Patient Centered mHealth Solutions for Chronic Disease Management

Frank Treiber, PhD.
Professor of Nursing & Psychiatry
Director, Technology Applications Center for Healthful Lifestyles (TACHL)
Medical University of South Carolina

Presented at: SCHA 7th Annual SC Transforming Health Symposium, Columbia, SC 4/2/14
Objectives

1. Provide synopsis of mHealth revolution in patient self management of chronic diseases
   ➢ What is it? ➢ Why does SC need it? ➢ What is TACHL?

2. Provide example of mHealth addressing med nonadherence & BP Control
   ➢ Series of 3 theory guided, iterative design based RCTs among EHs:
     ✓ Kidney transplant patients
     ✓ FQHC Hispanic migrant farmers
     ✓ FQHC African Americans

3. Provide Glimpse of Other TACHL mHealth projects:
   ➢ Tension Tamer (stress reduction)
   ➢ Uterine Contraction Monitoring
   ➢ Asthma Control
Obj.#1: Synopsis of mHealth Revolution in Patient Self Management

What is mHealth?

• Diverse application of wireless and mobile technologies designed to improve health research, health care delivery and health outcomes

• MUCH MORE THAN JUST CELL PHONES
mHealth
Includes any wireless device carried or worn that transmits health data & info

- Sensors (e.g., implantable nanosensors, accelerometers, temporary patches & tattoos)
- Monitors (e.g., ECG, BP, HR, glucose monitors; inhalers)
- Mobile phones
mHealth: Beyond Telemedicine

- **Portable:** Beyond POC Diagnostics
- **Scalable:** Economical to scale
- **Richer data input:** Continuous data sampling
- **Personal:** Patients receive & send information
- **Real-time:** Data collection & feedback in real-time using automated analyses & responses
mHealth Technology: What Have You Tried On Yourself? On Patients?

- Monitors: ECG, BP, HR, glucose monitors; inhalers)
- Sensors: accelerometers
- Phone apps
mHealth Technology Advancements

Holter monitor

Piix monitor

Old

New
Remote monitoring of physiological parameters

Wearable PiX, automatically collecting and transmitting data

Wireless Communication

zLink Mobile Transmitter

Data Analysis

Physician Access

Corventis™, Inc.
Intel® Health Guide

The Intel® Health Guide connects patients and their care teams for personalized care management at home.

- Vital sign measurement
- Reminders
- Patient education content
- Customizable care protocols
- Video conferencing

Patient → Intel® Health Care Management Suite → Technician Interface → Backend Services Tool Kit → Clinician
Bosch Telehealth System
TACHL’s Cost Effective Solution: BP Monitor Linked to Smart Phone
Mobile Communication Technology: A Primary Catalyst for mHealth

• Ubiquity of Mobile Phones:
  • 93% of Americans have cell phones
  • 56% use Smart Phones
  • Virtually all will be using smart phones in 2 yrs
  • 95 million Americans used smart phone as healthcare tool in 2013
  • ~ 40,000 chronic disease & health /wellness apps;
  Apple Marketplace: 95 HTN; 242BP
mHealth Apps: What's a Doc to Do?

• “Many apps have misleading medical claims & quality & safety concerns are a topic of inquiry.” Bakul Patel, F.D.A. policy adviser

• Majority have NOT been developed using evidence based guidelines, behavioral change theories, patient/provider centered, iterative approach & empirically validated

• Healthcare providers seek validated effective programs following evidence based guidelines
Obj.#1: Why Does SC Need mHealth?

Increasing #s of chronic disease patients & healthcare costs:
2003 ($5.5B) & 2023 ($20B)

- SC among the worst states in:
  - premature mortality (46th)
  - obesity (42nd) 31% of adults $1.2B
  - stroke (40th) 14,471 hospitalizations $530M
  - cancer (36th) 26,000 new cases $887M
  - CVD (35th) 57,794 hospitalizations $2.8B
  - diabetes (46th) 371,476 diagnosed $4.1B
Obj.#1: Why Does SC Need mHealth?

Growing healthcare costs, shrinking budgets & large rural underserved areas mandate cost effective solutions

- Proviso 33.34 (partnerships of FQHCs, free clinics and hospitals in care of uninsured, chronically ill, frequent ED users)

- SC’s Telemedicine Initiative (e.g., reaching rural hospitals - hub & spoke REACH model; day to day management via mHealth)

- mHealth offers potential to lower costs, enhance clinical outcomes & reach our underserved at risk populations
Obj.#1: What is TACHL?
Technology Applications Center for Healthful Lifestyles

- HSSC Center of Economic Excellence
- Tasked with development, testing & licensing of software & hardware technologies to foster:
  - health promotion
  - disease prevention
  - health care management
Goals:

➢ Provide economic growth to SC
  ✓ Grant awards, Licensures, Sales of products
  ✓ Establish start up companies

➢ Reduce healthcare costs via reductions:
  ✓ ED visits & hospitalizations
  ✓ premature death & disability
  ✓ incidence of chronic diseases
TACHL History
Launched Fall 2010

Generated ~$7.5M in Research Funding

- 2 NIH RO1s; 1 R21
- 4 NIH Faculty Training Awards (KO1s, KL2)
- 2 Foundation Awards (Duke Endowment & Verizon Foundation)
- Devpt. Core on: 1 R21, Kellogg & Macey Foundation Awards
- 6 Records of Invention
- 8 NDAs with medical device/life science companies
Obj.#2: Example of mHealth in chronic disease management

Leading unmet healthcare need in chronic disease management:
✓ patient non-adherence to medication regimens

What is take away message?
✓ Theory based, patient & provider centered, empirically validated, mHealth self management programs are viable solutions
Med Adherence: extent prescribed dose, frequency & timing of regimen followed

~ 50% of patients with chronic disease(s) adhere to medication regimens

- Med nonadherence leads to:
  - suboptimal clinical outcomes
  - reduced work force productivity
  - increased healthcare costs $100-300 B/yr
Obj.#2: Devpt. of mHealth Medication Adherence & BP Control Program Among Kidney Transplant Patients
Background

- Despite advances in medical/surgical care of kidney transplant recipients, 3-year graft survival is ~81% & graft half-life is only ~9 years.
- Medication non-adherence is a key contributor to premature graft loss.
- Minor degrees of non-adherence are associated with poorer outcomes even in the absence of rejection.
Rationale

- ~35% of renal transplant patients are non-adherent; ~70% if time constraint instituted
- Non-adherence contributes to graft loss by allowing for immune mediated rejection and the deleterious effects of poorly controlled comorbid conditions (i.e., HTN)
- mHealth technology has the potential to positively impact medication adherence and thereby improve graft survival
Development of mHealth Prototype System

- Little known about renal transplant patients’ attitudes toward mHealth technology
- Individual interviews conducted to determine attitudes toward, willingness and ability to use mHealth
- Prototype mHealth system developed (SMASH)
- 99 patients surveyed after being given a demonstration of SMASH mHealth system
Survey Results of mHealth prototype: SMASH

- 90% cell phones; 52% had smart phone access
- 61% texted; 38% surfed web
- 34% downloaded apps
- Only 7% had heard of mHealth/telehealth
- 79% very willing to use mHealth
- 87% very confident mHealth would increase communication with physician
- 84% felt doctor would make quicker med changes

McGillicuddy et al. (2014) Journal Medical Internet Research
SMASH System

Medication Reminder Device

MedMinder reports when medicine is taken

Medication Reminder Device

Weekly Summary Reports

Data Center

Weekly Summary Reports

Patient with Smart Phone

Physician changes regimen as needed

Automated Personalized Motivational Messages

Fora BP and Glucose Monitor

Blue Tooth

Patient with Smart Phone

Physician changes regimen as needed

Automated Personalized Motivational Messages

Weekly Summary Reports

Data Center

Data Center

Weekly Summary Reports

Data Center

Weekly Summary Reports

Data Center

Weekly Summary Reports

Data Center

Weekly Summary Reports

Data Center

Weekly Summary Reports

Data Center

Weekly Summary Reports

Data Center

Weekly Summary Reports

Data Center

Weekly Summary Reports

Data Center

Weekly Summary Reports

Data Center

Weekly Summary Reports

Data Center
Personalized Motivational Message Example

Background: 55 yr.-old single with EH & T2D. Family history: parents with EH, T2D & ESRD.

Life goals & personal values: religious, desires to spend more time with family, worries about dying young from kidney disease or a stroke like his parents

Medication dose(s) taken correctly:

Great, Frank! You’re taking your medicine on time! Your family history does not have to be your future!

Missed medication dose(s):

Frank, try and remember to take your medicine on time every day! God has blessed you, take care of His gift of life!
Med Adherence in Transplant Patients With Co-Morbidities (hypertension, diabetes, etc.)

Average of 13.5 different meds/bid-qid

Percent Adherence

Baseline  Month 1  Month 2  Month 3
60  89  92  95
50  53  59  56

mHealth  SOC

McGillicuddy et al. (2013a,b) Journal of Assn. Computing Machinery & Journal of Medical Internet Research
BP Changes Among Kidney Transplant Recipients

Obj.#2: mHealth (SMASH) & Hispanic Uncontrolled Hypertensives

Focus groups & surveys led to SMASH prototype refinement

- 81% cell phone; 39% smart phone
- 78% texted; 48% downloaded apps
- 19% had heard of mHealth
- 94% very willing to use mHealth
- 85% very confident mHealth would increase communication with physician
- 76% had complete trust in privacy of data

Price et al. (2013) Journal Medical Internet Research
BP Changes & Medication Adherence Among Hispanic Hypertensives

- SMASH med adherence ~97% across 3 months

Sieverdes et al. (2013) *Mobile Health Telecare*
Obj.#2: mHealth (SMASH) & African American FQHC Uncontrolled Hypertensives

Average ED visit Cost: $5,923
ED/Patient/Year Rate: 1.05

<table>
<thead>
<tr>
<th>ED Visits and Associated Costs</th>
<th>SMASH (n=8)</th>
<th>SOC (n=11)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Trial</td>
<td>During Trial</td>
</tr>
<tr>
<td># ED Visits</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Difference</td>
<td>4 (57%↓)</td>
<td>1 (7.7%↓)</td>
</tr>
<tr>
<td>ED Savings</td>
<td>$23,692</td>
<td>$5,923</td>
</tr>
</tbody>
</table>
Obj.#2: SMASH Hypothetical ED Use
Projected Cost Savings

MUSC ED visits /year/patient Rate: 2.7
57% reduction in ED visits
Average ED visit Cost: $5,923
SMASH Cost/patient/year: $1,913

Year 1
Patients: 10
Savings: $88,845
Additional Patients: 36

Year 2
Patients: 46
Savings: $414,610
Additional Patients: 170

Year 3
Patients: 216
Savings: $1,966,436
Additional Patients: 811

Year 4
Patients: 1027
Savings: $9,358,340
Total of 4,891 patients can now be managed
Obj. #3: Other Examples of mHealth Programs:

Tension Tamer App:
Breathing Meditation

HL 114957
6/13-5/18
Tension Tamer App Motivation and Evolution

- Nonin-$450
- Power drain from Bluetooth data transfer.
- Easy to lose.

2010

2012

2013
Obj. #3: Other Examples of mHealth Programs: Uterine Contraction Monitoring Program

- **Monica Beacon Contraction Monitor**
- Mobile devices send measurement data & receive alerts & feedback
- Secure TACHL Data server, analysis server & web portal.
- Dynamic reporting, analysis & integration of contraction data & decision making data.
- Feedback & intervention to patient via clinician &/or dynamic decision making & alert system.
mHealth Monitoring Program for Asthma

Sensor attached to inhaler. Using GPS, App provides info on where & when inhaler used, also pollen &/or pollution levels.

Data sent securely & encrypted to database servers.

Patient inhaler usage analyzed & trend reports sent to patient.

Automated summary reports

Navigator contact based upon trigger alerts

Secure login by clinician/administrator to select customized reports. Share data with complex systems (EMR, HealthVault, etc.)