



University of Pittsburgh

“Utilizing Technology to Implement Guidelines-based Care: Telemedicine in Chronic Disease”

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CHEST2012

Atlanta, GA

25 October 2012

Disclosure:

- I have no financial interest or other forms of relationships that could be considered a conflict of interest by participants.
- I will not be discussing any information about a product/procedure/technique that is considered research and is not yet approved for any purpose.

Topics

- Background - Telemedicine
- Internet-Based Home Monitoring
 - Literature Review
 - Commercial Monitoring Systems
- Role of Cell phones in health (mHealth)
- Wireless Body Area Networks
- Conclusions

Definition

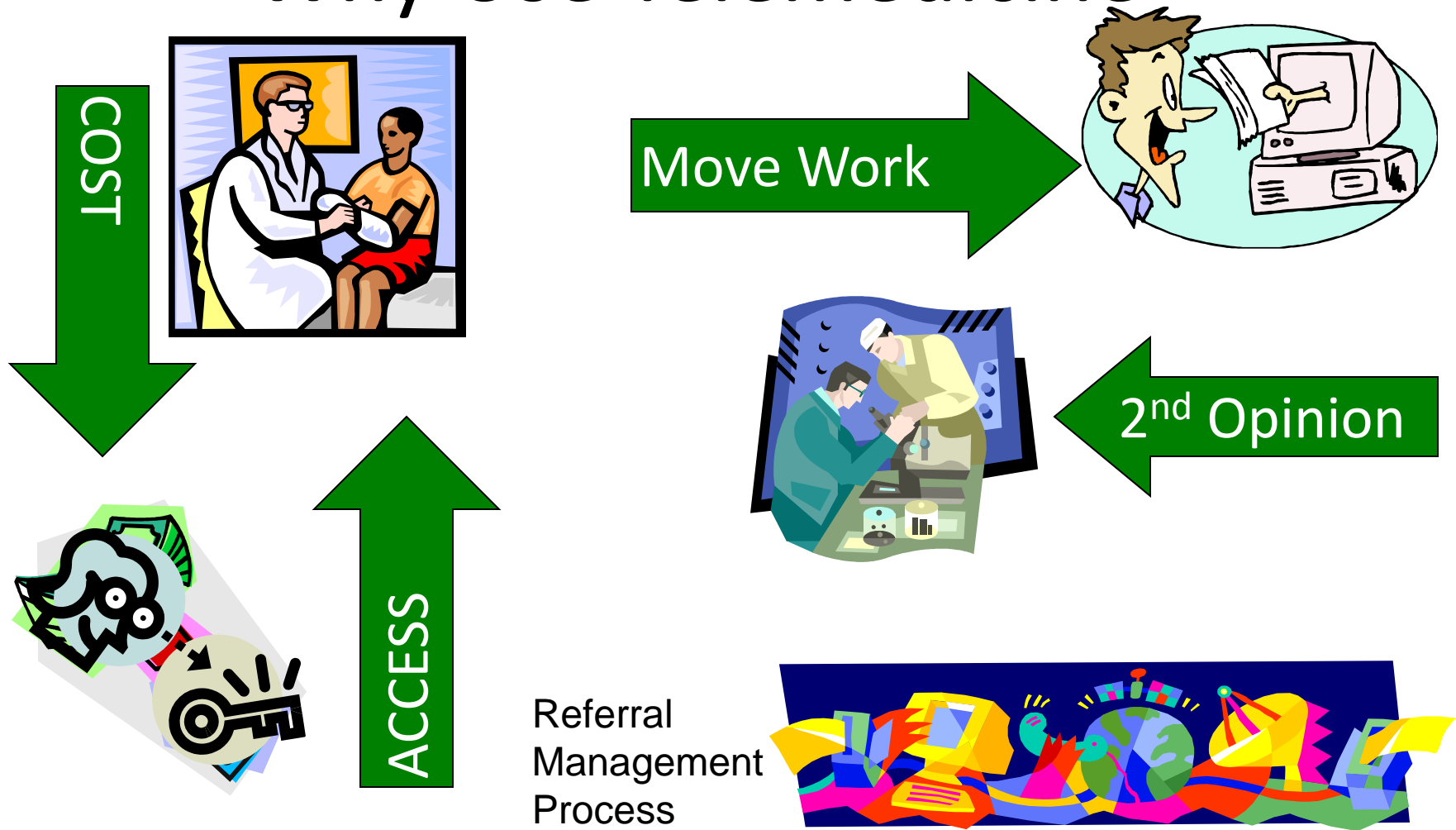
Telemedicine

Use of [communications](#) and [information technologies](#)
for the delivery of clinical care

Telemedicine – “Radio Doctor” – April 1924



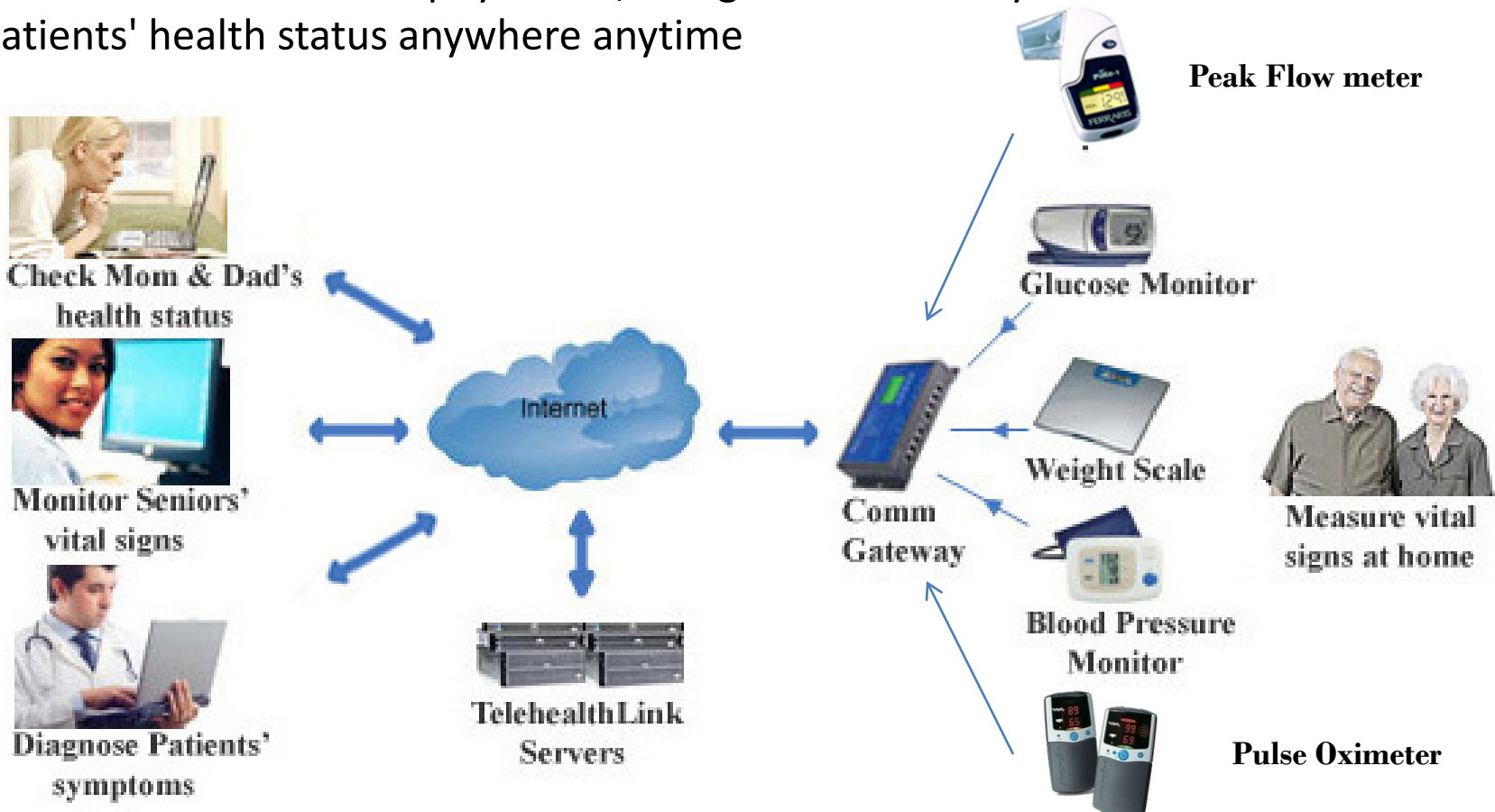
Why Use Telemedicine





Current Home Telehealth Overview

- Automatically processes vital signs and simultaneously informs caregivers or/and family members if the patient needs immediate medical attentions
- Centralized real-time data collection allows vital signals processing automatically in real-time or near-real-time with alert features
- Web Interface enables physicians, caregivers and family members to monitor patients' health status anywhere anytime



Commercial Monitoring systems

- Measure peak flow at home
 - Upload to cell phone/Web site
- Review PEF/symptoms graph
- Discuss with provider
- Adjust therapy in person or on-line



Internet-Based Home Monitoring

- Success of in-home monitoring for cardiac conditions & diabetes applied to asthma
- Evolved from:
 - spirometry & home phone to central server
 - Asthma nurse: management/education
 - Internet-based home monitoring
- Research
 - Pilot trials/ Feasibility studies
 - Randomized studies emerging



Adults living with chronic disease are disproportionately offline in an online world

- 2010 survey data from the Pew Internet Project and the California HealthCare Foundation show that adults living with chronic disease are significantly less likely than healthy adults to have access to the internet:
 - 81% of adults reporting no chronic diseases go online.
 - 62% of adults living with one or more chronic disease go online.

Home Health Monitoring

Defining the Need

- Chronic condition care requires daily, real-time monitoring of physiological data, direct patient feedback, coaching, and a high level of patient-clinician interaction to achieve positive results.
- With the geographical distance widening between doctors and their patients, the problem solution depends on: digital literacy & effective multimodal communication
- Home patient monitoring means:
 - imminent rise of the expert patient whom the health authorities anticipate would self-manage his long-term medical conditions
 - prominence of mobile devices as the go-between for clinicians and patients.

Home Health Monitoring

Home health monitoring and telemedicine will grow:

- Markets at \$608 million in 2010 are anticipated to reach \$3.1 billion by 2017

Planned products: a house that monitors your every move, from bedside to bathroom and from medicine cabinet to fridge. Aim is to help the elderly to lead safe and independent lives.

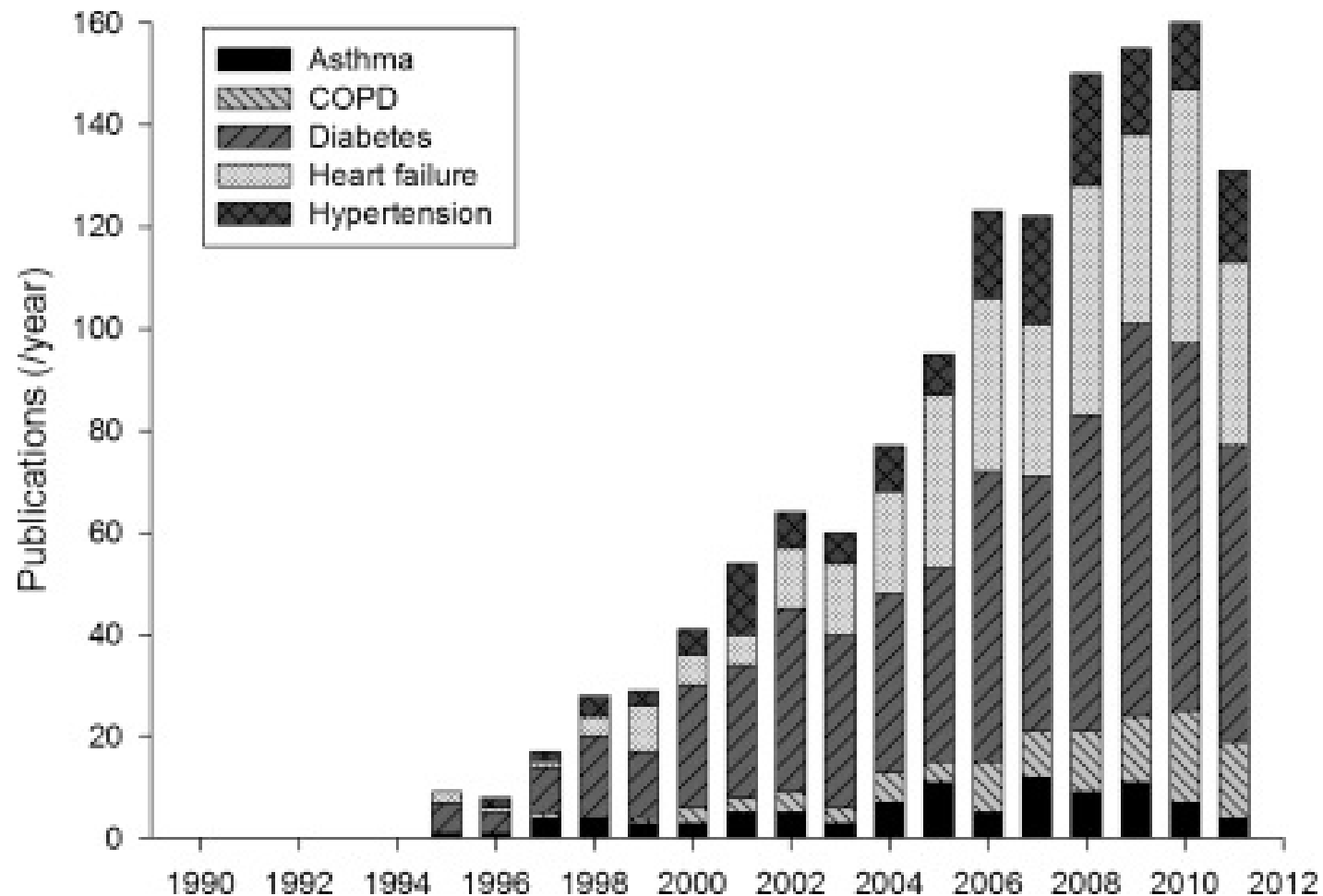
“Health House” tracks everyday habits, but also check weight and blood pressure and predict whether a person is at risk of a serious fall.

Examples - how many times a person opens the fridge door or uses the faucet: Repeat trips to the fridge could signal mental impairment, and a failure to use the faucet might suggest an increased risk of dehydration.

The next generation of sensors also studies activity such as bathroom use, time spent sleeping and when medicine is taken, plus vital signs such as blood pressure, weight and blood-oxygen levels.



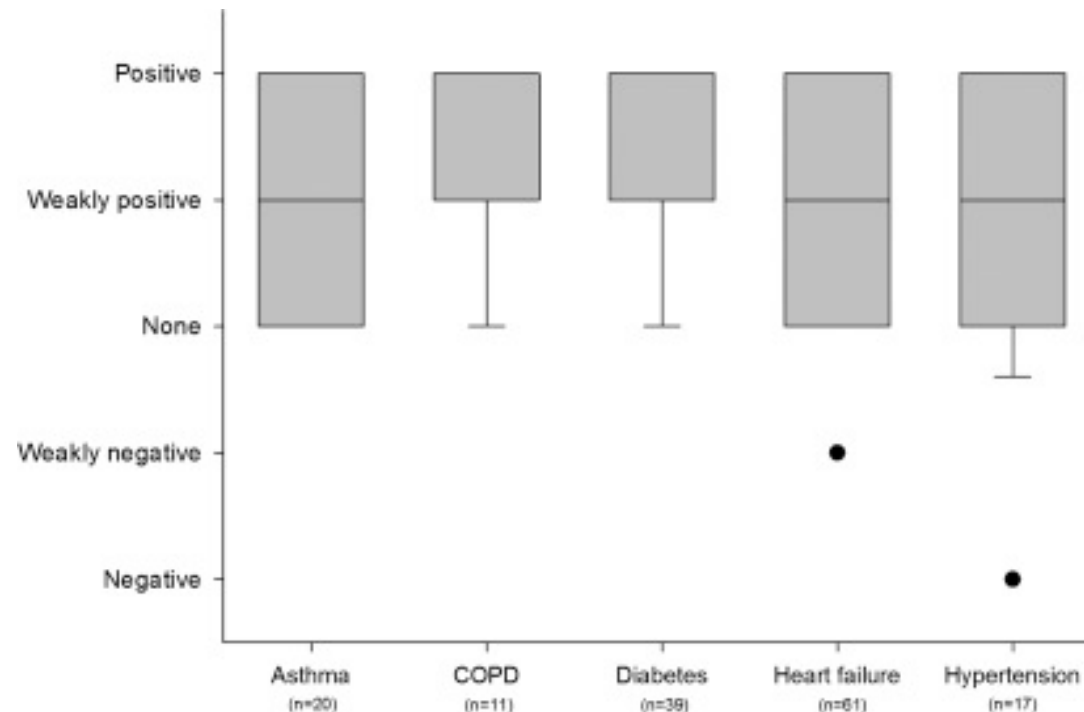
Medline publications on telemedicine and five chronic diseases between 1990 and 2011.



N=1324 publications

Twenty years of telemedicine in chronic disease management-an evidence synthesis

- Total of 141 randomised controlled trials (RCTs)
- N = 37,695 patients.
- Most studies reported positive effects (n = 108)
- almost none reported negative effects (n = 2).
- No significant differences between the chronic diseases, i.e. telemedicine seems equally effective (or ineffective) in the diseases studied
- Most studies were relatively short-term (median duration 6 months)
- **Summary:** evidence base for the value of telemedicine in managing chronic diseases is weak and contradictory



A randomized controlled trial of telemonitoring in older adults with multiple health issues to prevent hospitalizations and emergency department visits.

- **STUDY GOAL:** This study sought to assess differences in hospitalizations and emergency department (ED) visits among older adults using telemonitoring vs usual care.
- **METHODS:** A randomized controlled trial - telemonitoring (with daily input) or to patient-driven usual care. Telemonitoring was accomplished by daily biometrics, symptom reporting, and videoconference. Patients followed for 12 months
- **RESULTS:** n=205; with a mean age of 80.3 years. The primary outcome of hospitalizations and ED visits did not differ between the telemonitoring group (63.7%) and the usual care group(57.3%) (P=.35).
- **CONCLUSIONS:** Among older patients, telemonitoring did not result in fewer hospitalizations or ED visits.

Asthma In-Home Monitoring

“Internet-based home monitoring and education of children with asthma is comparable to ideal office-based care: Results of a 1-year asthma in-home monitoring trial”

- Prospective, randomized study
- n=60; ages 6-17; 12 month study
- Home asthma tele-monitoring compared to in-person, office based visits (traditional education/management)
- Study group
 - Home computer/camera/Internet used to video record use of inhalers, peak flow meters and uploaded to secure server
 - Case managers view videos/data/on-line symptoms; available 24/7 to patient
- Results
 - “Virtual” patients had better metered dose inhaler technique (94 vs. 89%)
 - Better adherence to daily asthma symptom diary submission (35 vs. 21%)
 - Both groups experienced an increase in quality of life/asthma knowledge score

“The Use of Telemedicine Access to Schools to Facilitate Expert Assessment of Children with Asthma”

Role of Telemedicine in Schools

- Prospective, cohort study in 3 urban schools in San Francisco
- n=83; ages 5-12; 8 month study
- Hypothesis: Access to expert asthma care can improve through a telemedicine link between an asthma specialist & a school-based asthma program
- Study group
 - Each subject was seen by an asthma expert at 0, 8, 16 and 32 weeks.
 - Assessment & recommendations for care were sent to the primary care physician (PCP) & parents were told to contact their physician for follow-up care.
- Results
 - Subjects experienced improvement ($P < .05$) in family social activities and the number of asthma attacks.
 - 94% of subjects rated the program as good or excellent.



Asthma In-Home Monitoring

3 Additional Studies & Conclusions

- “An Internet-based interactive telemonitoring system for improving childhood asthma outcomes in Taiwan”
 - Telemed J E Health 2007; 13:257-268
 - The Internet-based asthma telemonitoring program increases self-management skills, improves asthma outcomes, and appears to be an effective and well-accepted technology for the care of children with asthma and their caregivers.
- “Internet-based monitoring of asthma: A long term randomized clinical study of 300 asthmatic subjects”
 - J Allergy Clin Immunol 2005; 115:1137-1142
 - When physicians and patients used an interactive Internet-based asthma monitoring tool, better asthma control was achieved.
- “Internet-based home asthma telemonitoring: Can patients handle the technology?”
 - Chest 2000; 117:148-155
 - Internet-based home asthma telemonitoring can be successfully implemented in a group of patients with no computer background.

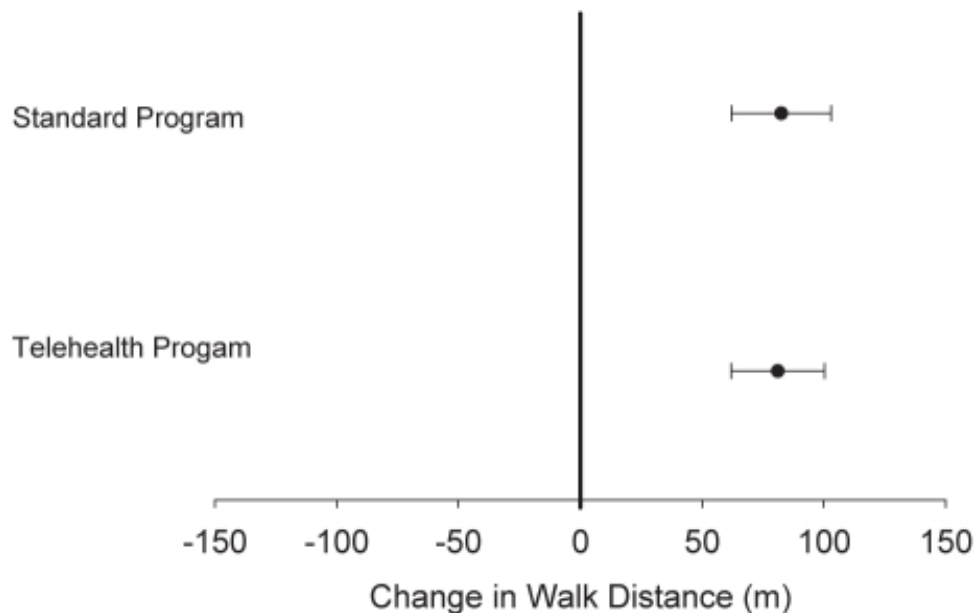
COPD In-home monitoring

- **“Cost-minimization analysis of a telehomecare program for patients with chronic obstructive pulmonary disease”**
 - Telemed J E Health. 2006 Apr;12(2):114-21
 - Patients were found to easily accept the idea of using the technology, and the telehomecare program demonstrated significant clinical benefits. Financial advantages of the program could have been more pronounced had it not been for the cost of technology that effectively erased a good portion of the savings.
- **Randomized controlled trial of an internet-based versus face-to-face dyspnea self-management program for patients with chronic obstructive pulmonary disease: pilot study**
 - J Med Internet Res. 2008 Apr 16;10(2):e9
 - Although there were numerous technical challenges with the eDSMP, both dyspnea self-management programs were effective in reducing dyspnea with ADL in the short term. Our findings will need to be confirmed in a larger randomized trial with more mature Web and personal digital assistant tools, use of a control group, and longer follow-up.



Using Telehealth technology to deliver pulmonary rehabilitation in chronic obstructive pulmonary disease patients.

- There is insufficient pulmonary rehabilitation (PR) capacity to service all COPD patients
- Study determined the efficacy of standard PR (n=262) vs. Telehealth PR (n=147)
- Primary outcome measure was change in quality of life (SGRQ)
- Summary: Telehealth PR was as effective as Standard PR



Mean change (\pm 95 CI) in 12 min walk distance with the Standard and Telehealth pulmonary rehabilitation programs.

Data presented using intention-to-treat analysis

Telemonitoring in patients with heart failure

- **BACKGROUND:** Small studies suggest that telemonitoring may improve heart-failure outcomes, but its effect in a large trial has not been established.
- **METHODS:** 1653 patients who had recently been hospitalized for heart failure randomized to telemonitoring (826 patients) or usual care (827 patients). Telemonitoring was accomplished by means of a telephone-based interactive voice-response system that collected daily information about symptoms and weight that was reviewed by the patients' clinicians. The primary end point was readmission for any reason or death from any cause within 180 days after enrollment.
- **RESULTS:** median age of the patients was 61 years; 42.0% were female, and 39.0% were black.
 - Readmission for any reason occurred in 49.3% of patients in the telemonitoring group, vs. 47.4% of patients in the usual-care
 - Death occurred in 11.1% of the telemonitoring group, vs. 11.4% of the usual care group
- **CONCLUSIONS:** Among patients recently hospitalized for heart failure, telemonitoring did not improve outcomes

Reducing admissions for long-term conditions: is telehealth the answer?

- What is Whole Systems Demonstrator (WSD)?
 - established by the UK Department of Health (DH) to evaluate how the use of telehealth technologies can support people with long-term health and care needs to live independently
- Largest evidence base for telehealth in the UK (6000 patients studied for 2 years)
 - 31million British pounds spent
- Results:
 - **45%** reduction in mortality rates
 - **20%** reduction in emergency admissions
 - **14%** reduction in elective admissions
 - **14%** reduction in bed days
 - **8%** reduction in costs
- study focused on: diabetes, COPD and coronary heart disease
- Telehealth endorsed by the Prime Minister (Dec. 2011) and announced its potential to benefit 3 million patients per year

Implementing home tele-management of congestive heart failure using Xbox gaming platform

- Gaming platforms are user-friendly and widely available
- System questions patients with CHF to monitor symptoms, weight changes, medication adherence & quality of life while educating the patient on their disease
- N=10; Patients found the system easy to use
- Summary: potential to optimize the care of patients with CHF



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How can Health IT reach people?

What technology do people already use?

- Internet Access:

- 66% of adults have Internet access (Source: Pew Internet & American Life Project. Degrees of Access (May 2010 data))
- Only 50% of people with chronic conditions have Internet access (Source: Pew Internet & American Life Project. Degrees of Access (May 2008 data))
- Average Internet use <1 hour per day (Source: Nielsen. Record High TV Use, Despite Online/Mobile Video Gains. November 24th, 2008)



- Mobile phones

- Nearly 90% of Americans have mobile phones. (Source: Harris Interactive, "Cell Phone Usage Continues to Increase." April 2008)
- 32% of households only have a mobile phone. (Source: US Centers for Disease Control: Wireless-Only Phone Use. December 2011)
- 7 trillion SMS text messages sent worldwide in 2011. (Source: CTIA http://www.ctia.org/media/industry_info/index.cfm/AID/10323 <http://www.cellular-news.com/story/47162.php>)



The Propagation of Mobile Technologies

- 90 % of the world population lives in range of a wireless signal
- 70% of the 6 billion cell phone users are in third world countries
- 50% of all cell phone users will be able to access the web on their cell phones by 2015
- 100 countries currently using some form of mobile health technology



Mobile phones – then and now!

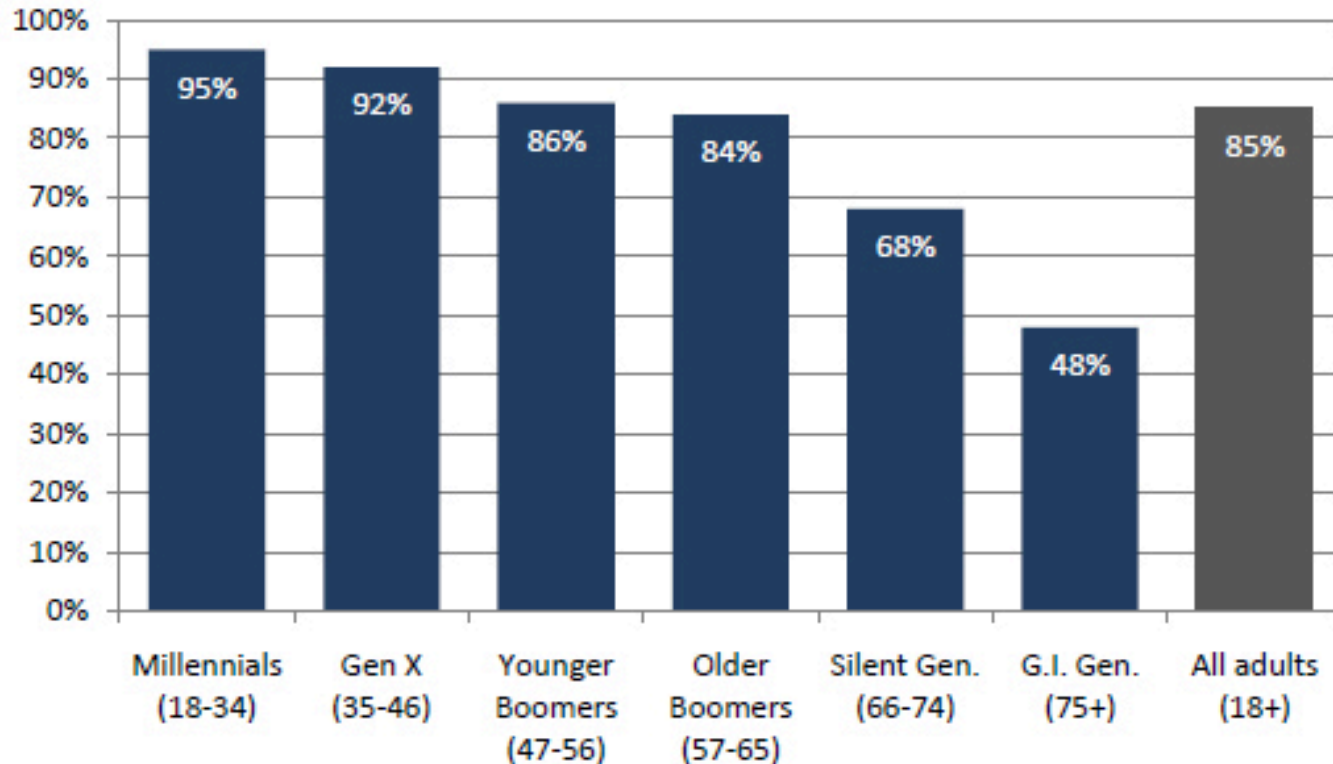


MODEL SELECTIVE TELEPHONES ON DRESS PARADE.



“Generations and their Gadgets”

Do you have a cell phone, or a Blackberry or iPhone or other device that is also a cell phone?



Source: Pew Research Center's Internet & American Life Project, August 9-September 13, 2010 Tracking Survey. N=3,001 adults 18 and older, including 1,000 reached via cell phone. Interviews were conducted in English (n=2,804) and Spanish (n=197).

Mobile Health Applications Flooding Marketplace



Mobile Health Applications - 2010

Application	Number of health applications available for download	Intended for consumer / patient	Intended for healthcare professional	Number of downloads
iPhone	~6000	73%	30%	Unknown
Android	~600	81%	20%	3.5 million +
Blackberry	~200	70%	30%	Unknown

Mobile Health iTunes Applications for Diabetes

A growing business!

July 2009:	60 apps
February 2012:	260 apps

What is mHealth?

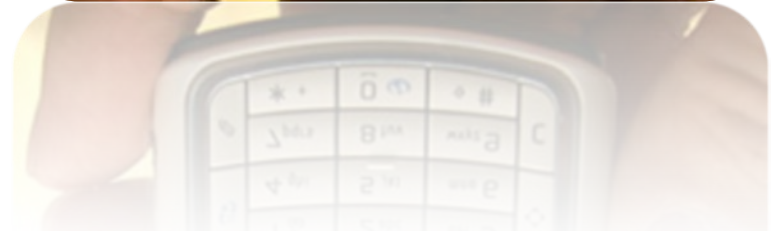
- mhealth is the use of mobile and wireless devices to improve health outcomes, healthcare services and health research.

This definition was developed by a NIH Consensus group



Cell Phone Applications for mHealth

- Clinical consultation
- Education
- Research
- Biosurveillance
- Disease Management



Current Studies

Text Messaging as a Tool for Behavior Change in Disease Prevention and Management

Heather Cole-Lewis* and Trace Kershaw

* Correspondence to Heather Cole-Lewis, Yale University School of Epidemiology and Public Health, P.O. Box 208034, New Haven, CT 06520-8034 (e-mail: heather.cole-lewis@yale.edu).

Accepted for publication January 25, 2010.

Mobile phone text messaging is a potentially powerful tool for behavior change because it is widely available, inexpensive, and instant. This systematic review provides an overview of behavior change interventions for disease management and prevention delivered through text messaging. Evidence on behavior change and clinical outcomes was compiled from randomized or quasi-experimental controlled trials of text message interventions published in peer-reviewed journals by June 2009. Only those interventions using text message as the primary mode of communication were included. Study quality was assessed by using a standardized measure. Seventeen articles representing 12 studies (5 disease prevention and 7 disease management) were included. Intervention length ranged from 3 months to 12 months, none had long-term follow-up, and message frequency varied. Of 9 sufficiently powered studies, 8 found evidence to support text messaging as a tool for behavior change. Effects exist across age, minority status, and nationality. Nine countries are represented in this review, but it is problematic that only one is a developing country, given potential benefits of such a widely accessible, relatively inexpensive tool for health behavior change. Methodological issues and gaps in the literature are highlighted, and recommendations for future studies are provided.

Epidemiologic Reviews Advance Access published March 30, 2010



mHealth Evidence

Agents for Behavior Change

- Smoking Cessation: 28% of smokers receiving SMS messages quit vs. 13% of control group. (A. Rogers et.al. Do u smoke after txt? *Tobacco Control* 2005;14:255-261).
- Diabetes: For patients using interactive SMS support service, mean HbA1c improved from $7.5 \pm 1.5\%$ to $7.0 \pm 1.1\%$ ($P = 0.003$). Hyuk-Sang Kwon, et. al. *Diabetes Research and Clinical Practice* Volume 66, December 2004: Pages S133-S137
- Diabetes: The web-based intervention using SMS messaging improved levels of HbA1c in type-2 diabetic patients for the six-month duration of the trial. *Journal of Clinical Nursing*, June, 2007, Vol. 16 No. 6, pp 1082-1087 Hee-Seung Kim, Ph.D., RN; Hye-Sun Jeong PhD, RN
- Appointment Attendance. SMS reminders improved primary care attendance from 48% to 59%. The use of text messaging to improve attendance in primary care: a randomized controlled trial. *Family Practice* 2006 23(6):699-705

Multiple behavior changes in diet and activity: a randomized controlled trial using mobile technology

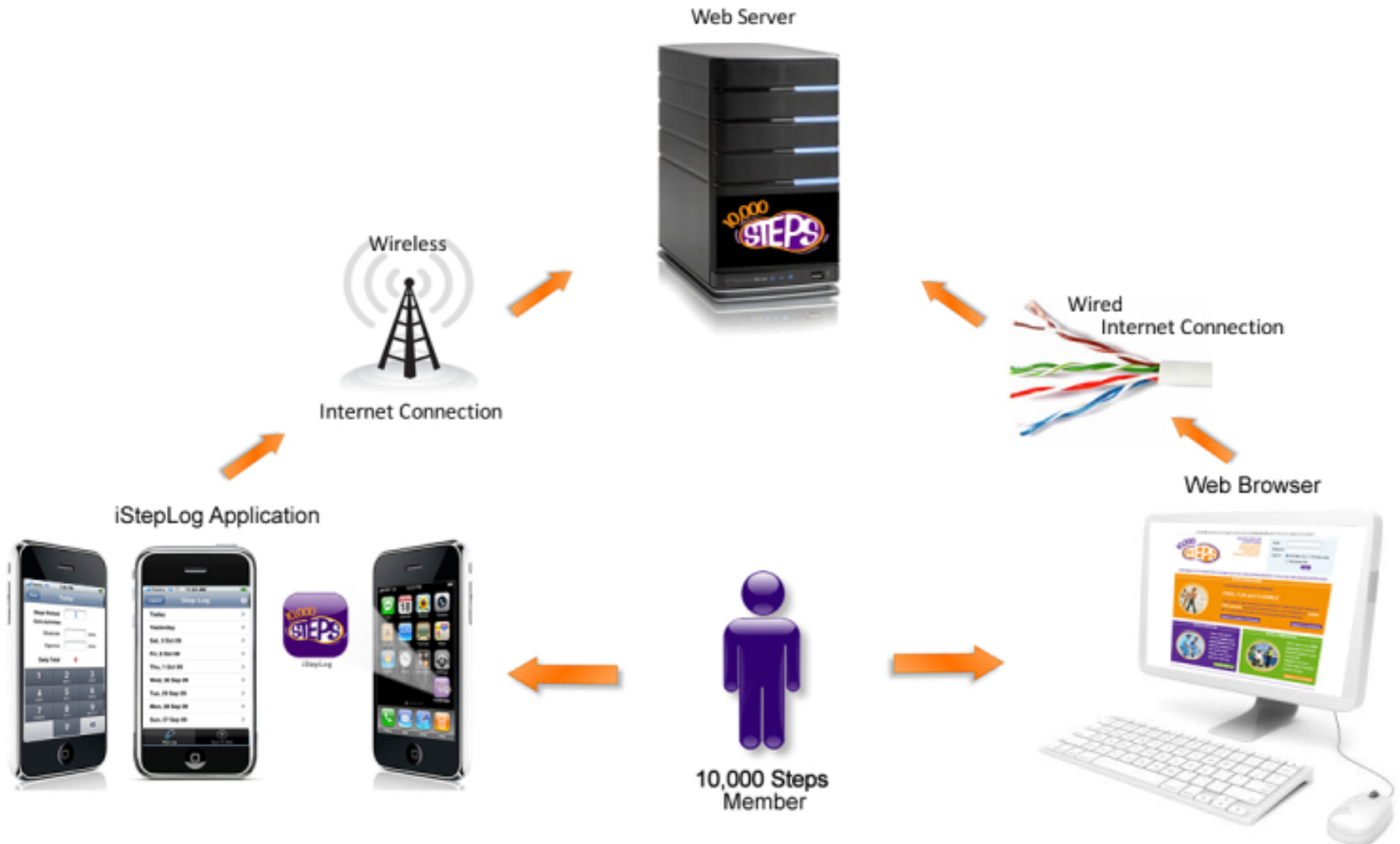
- **BACKGROUND:** Many patients exhibit multiple chronic disease risk behaviors. Research provides little information about advice that can maximize simultaneous health behavior changes.
- **METHODS:** n=204 adults (elevated saturated fat and low fruit/vegetable intake, high sedentary leisure time, and low physical activity)
- Randomized to 1 of 4 treatments for 3 weeks with mHealth coaching:
 - increase fruit/vegetable intake and physical activity,
 - decrease fat and sedentary leisure,
 - decrease fat and increase physical activity,
 - increase fruit/vegetable intake and decrease sedentary leisure.
- **CONCLUSIONS:** Remote coaching supported by mobile technology and financial incentives holds promise to improve diet and activity. Targeting fruits/vegetables and sedentary leisure together maximizes overall adoption and maintenance of multiple healthy behavior changes.

Personal Health Care

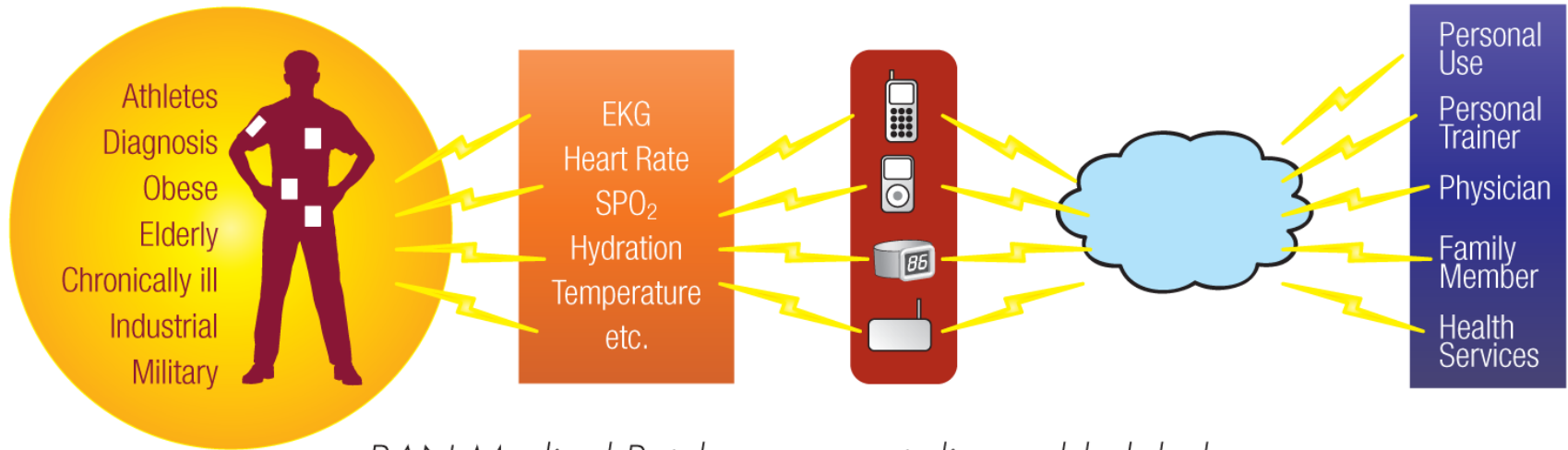


Using smartphone technology to monitor physical activity in the 10,000 Steps program: a matched case-control trial

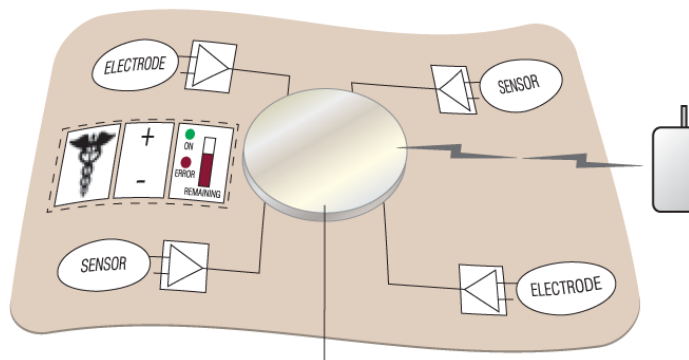
Procedure for participants to upload their daily steps to the 10,000 Steps Web server



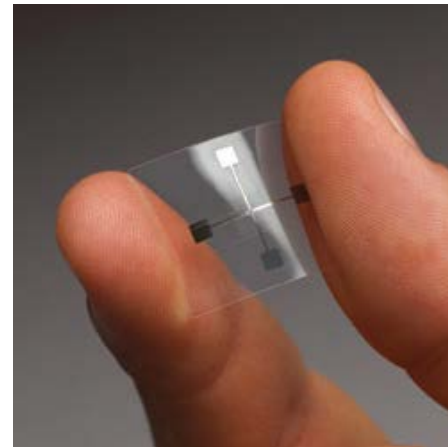
Wireless Body Area Network (wBAN)



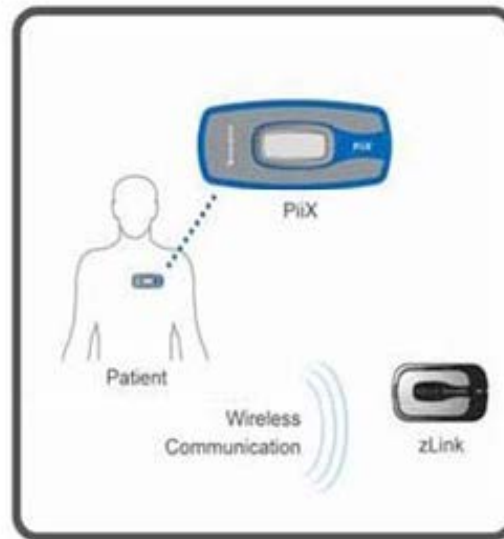
BAN Medical Patches as smart disposable labels.



Standardized, detachable, re-usable radio



First Clinical Trial



Wireless
Communication

corventis



Data Collection
and Analysis

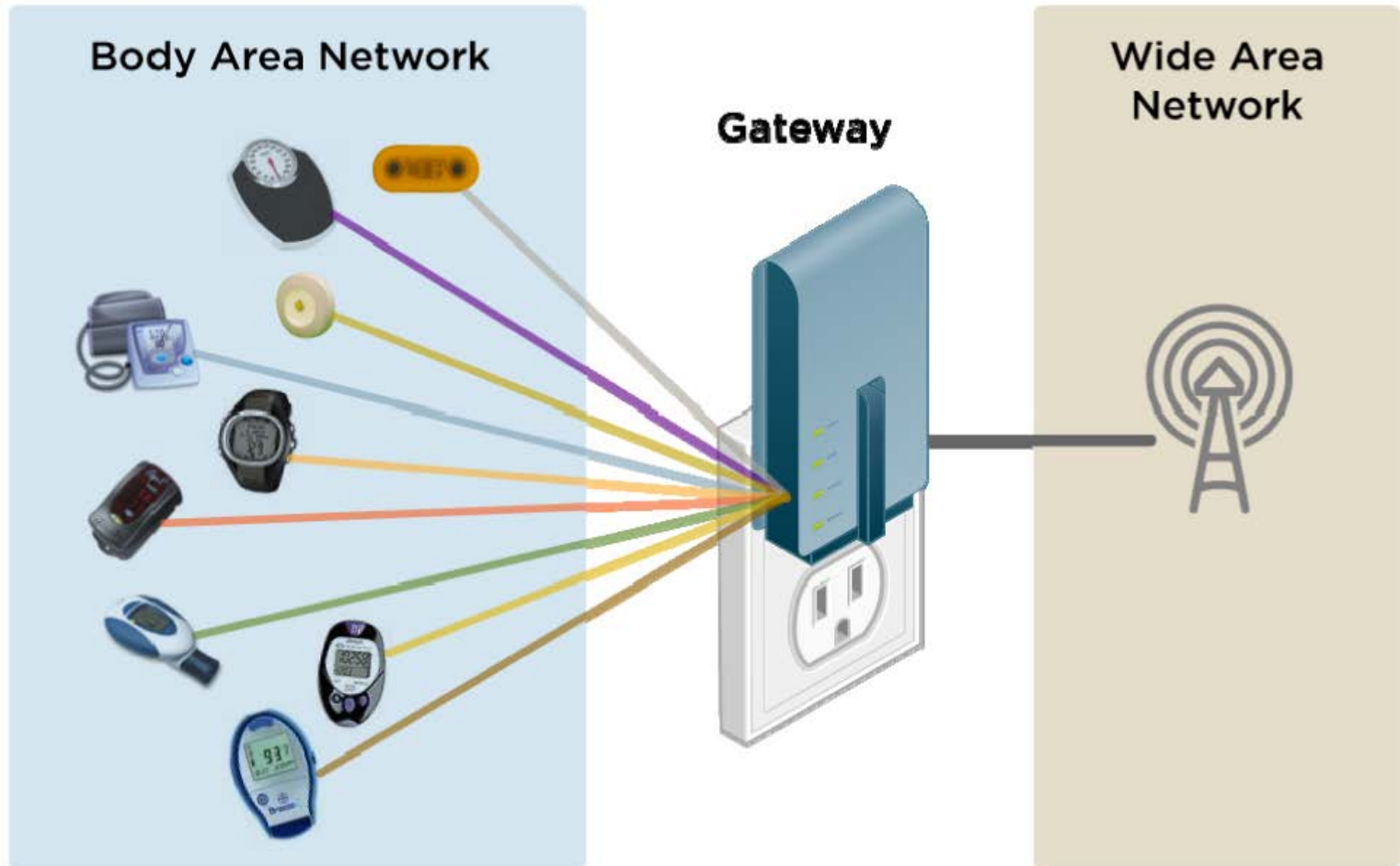


Clinician

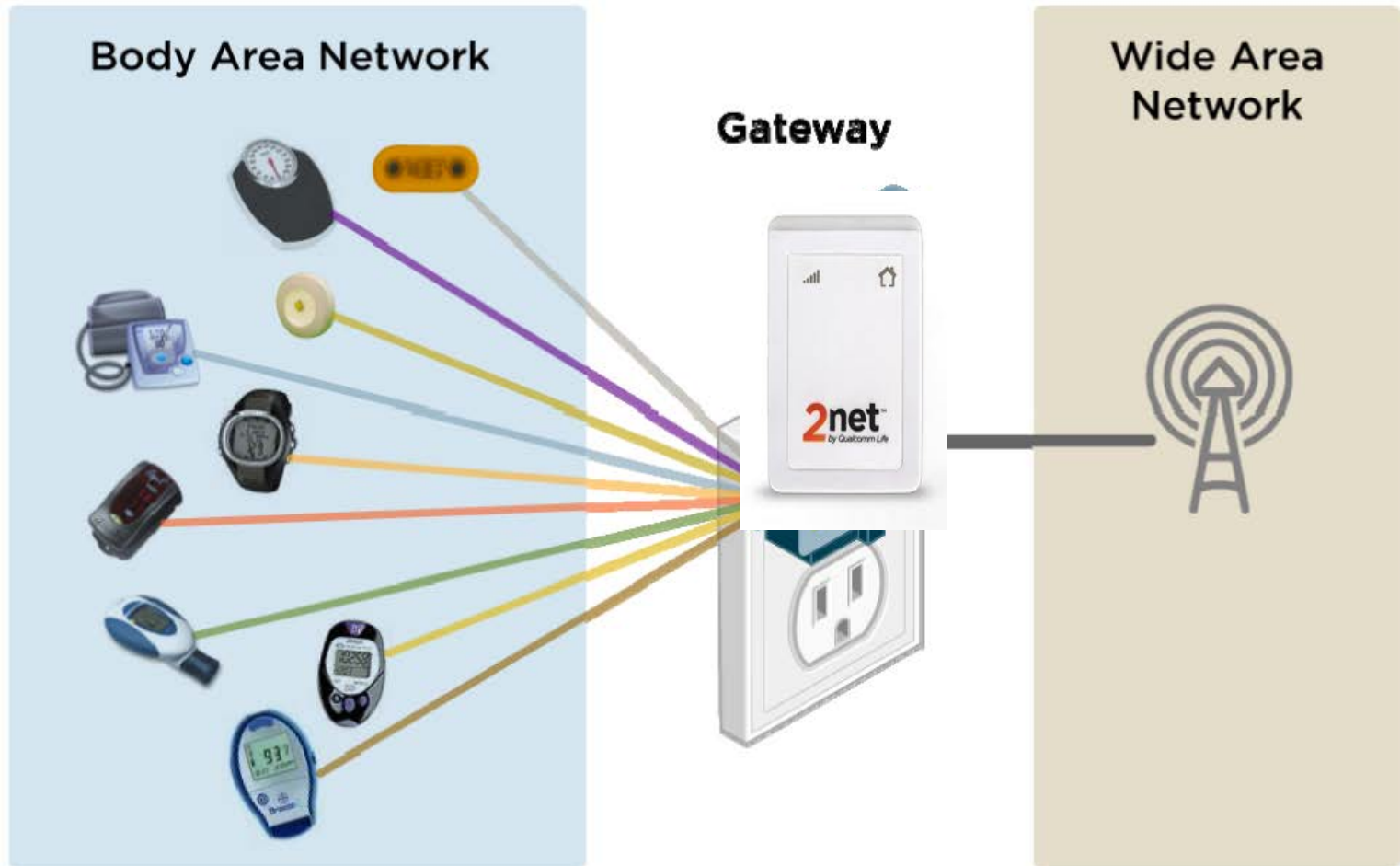
corventis



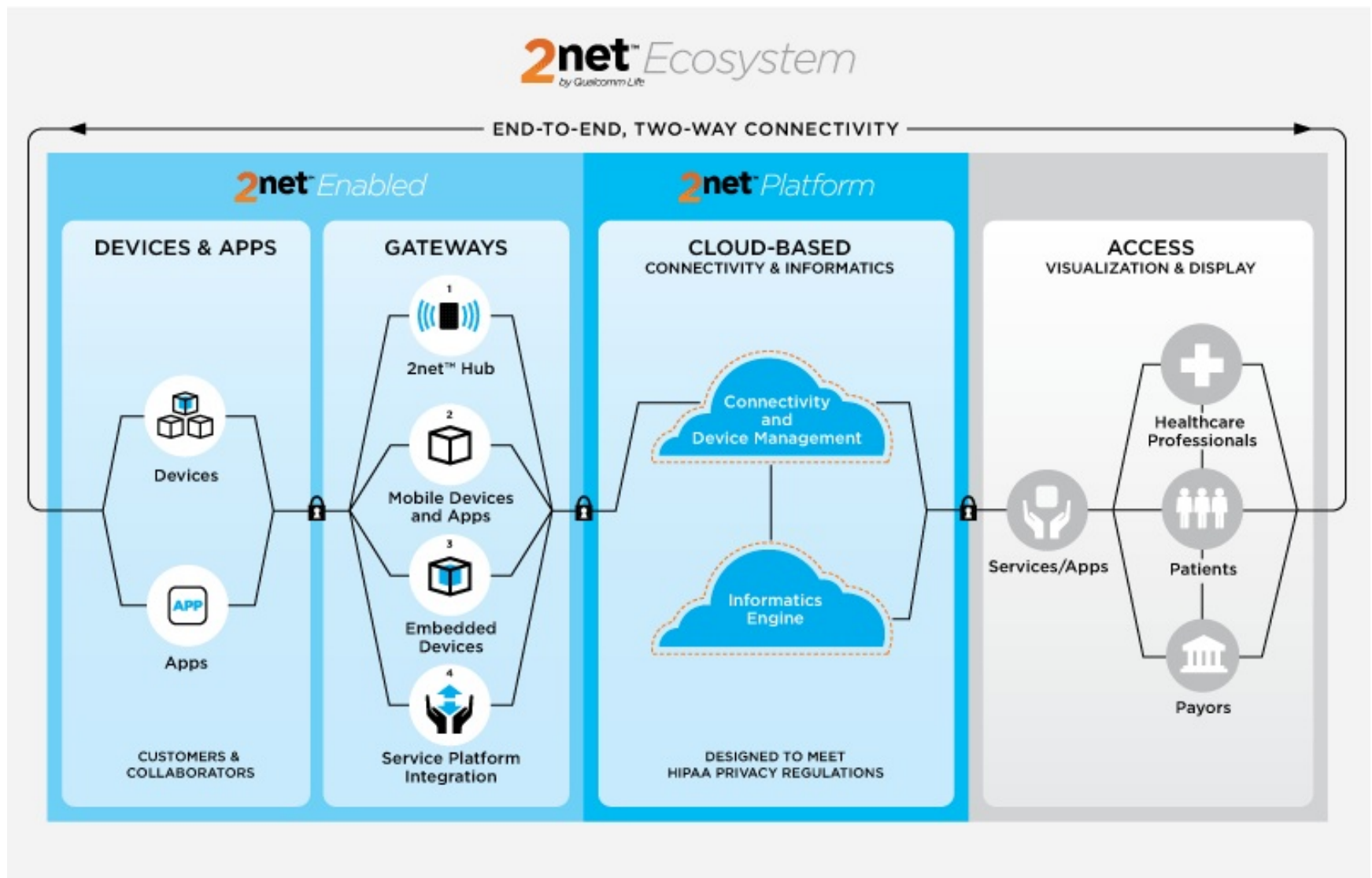
Low Cost, Easy to Deploy Health Gateway



Low Cost, Easy to Deploy Health Gateway



Qualcomm 2net concept



The FDA Takes On Mobile Health Apps

Regulation is coming soon to health apps

- mHealth industry has grown too fast, outpacing US Government regulators
- iTunes app store now contains 13,000 health & wellness apps
- FDA has the authority to regulate medical devices and software that diagnose or treat disease, but not those that contribute to general wellness
- FDA guidelines coming out by December 2012



Mobile Medical Provider



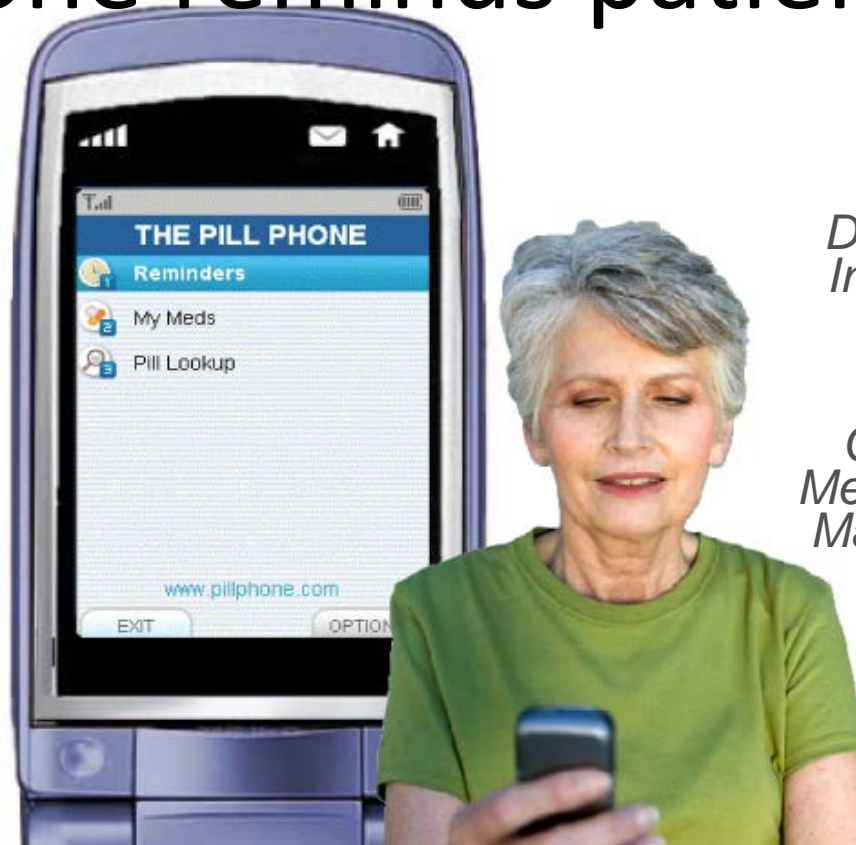
Phone reminds patients

*Confirms
Compliance with
Loved Ones*

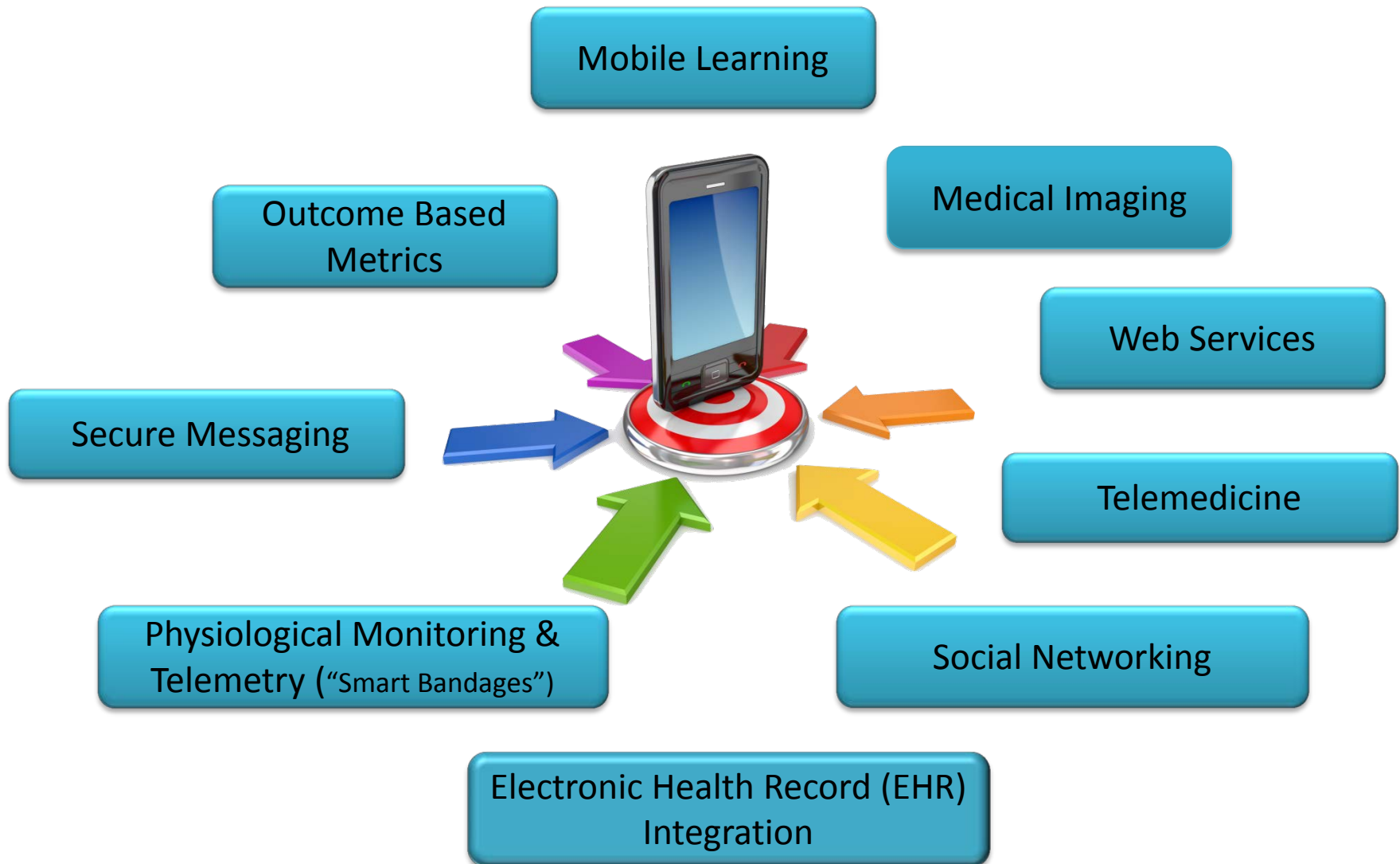
*Drug-to-Drug
Interactions*

*Survey Surveillance
Features*

*Convenient
Medication List
Management*



Key Mobile Health Capabilities



More data, from more sources





University of Pittsburgh

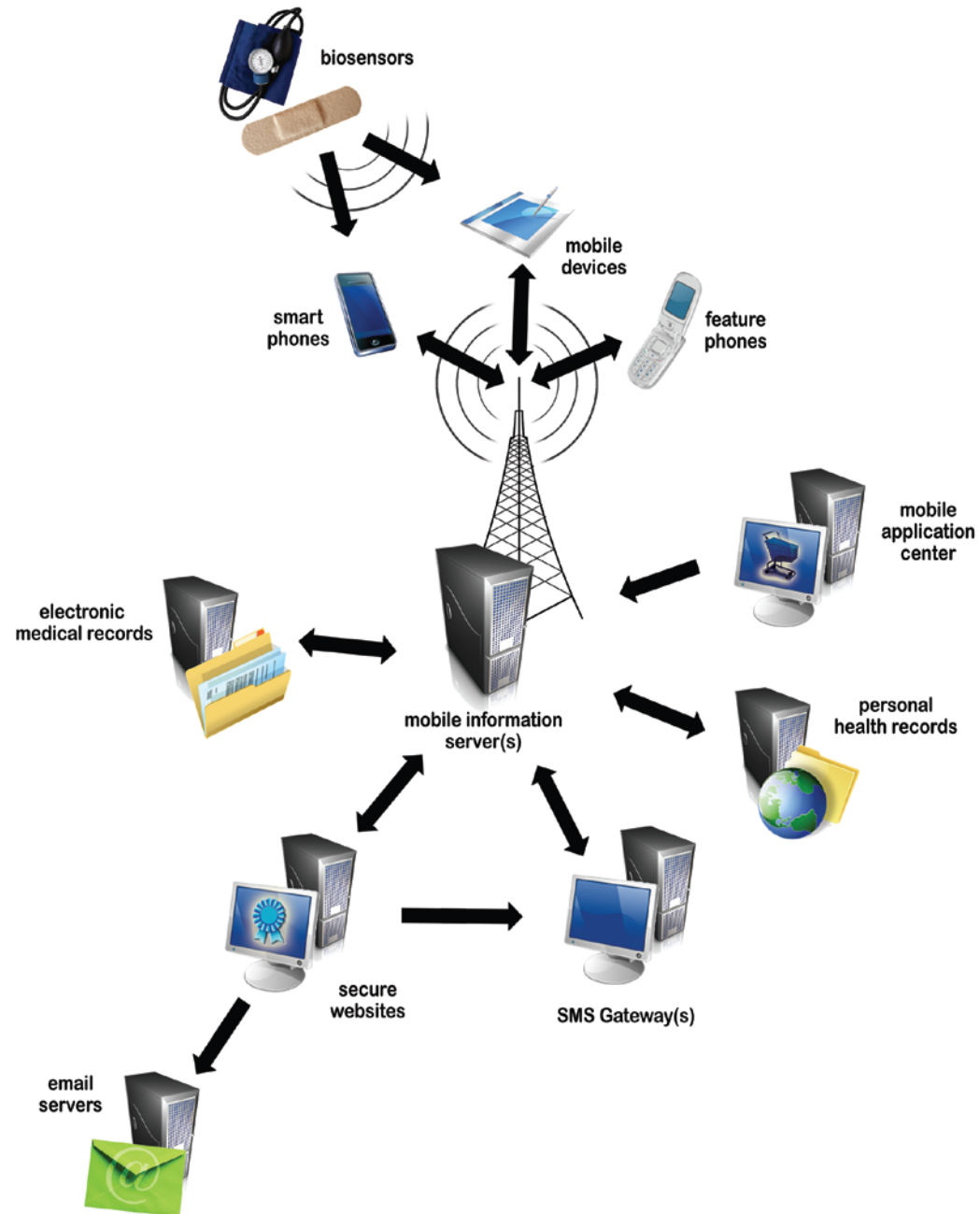
The tidal wave of data

Will mHealth overwhelm providers
with too much data?

Challenges

- Data Collection
- Data Archiving
- Data aggregation
- Data Processing
- Data Reduction
- Notification - Who is going to monitor and analyze the data?

Mobile Health High Level Operational Concept



Conclusions

- More research, with large sample sizes, studied for long periods of time are needed to prove the benefits of Internet-based home monitoring programs for chronic disease .
- Data for Remote Monitoring for asthma/COPD research are emerging from longer, randomized trials.
- Telemedicine will continue to play an increasingly critical role in chronic disease management, as technology advances.
- mHealth and Body Area Networks use is growing for home monitoring of chronic diseases
- Challenges of mHealth includes provider availability to monitor and analyze data due to the tsunami of information generated.

Questions?

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