Improved Patient Adherence (Compliance) to Therapy Through Mobile Technology

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June 13th 2018

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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

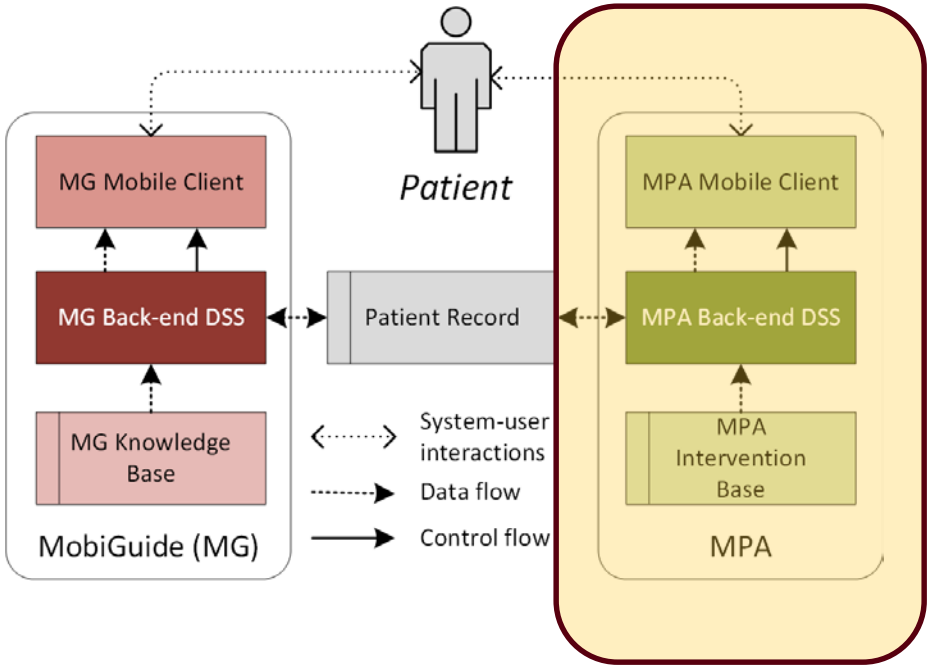
Critical role of self-reporting → "priming for honesty" to increase its reliability

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

Willingness to be in charge of one's health → **engagement**

	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

Case Study:

Psychobehavioral Targets

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

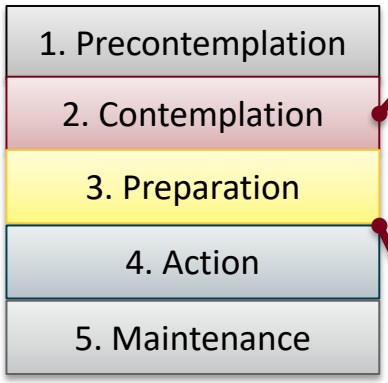
	Sociodemographic context	Psychobehavioral target			
	Adherence_history	Smoking_or_alcohol	In_charge	Adherence_level	Impact [%]
r1	>= none_or_moderate	<= none_or_light	>= yes	>= good	54.9
r2	>= good			>= moderate	
r3	>= none_or_moderate	<= none_or_light		>= moderate	9.1
r4	<= poor			<= poor	
r5		>= heavy		<= 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

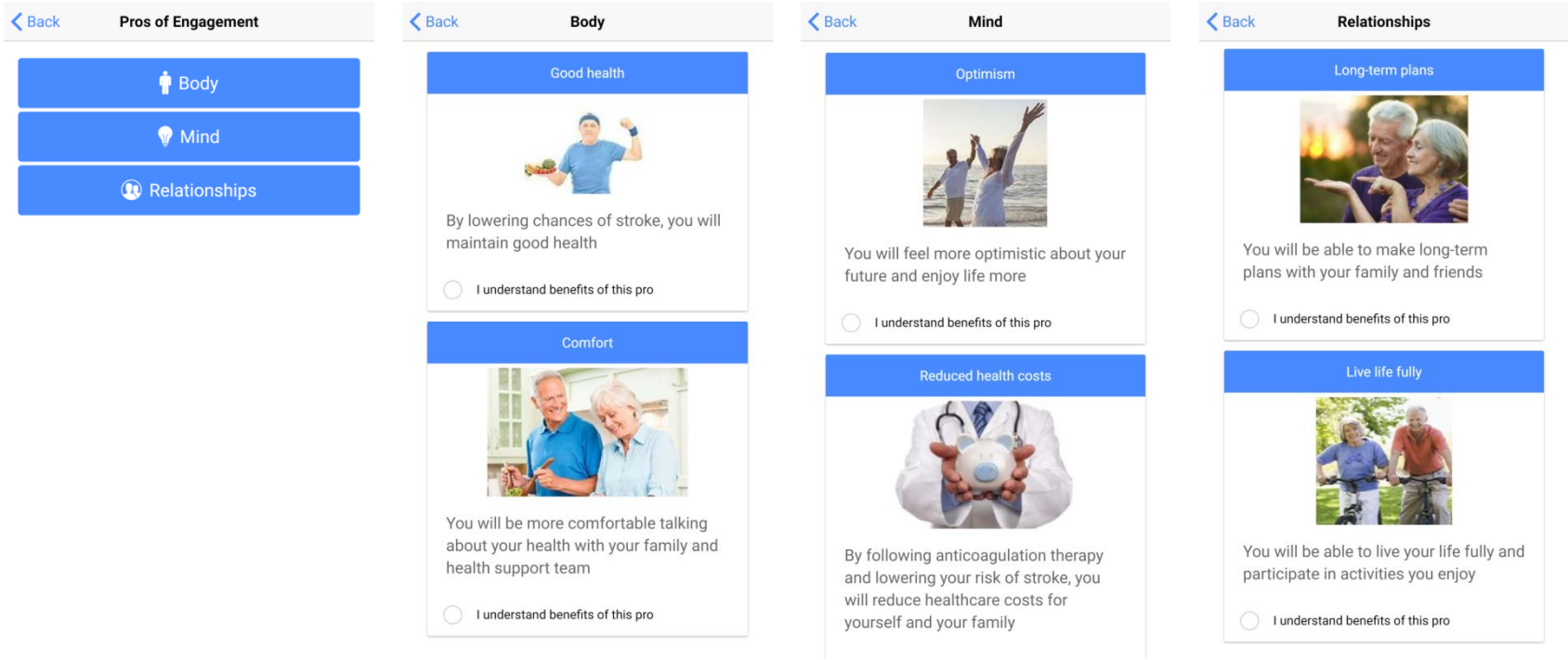
Education actions	Behavior change actions
1. Engagement (e.g., benefits, risks – communicated in text and as a video inter-view with an AF patient) 2. Anticoag facts (e.g., etiology, therapies, management) 3. Risk of stroke and its treatment by anticoags	1. Interactive exploration of pros of engagement

Education actions	Behavior change actions
1. As above 2. Lifestyle (e.g., diet, exercise) 3. Self-care (e.g., risky events)	1. Barriers and ways to remove/mitigate them 2. Self re-evaluation questionnaire 3. Action planning and goal setting 4. 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

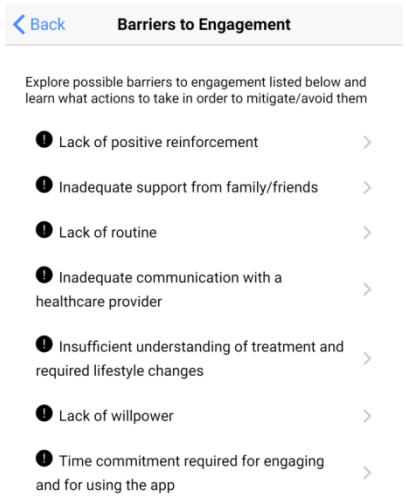


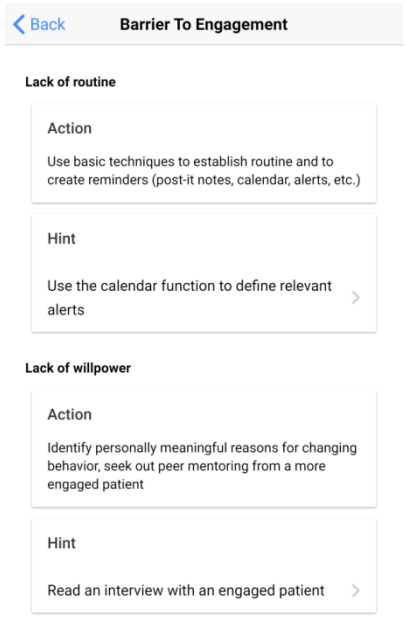
Case Study:

Patient-Tailored Psychobehavioral Interventions

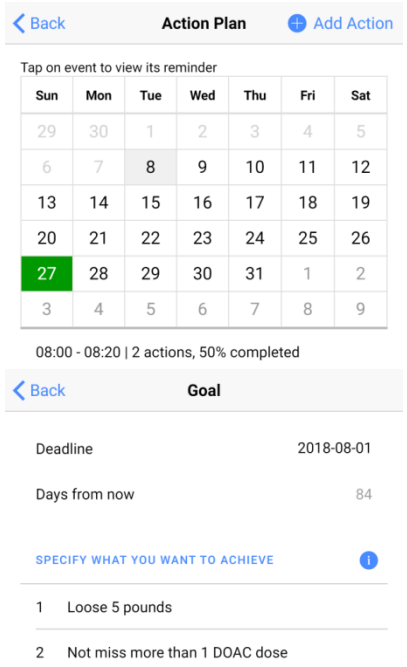
- Behavior modification interventions for the *preparation/action* stage

Barriers to engagement





Action planning and goal setting

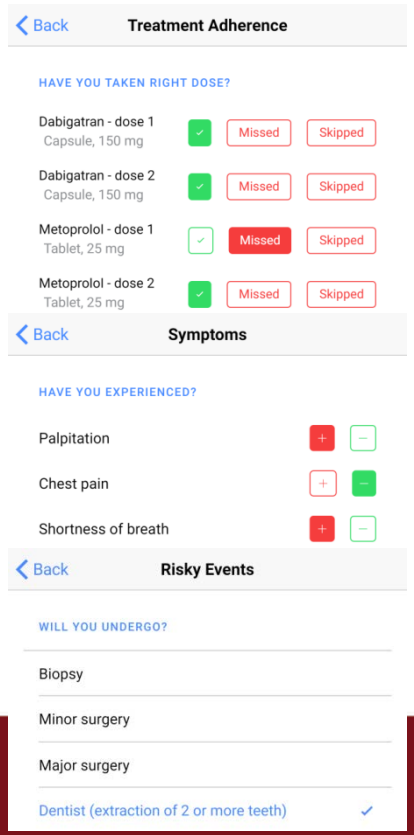


Case Study:

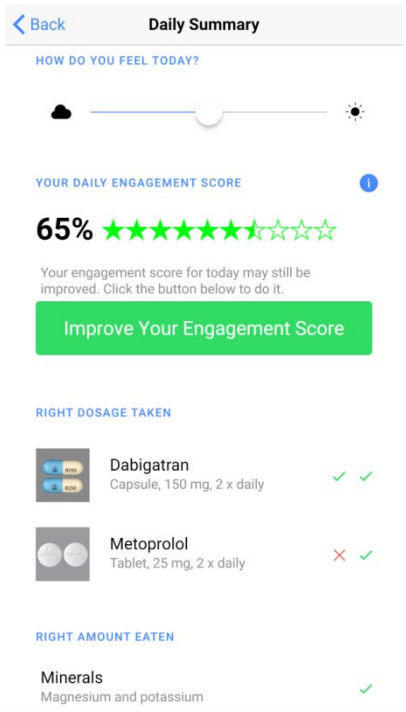
Patient-Tailored Psychobehavioral Interventions

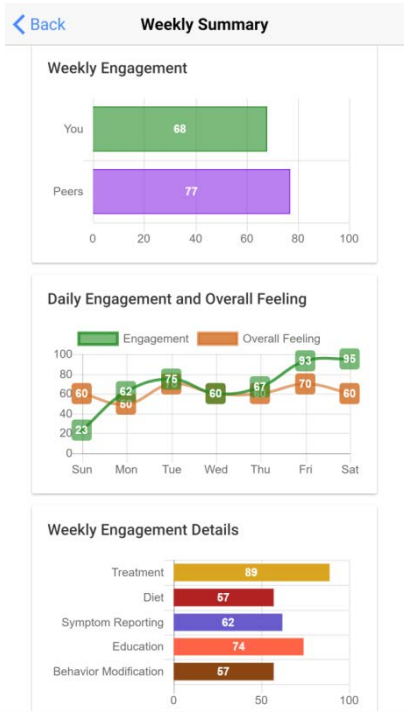
- Behavior modification interventions for the *preparation/action* stage

Reporting



Daily and weekly summaries





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."

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