Improved Patient Adherence (Compliance) to Therapy Through Mobile Technology

Martin Michalowski, PhD
University of Minnesota, School of Nursing
June 13th 2018
Collaborators

- Szymon Wilk
- Wojtek Michalowski
- Mor Peleg
- Dympna O'Sullivan
- Enea Parimbelli
- Marc Carrier
Motivation and Goal

• Non-adherence is one of the most significant barriers to effective treatment: 20-30% for short-term treatment, 50% for long-term and 70-80% for lifestyle changes [Jin et al., 2008]

• Interventions improving adherence have far greater impact on patient outcomes than those improving therapies [Haynes et al., 2008]

• Successful interventions combine patient education and behavior modification [Benjamin, 2012]

Our goal: to develop a mobile-based adherence support framework to help patients follow prescribed therapies and tailored to their individual needs
mHealth-Based Decision Support

- **MobiGuide** [Peleg et al., 2017]
  - Evidence-based clinical decision-support system
  - Delivers personalized reminders and recommendations to care providers and patients,
  - Gestational diabetes patients’ mean adherence to the clinical recommendations = 87%
  - Mean adherence of patients with atrial fibrillation = ~70%
Motivational Patient Assistant (MPA)

• Provides behavioral interventions
  – Patient-tailored

• Based in health behavior theories

• Interventions delivered via the platform that is most suitable for patient needs
  – Mobile
  – Web-based
  – TV
MPA Framework

1. Data-driven
   – Identification of psychobehavioral targets → patterns in patient’s psychological characteristics and behaviors that affect adherence
   – Application of dominance-based rough set approach (DRSA) to induce rules that capture patterns associated with adherence levels

2. Expert-driven
   – Construction and selection of psychobehavioral interventions → systematic plans of actions that affect patients’ behaviors and psychological stance
   – Application of predefined categories of generic interventions [Abraham, Michie, 2008] and domain knowledge

3. Technology-driven
   – Integration with mobile decision support system tailored to patient’s computer literacy level
Dominance-Based Rough Set Approach (DRSA) – Phase 1

- Data analysis and knowledge discovery technique suitable for mining imperfect (incomplete, inconsistent) data
- Objects categorized into ordered classes (from worst to best) and described using features with (possibly) ordered values
  - Decision rules derived from set of objects
- Classification- and intervention-oriented perspectives associated with decision rules
  - Change values of object’s features and affect its classification
  - Defines the target and specifies the expected change in classification
Types of Intervention Targets

- **Positive** target
  - Associated with changes that improve class assignment, i.e., improving a patient’s likelihood of adherence to prescribed therapy

- **Negative** target
  - Associated with changes that result in deteriorated class assignment, i.e., reducing the chance a patient adheres to prescribed therapy

Positive targets should be achieved, while negative targets should be avoided
Identification of Psychobehavioral Targets

- Patients described using sociodemographic, psychological and behavioral features [IOM, 2015]
  - Interventions are applied only to the latter two (→ psychobehavioral features)

- DRSA applied to induce decision rules

- Positive and negative psychobehavioral targets associated with improving or maintaining adherence
Construction of Psychobehavioral Interventions – Phase 2

• Two major components of psychobehavioral interventions: **educational** and **behavior change** actions
• Educational actions should
  – Educate on disease manifestation, prognosis and management
  – Provide information about behavior-health links (benefits of a proper behavior and consequences of improper one)
  – Emphasize the key role of the patient in a successful therapy
• Behavior change actions should
  – Engage the patient in goal setting
  – Provide feedback on goal attainment
  – Encourage the patient for positive behavior

Critical role of self-reporting → “priming for honesty” to increase its reliability
Selection of Psychobehavioral Interventions

• Associations between psychobehavioral targets and interventions

• Additional constructs for fine-grained and dynamic selection of intervention
  – Transtheoretical model (TTM) – classifies the patient according to their readiness for change
  – Self-determination theory (SDT) – evaluates the patient’s level of autonomous (or intrinsic) motivation
  – Fogg’s Behavioral Model (FBM) – ties behavioral change to a cue or cyclical event

• TTM and SDT define a stopping condition for delivering specific psychobehavioral interventions
mHealth Instantiation – Phase 3
Case Study: Treating Atrial Fibrillation Patient for Primary Stroke Prevention

• One of the most prevalent types of cardiac arrhythmias → approximately 30% of hospitalizations for arrhythmias

• Independently living older adults with atrial fibrillation adhere to anticoagulation therapy (vitamin K antagonists (VKA) or direct oral anticoagulants (DOAC)) for primary stroke prevention

• ~50% of patients adhere to prescribed anticoagulation therapy [Castellucci et al., 2015]

• Adherence remains low with introduction of the DOACs [Jackevicius et al., 2017]

• Limited support for patients to help with their adherence
Case Study:

Data and Selected Features

- 12 patient vignettes vetted and revised by a hematologist
  - Described by 10 features (consistent with recommendation of IOM for EHR) – 2 psychobehavioral and 8 sociodemographic
  - Categorized into 3 adherence levels
- Original set of features further limited to three features by a reduction analysis using UTA method

<table>
<thead>
<tr>
<th>Vignette</th>
<th>Adherence_history</th>
<th>Smoking_or_alcohol</th>
<th>In_charge</th>
<th>Adherence_level</th>
</tr>
</thead>
<tbody>
<tr>
<td>v1</td>
<td>(3) good</td>
<td>(2) moderate</td>
<td>(2) yes</td>
<td>(2) moderate</td>
</tr>
<tr>
<td>v2</td>
<td>(2) none_or_moderate</td>
<td>(1) none_or_light</td>
<td>(2) yes</td>
<td>(3) good</td>
</tr>
<tr>
<td>v3</td>
<td>(2) none_or_moderate</td>
<td>(1) none_or_light</td>
<td>(1) no</td>
<td>(2) moderate</td>
</tr>
<tr>
<td>v4</td>
<td>(1) poor</td>
<td>(1) none_or_light</td>
<td>(2) yes</td>
<td>(1) poor</td>
</tr>
<tr>
<td>v5</td>
<td>(2) none_or_moderate</td>
<td>(3) heavy</td>
<td>(1) no</td>
<td>(1) poor</td>
</tr>
<tr>
<td>v6</td>
<td>(1) poor</td>
<td>(2) moderate</td>
<td>(1) no</td>
<td>(1) poor</td>
</tr>
<tr>
<td>v7</td>
<td>(3) good</td>
<td>(1) none_or_light</td>
<td>(2) yes</td>
<td>(3) good</td>
</tr>
<tr>
<td>v8</td>
<td>(2) none_or_moderate</td>
<td>(1) none_or_light</td>
<td>(1) no</td>
<td>(2) moderate</td>
</tr>
<tr>
<td>v9</td>
<td>(2) none_or_moderate</td>
<td>(1) none_or_light</td>
<td>(1) no</td>
<td>(2) moderate</td>
</tr>
<tr>
<td>v10</td>
<td>(3) good</td>
<td>(2) moderate</td>
<td>(2) yes</td>
<td>(2) moderate</td>
</tr>
<tr>
<td>v11</td>
<td>(2) none_or_moderate</td>
<td>(1) none_or_light</td>
<td>(2) yes</td>
<td>(3) good</td>
</tr>
<tr>
<td>v12</td>
<td>(1) poor</td>
<td>(3) heavy</td>
<td>(1) no</td>
<td>(1) poor</td>
</tr>
</tbody>
</table>

Willingness to be in charge of one’s health → engagement
Case Study: Psychobehavioral Targets

- Leave-one-out schema for reliable identification and evaluation of psychobehavioral targets

<table>
<thead>
<tr>
<th>Sociodemographic context</th>
<th>Psychobehavioral target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adherence_history</td>
<td>Smoking_or_alcohol</td>
</tr>
<tr>
<td>r1</td>
<td>&gt;= none_or_moderate</td>
</tr>
<tr>
<td>r2</td>
<td>&gt;= good</td>
</tr>
<tr>
<td>r3</td>
<td>&gt;= none_or_moderate</td>
</tr>
<tr>
<td>r4</td>
<td>&lt;= poor</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>r5</td>
<td></td>
</tr>
<tr>
<td>r6</td>
<td>&lt;= poor</td>
</tr>
<tr>
<td>r7</td>
<td></td>
</tr>
</tbody>
</table>

- Positive target in \(\rightarrow\) limit smoking or drinking (to none or light) and improve patient’s engagement

- Negative target in \(\rightarrow\) maintain current (at most moderate) smoking or drinking level
Case Study:

Psychobehavioral Interventions

- Abraham and Michie framework, used in patient-tailored interventions
- Fine-grained selection based on the patient’s stage in the TTM model and SDT

<table>
<thead>
<tr>
<th>TTM Stages</th>
<th>Education actions</th>
<th>Behavior change actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Precontemplation</td>
<td>1. Engagement (e.g., benefits, risks – communicated in text and as a video inter-view with an AF patient)</td>
<td>1. Interactive exploration of pros of engagement</td>
</tr>
<tr>
<td></td>
<td>2. Anticoag facts (e.g., etiology, therapies, management)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Risk of stroke and its treatment by anticoags</td>
<td></td>
</tr>
<tr>
<td>2. Contemplation</td>
<td>1. As above</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Lifestyle (e.g., diet, exercise)</td>
<td>1. Barriers and ways to remove/mitigate them</td>
</tr>
<tr>
<td></td>
<td>3. Self-care (e.g., risky events)</td>
<td>2. Self re-evaluation questionnaire</td>
</tr>
<tr>
<td>3. Preparation</td>
<td>1. Interactive exploration of pros of engagement</td>
<td>3. Action planning and goal setting</td>
</tr>
<tr>
<td>4. Action</td>
<td>1. Interactive exploration of pros of engagement</td>
<td>4. Daily reporting of: symptoms, compliance to anticoag medication, risky events, wellbeing, engagement summaries (daily, weekly)</td>
</tr>
<tr>
<td>5. Maintenance</td>
<td>1. Interactive exploration of pros of engagement</td>
<td></td>
</tr>
</tbody>
</table>
Case Study:

Patient-Tailored Psychobehavioral Interventions

• Behavior modification interventions for the *contemplation* stage
  – Exploration of the pros of engagement

- **Body**
  - **Good health**
    - By lowering chances of stroke, you will maintain good health
    - I understand benefits of this pro
  - **Comfort**
    - You will be more comfortable talking about your health with your family and health support team
    - I understand benefits of this pro

- **Mind**
  - **Optimism**
    - You will feel more optimistic about your future and enjoy life more
    - I understand benefits of this pro
  - **Reduced health costs**
    - By following anticoagulation therapy and lowering your risk of stroke, you will reduce healthcare costs for yourself and your family
    - I understand benefits of this pro

- **Relationships**
  - **Long-term plans**
    - You will be able to make long-term plans with your family and friends
    - I understand benefits of this pro
  - **Live life fully**
    - You will be able to live your life fully and participate in activities you enjoy
    - I understand benefits of this pro
Case Study: Patient-Tailored Psychobehavioral Interventions

- Behavior modification interventions for the preparation/action stage

Barriers to engagement

<table>
<thead>
<tr>
<th>Barriers to Engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of positive reinforcement</td>
</tr>
<tr>
<td>Inadequate support from family/friends</td>
</tr>
<tr>
<td>Lack of routine</td>
</tr>
<tr>
<td>Inadequate communication with a healthcare provider</td>
</tr>
<tr>
<td>Insufficient understanding of treatment and required lifestyle changes</td>
</tr>
<tr>
<td>Lack of willpower</td>
</tr>
<tr>
<td>Time commitment required for engaging and for using the app</td>
</tr>
</tbody>
</table>

Action planning and goal setting

<table>
<thead>
<tr>
<th>Action Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deadline: 2018-08-01</td>
</tr>
<tr>
<td>Days from now: 84</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPECIFY WHAT YOU WANT TO ACHIEVE</td>
</tr>
<tr>
<td>1. Loose 5 pounds</td>
</tr>
<tr>
<td>2. Not miss more than 1 DOAC dose</td>
</tr>
</tbody>
</table>
Case Study:

Patient-Tailored Psychobehavioral Interventions

- Behavior modification interventions for the preparation/action stage

Reporting

Daily and weekly summaries

- Daily Summary
  - HOW DO YOU FEEL TODAY?
  - YOUR DAILY ENGAGEMENT SCORE: 65%
  - Your engagement score for today may still be improved. Click the button below to do it.
  - Improve Your Engagement Score

- Weekly Summary
  - Weekly Engagement
  - Daily Engagement and Overall Feeling

Risky Events

- Will You Undergo?
  - Biopsy
  - Minor surgery
  - Major surgery
  - Dentist (extraction of 2 or more teeth)

University of Minnesota
Conclusions

• A framework for delivering patient-tailored psychobehavioral and educational interventions
  – Developed generic system architecture that can be easily ported to other chronic conditions
• Combination of data-, expert-, and technology-driven phases
• Implementation of the framework within the Motivational Patient Assistant (MPA)
  – A specialized version aimed at adherence to oral anticoagulation therapy
  – Evaluated with patient advocates and physician. [Under review]

Ultimate goal is to use technology to deliver comprehensive and patient-tailored interventions at the most effective time and place.
Questions/Comments?

"Nurse, get on the internet, go to SURGERY.COM, scroll down and click on the 'Are you totally lost?' icon."

martinm@umn.edu