just now beginning to leverage for healthcare.

• The availability and variety of wearable sensors for health and wellness is rapidly increasing, although with limited clinical uptake.

• Consumer-facing, non-traditional providers may be in a stronger position to lead the transformation of healthcare in the US than are legacy healthcare systems.

• mHealth technologies can enable, but alone will not drive the complete re-engineering of the healthcare landscape.