

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



uOttawa



CITY
UNIVERSITY OF LONDON
EST 1894



Ottawa Hospital
Research Institute
Institut de recherche
de l'Hôpital d'Ottawa



SCHOOL OF NURSING
UNIVERSITY OF MINNESOTA

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

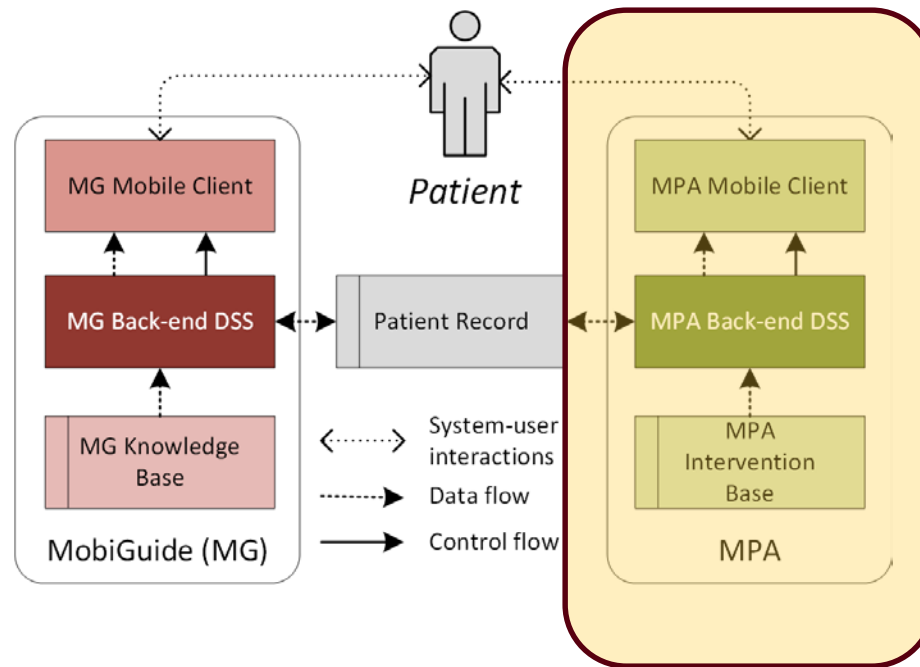


Selection of Psychobehavioral Interventions

- 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

| | Adherence_history | Smoking_or_alcohol | In_charge | Adherence_level |
|------------|--------------------------|---------------------------|------------------|------------------------|
| v1 | (3) good | (2) moderate | (2) yes | (2) moderate |
| v2 | (2) none_or_moderate | (1) none_or_light | (2) yes | (3) good |
| v3 | (2) none_or_moderate | (1) none_or_light | (1) no | (2) moderate |
| v4 | (1) poor | (1) none_or_light | (2) yes | (1) poor |
| v5 | (2) none_or_moderate | (3) heavy | (1) no | (1) poor |
| v6 | (1) poor | (2) moderate | (1) no | (1) poor |
| v7 | (3) good | (1) none_or_light | (2) yes | (3) good |
| v8 | (2) none_or_moderate | (1) none_or_light | (1) no | (2) moderate |
| v9 | (2) none_or_moderate | (1) none_or_light | (1) no | (2) moderate |
| v10 | (3) good | (2) moderate | (2) yes | (2) moderate |
| v11 | (2) none_or_moderate | (1) none_or_light | (2) yes | (3) good |
| v12 | (1) poor | (3) heavy | (1) no | (1) poor |

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

| | Sociodemographic context | Psychobehavioral target | | | |
|----|--------------------------|-------------------------|-----------|-----------------|------------|
| | Adherence_history | Smoking_or_alcohol | In_charge | Adherence_level | Impact [%] |
| r1 | >= none_or_moderate | <= none_or_light | >= yes | >= good | 54.9 |
| r2 | >= good | | | >= moderate | |
| r3 | >= none_or_moderate | <= none_or_light | | >= moderate | 9.1 |
| r4 | <= poor | | | <= poor | |
| r5 | | >= heavy | | <= poor | 66.7 |
| r6 | | | <= no | <= moderate | 25.0 |
| r7 | | >= moderate | | <= moderate | 25.0 |

- Positive target in → limit smoking or drinking (to none or light) and improve patient's engagement
- Negative target in → 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



TTM Stages

| Education actions | Behavior change actions |
|--|--|
| <ol style="list-style-type: none">1. Engagement (e.g., benefits, risks – communicated in text and as a video inter-view with an AF patient)2. Anticoag facts (e.g., etiology, therapies, management)3. Risk of stroke and its treatment by anticoags | <ol style="list-style-type: none">1. Interactive exploration of pros of engagement |
| Education actions | Behavior change actions |
| <ol style="list-style-type: none">1. As above2. Lifestyle (e.g., diet, exercise)3. Self-care (e.g., risky events) | <ol style="list-style-type: none">1. Barriers and ways to remove/mitigate them2. Self re-evaluation questionnaire3. Action planning and goal setting4. Daily reporting of: symptoms, compliance to anticoag medication, risky events, wellbeing, engagement summaries (daily, weekly) |

Case Study:

Patient-Tailored Psychobehavioral Interventions

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

The screenshot displays a user interface for a patient-tailored psychobehavioral intervention. It features a navigation menu on the left with three options: 'Body', 'Mind', and 'Relationships'. The main content is organized into four columns, each representing a different benefit category. Each column has a 'Back' button and a title bar. The first column, 'Pros of Engagement', lists 'Body', 'Mind', and 'Relationships'. The second column, 'Body', includes 'Good health' and 'Comfort'. The third column, 'Mind', includes 'Optimism' and 'Reduced health costs'. The fourth column, 'Relationships', includes 'Long-term plans' and 'Live life fully'. Each benefit is accompanied by an image, a descriptive text, and a radio button for 'I understand benefits of this pro'.

| Category | Benefit | Description | Image |
|--------------------|----------------------|--|------------------|
| Pros of Engagement | Body | | |
| | Mind | | |
| | Relationships | | |
| Body | Good health | By lowering chances of stroke, you will maintain good health | Man with fruit |
| | Comfort | You will be more comfortable talking about your health with your family and health support team | Older couple |
| Mind | Optimism | You will feel more optimistic about your future and enjoy life more | People on beach |
| | Reduced health costs | By following anticoagulation therapy and lowering your risk of stroke, you will reduce healthcare costs for yourself and your family | Doctor with pill |
| Relationships | Long-term plans | You will be able to make long-term plans with your family and friends | Older couple |
| | Live life fully | You will be able to live your life fully and participate in activities you enjoy | People on bikes |

Case Study:

Patient-Tailored Psychobehavioral Interventions

- Behavior modification interventions for the *preparation/action* stage

Barriers to engagement

[← Back](#) **Barriers to Engagement**

Explore possible barriers to engagement listed below and learn what actions to take in order to mitigate/avoid them

- ❶ Lack of positive reinforcement >
- ❷ Inadequate support from family/friends >
- ❸ Lack of routine >
- ❹ Inadequate communication with a healthcare provider >
- ❺ Insufficient understanding of treatment and required lifestyle changes >
- ❻ Lack of willpower >
- ❼ Time commitment required for engaging and for using the app >

[← Back](#) **Barrier To Engagement**

Lack of routine

Action
Use basic techniques to establish routine and to create reminders (post-it notes, calendar, alerts, etc.)

Hint
Use the calendar function to define relevant alerts >

Lack of willpower

Action
Identify personally meaningful reasons for changing behavior, seek out peer mentoring from a more engaged patient

Hint
Read an interview with an engaged patient >

Action planning and goal setting

[← Back](#) **Action Plan** [+ Add Action](#)

Tap on event to view its reminder

| Sun | Mon | Tue | Wed | Thu | Fri | Sat |
|-----|-----|-----|-----|-----|-----|-----|
| 29 | 30 | 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | 31 | 1 | 2 |
| 3 | 4 | 5 | 6 | 7 | 8 | 9 |

08:00 - 08:20 | 2 actions, 50% completed

[← Back](#) **Goal**

Deadline 2018-08-01

Days from now 84

[SPECIFY WHAT YOU WANT TO ACHIEVE](#) [1](#)

- Loose 5 pounds
- Not miss more than 1 DOAC dose



Case Study:

Patient-Tailored Psychobehavioral Interventions

- Behavior modification interventions for the *preparation/action* stage

Reporting

[← Back](#) **Treatment Adherence**

HAVE YOU TAKEN RIGHT DOSE?

| | | | |
|--|-------------------------------------|---------------------------------|----------------------------------|
| Dabigatran - dose 1 Capsule, 150 mg | <input checked="" type="checkbox"/> | <input type="checkbox"/> Missed | <input type="checkbox"/> Skipped |
| Dabigatran - dose 2 Capsule, 150 mg | <input checked="" type="checkbox"/> | <input type="checkbox"/> Missed | <input type="checkbox"/> Skipped |
| Metoprolol - dose 1 Tablet, 25 mg | <input checked="" type="checkbox"/> | <input type="checkbox"/> Missed | <input type="checkbox"/> Skipped |
| Metoprolol - dose 2 Tablet, 25 mg | <input checked="" type="checkbox"/> | <input type="checkbox"/> Missed | <input type="checkbox"/> Skipped |

[← Back](#) **Symptoms**

HAVE YOU EXPERIENCED?

| | | |
|---------------------|----------------------------|----------------------------|
| Palpitation | <input type="checkbox"/> + | <input type="checkbox"/> - |
| Chest pain | <input type="checkbox"/> + | <input type="checkbox"/> - |
| Shortness of breath | <input type="checkbox"/> + | <input type="checkbox"/> - |

[← Back](#) **Risky Events**

WILL YOU UNDERGO?

| | |
|---|-------------------------------------|
| Biopsy | <input type="checkbox"/> |
| Minor surgery | <input type="checkbox"/> |
| Major surgery | <input type="checkbox"/> |
| Dentist (extraction of 2 or more teeth) | <input checked="" type="checkbox"/> |

Daily and weekly summaries

[← Back](#) **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.

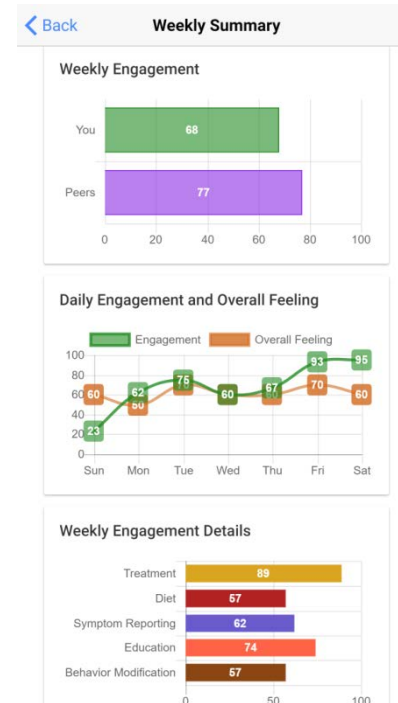
[Improve Your Engagement Score](#)

RIGHT DOSAGE TAKEN

| | |
|--|---|
|  Dabigatran Capsule, 150 mg, 2 x daily | <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> |
|  Metoprolol Tablet, 25 mg, 2 x daily | <input checked="" type="checkbox"/> <input type="checkbox"/> |

RIGHT AMOUNT EATEN

Minerals
Magnesium and potassium



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

