Multiple Scenarios for Rewards and Punishments in Medication Adherence

Completed Research

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Abstract

Medication adherence works as the key mediator between practice and patient outcomes. However, in actual application, inadequate medication adherence is a pervasive cause of poor health outcomes. Many interventions have been developed to help promote patients’ healthy behavior in taking medication. In this paper, we discuss the theoretical background that supports a novel intervention which includes not only rewards but also punishments through the use of mobile phone to increase medication adherence rate. We also design multiple scenarios of the intervention to illustrate further its applications based on the theories. Moreover, the comparison of different scenarios provides a deeper understanding of the cost-effectiveness and targeted patient type for each scenario. We contribute to mobile health practice by designing and fully examining a novel intervention, and we extend related theories to explain the application of intervention.

Keywords

Medication adherence, scenarios, rewards and punishments, intervention

Introduction

Medication adherence (MA) has been a major global challenge for a long time. According to Osterberg and Blaschke (2005), more than half of Americans with chronic disease do not take any or all of their medications correctly. A strong association between MA and clinical outcomes such as rehospitalization, morbidity, and mortality has been demonstrated in previous research (Smith et al. 2011). This has led to design and implementation of numerous behavioral change interventions for improving adherence. In the recent years, mobile health solutions facilitate most of these behavioral interventions because mobile phones, being the most commonly used form of technology worldwide, have the greatest potential to influence a large population.

Sending educational text messages about diseases, delivering reminders, facilitating patients’ self-monitoring, and working as an instant connector to healthcare professionals are the most common intervention types accomplished on mobile platform. Educational text messages and reminders are both showed to be highly acceptable and effective intervention to improve MA (Park et al. 2015). Also, mobile application which enables interactive connection between patients and physicians is proved to be able to improve MA and social interactions (Granholm et al. 2012). Despite these promising results, the lack of long-term studies, appropriate statistical and economic analysis, and the test of theory-based interventions have been criticized to make the previous research less convincible (Park et al. 2015).

Two years ago, a novel intervention was proposed that involves not only sending reminders to patients when their medications are due but also includes both rewards and punishments to help deal with patients’ intentionally non-adherent behaviors (Liu and Varshney 2016). It defines time window when doses can be taken. A predefined award will be provided to the patient when he/she takes the medication during the time window. If the patient misses a dose and his/her Medication Adherence Rate (MAR) falls below the satisfactory level, he/she will receive some predefined punishments (i.e., blocking of user’s most-used app). However, the intervention lacks theoretical base and application analysis. To improve the feasibility of this intervention, we will expand the intervention by designing several scenarios and subdivided scenario components using multiple theories to answer the following research questions: what is the theoretical
support of an intervention which takes advantage of rewards and punishments? And how can different applicable intervention scenarios fit different patient types? By answering these questions, we contribute to the extension of theories to explain the intervention application in the mHealth field. Moreover, the design and examination of proposed intervention provide a critical practical contribution.

In the following sections, we will first briefly overview the intervention process followed by the theoretical background. Then, using theories, we will discuss different scenarios of behavioral change intervention and provide a qualitative discussion. Then research discussion and conclusions are presented. Finally, we will talk about some future research directions.

**Designed Intervention Process**

The original intervention process proposed by Liu and Varshney (2016) contains more details, and here we only present a high-level description (Figure 1). It starts with defining the scenario that a patient will go through by setting healthcare events, actions, reinforcements (rewards and punishments), and medication adherence rate (MAR) goal. The details of different scenarios will be discussed in a later section. The system will send a reminder to the patient if a medication event is due. If the patient takes his/her medication, a corresponding reward will be added to the reward record. If the patient does not take his/her medication, the system will calculate whether this medication dose is a critical one to maintain the MAR goal. If it is a critical dose, then the punishment will be implemented by the system immediately. Unlike punishment, the accumulated reward will be granted to the patient at the end of each pre-set intervention period.

![Figure 1: The Simplified Carrot and Stick Intervention (Adapted from Liu and Varshney 2016)](image)

An example of the intervention with pre-set MAR goal equals to 80% and intervention period of seven doses is given in Figure 2. O represents a dose that is taken by the patient, and X represents a dose that is not taken by the patient. We can see that when the patient misses the fifth dose, punishment is not implemented because the calculated MAR is not below the pre-set one. However, if the patient also misses the sixth dose,
punishment is implemented. At the end of this seven-dose intervention period, the accumulated reward of five doses will be granted to the patient.

![Figure 2: Seven Dose Intervention Example (Adapted from Liu and Varshney 2016)](image)

### Theoretical Background

In this section, we discuss the theories that support the effectiveness of the designed intervention. Also, these theories provide us the direction in setting scenarios of intervention application.

#### Social Cognitive Theory and Health Promotion

Based on Social Learning Theory, Social Cognitive Theory (SCT) posits that learning occurs in a social context with a dynamic interaction of the person, environment, and behavior (Bandura 1986). One unique feature of SCT is its emphasis on social influence on external and internal social reinforcement. SCT is widely applied in public health field because it considers the maintenance of behavior and not just initiation of behavior. SCT explains how people regulate their behavior through control and reinforcement to achieve goal-directed behavior that can be maintained over time (Bandura 1986). The five core determinants that SCT specifies in health promotion behaviors (Bandura 2004) include

1. Knowledge of health risks and benefits of different health practices. This is the precondition for any changes in behaviors because it is unlikely that people will change their habits if they lack knowledge about how these behaviors would affect their health.
2. Outcome expectations about different health habits. The outcomes include not only positive or negative effects of the behavior on an individual but also consider social reactions of the behavior. Besides, self-evaluative reactions are also a form of outcome.
3. The health goals people set for themselves and the concrete plans and strategies for realizing them. Cognitive goals provide further self-incentives and guides to health behavior. In self-motivation through goal setting, people monitor their behavior and react to their attainments.
4. Perceived facilitators and social/structural impediments to the changes. The smoothness of change would be partly determined by the perceived facilitators and obstacles.
5. Perceived self-efficacy that one can exercise over one’s health habits. Self-efficacy is a focal determinant because it affects health behavior both directly and by influencing other determinants. Self-efficacy beliefs can help shape people’s outcome expectations and determine how obstacles are viewed.

Based on these five determinants in SCT, several approaches to encourage people to adopt health-promoting behaviors have been developed. The first approach is to inform people about the health risks of detrimental habits and the benefits of healthy behaviors. However, this approach has its limitation on biased knowledge base caused by the selective focus on the “habitual losers” who failed in shaping good health behaviors (Granfield and Cloud 1996).

The second approach tried to reward people into health-promotion behaviors by linking those behaviors to extrinsic rewards and punishments. The changes that are achieved by imposing incentive control were modest to begin with, however, they are usually dissipated after the control was lifted (Granfield and Cloud 1996). One possible reason is that effects of rewards were solely examined in almost all studies, but the combined effects of both rewards and punishments were rarely tested. Another possible explanation is that the benefits people get from following the good behavior are only reflected in gaining rewards but are not internalized to the perceived health condition improvement before the incentives are lifted.
The third approach treats personal change as occurring within a network of social influences. Social relationships can help bring satisfaction to one’s life and relieve the adverse effects of stress. Also, the perceived social support and self-efficacy can strengthen each other in both directions. One weakness of this approach is that social support is not a self-forming entity. People have to go out and find or create supportive relationships for themselves (Granfield and Cloud 1996).

We can see that each of these three approaches has its advantages and weaknesses. Also, we identify a gap considering negative reinforcement (punishment). The previously proposed intervention process filled in this gap. We can also identify that goal-setting in intervention’s initialization stage and social connection of intervention receivers should be considered in intervention application scenarios.

**Goal Setting Theory**

As we discussed in social cognitive theory, goals people set and the plans they make to realize them are important determinants of behavior change process. Furthermore, in goal setting theory, one central tenet is that for many tasks, setting specific goals to achieve a task, in combination with performance feedback, leads to higher performance than does no goal or a vague goal (Latham and Locke 1991; Mento et al. 1987). Three motivational mechanisms have been found beneficial for performance: effort, persistence, and concentration (Latham and Locke 1991). Goal setting encourages a person to try harder and for longer periods of time, with less distraction from the task at hand. Based on this, another central tenet of goal setting theory is the lineal goal difficulty-performance relationship. The higher the goal set, the better people perform, even when the goal is very high (Latham and Locke 1991; Mento et al. 1987). Of course, there are conditions that the goal difficulty-performance relationship is not strong: (1) tasks that are too complex for an individual are set as goals, (2) the individual is not capable of performing tasks related to the goals, and (3) the individual is not committed to the goals (Cervone et al. 1991).

Therefore, to ensure a strong goal difficulty-performance relationship in the designed intervention process for health-promotion behaviors, one question needs to be answered: which one is better, self-set goal or system-assigned goal? In previous research, contradictory findings have been revealed. Alexy (1985) found that letting patients select their own health behavior change goals did not lead to a different result from behavior change with provider-assigned goals. In another weight loss experiment, the assigned goal group was found statistically superior to the self-set goal group (Boyce and Wayda 1994).

One can think of situations in which self-set goals would result in poorer outcomes than counselor-assigned goals. A Self-set goal might be either too easy or too difficult, while a counselor-assigned goal based on counselor’s experience can be more appropriate. On the other hand, the counselor may not always possess knowledge of the real difficulties a user is likely to experience and consequently set goals that are inappropriate for the user. Also, individuals may sometimes have a greater commitment to self-set goals (Tesser et al. 1984).

**Social Exchange Theory**

Homans defined social exchange as the exchange of activity, tangible or intangible, and more or less rewarding or costly, between at least two parties (Homans 1958). He studied social exchange on individual level and argued that “there was nothing that emerges in social groups that cannot be explained by propositions about individuals as individuals, together with the given condition that they happen to be interacting” (Fiske et al. 2010). Reinforcement principles derived from the behavioral research were used to explain the persistence of exchange relations. Behavior is viewed as a function of payoffs, whether the payoffs are provided by the environment or by other humans.

Homans had five key propositions that examined social behavior regarding both positive and negative reinforcement, in other words, rewards and punishments. His first proposition, which calls the success proposition, states that behavior which generates rewards is likely to be repeated. The second proposition, which calls the stimulus proposition, states that behavior which has been rewarded under certain circumstance in the past will be performed in similar situations in the future. The third proposition, which calls the value proposition, states that an individual is more likely to perform an action if the action has more valuable result to him/her. The fourth proposition, which calls the deprivation-satiation proposition, introduces an idea of diminishing marginal utility: the more often an individual has recently received a particular reward for an action, the less valuable is an additional unit of that reward. Finally, the fifth
proposition considers that individuals will react to different reward situations emotionally. People will become angry when they do not receive what they anticipate (Homans 1974).

**Scenarios**

The designed process should be able to consider the individual level variance of users. Based on the last section’s theories, we will discuss different scenarios of the intervention. We have three segments of scenarios. The first one is about positive and negative reinforcements, in other words, rewards and punishments, the second segment is about goal-setting, the third one is about social connection. All scenario components details are listed in Table 1.

**Rewards and Punishments**

Rewards have been used as an incentive to create desirable behavior in individuals. Some forms of rewards, such as money, lottery, and voucher, were also tested in clinical trials to examine their effect on patients' medication adherence behavior. Most of the studies have found rewards are significantly effective in increasing patient’s adherence rate (Sen et al. 2014) while few of them found no significant difference between treatment and control groups but treatment group which receives rewards do have higher adherence rate (Barnett et al. 2009). Following the discussion in social exchange theory, the same reward would have a diminished effect in keeping people involved in an activity. Thus, the reward should have an increasing value over time. However, different individuals would have different sensitivity to the same repeated reward. The reward amount is accumulated and calculated on a period’s base. If the benefits of continuing certain behavior can be internalized to perceived health wellness in one intervention period, the diminishing utility of repeated reward would have little impact on patient’s behavior because the diminished part could be supplemented by increased internal health wellness. Otherwise, reward needs to have an increasing value over time to keep their effectiveness as an intervention. Thus, in the application of reward, it should be a fixed amount for some patients and an increasing amount for others to capture variations in patients.

Beside pursuing rewards, individuals can also adopt or give up certain behavior to avoid punishments. Sometimes, people tend to avoid losses to acquiring equivalent gains (Kahneman and Tversky 2013), and this is called loss aversion. In other words, people may think it is better not to lose $5 than to gain $5. Some studies have even suggested that losses can be twice as powerful as gains psychologically (Tversky and Kahneman 1992). Thus, we can reasonably expect that punishment can also increase a patient’s medication adherence rate. However, unlike rewards, punishments can cause annoyances in individuals. In other words, fixed punishments may lead patients to stop involving in receiving the intervention, let alone increasing punishment level over time. On the other side, similar to reward, patients would have different sensitivity toward punishments so that we would have zero or fixed punishment in our application scenario components. Thus, we have the following four different scenario components of reinforcements.

1. Fixed reward and no punishment
2. Increasing reward and no punishment
3. Fixed reward and fixed punishment
4. Increasing reward and fixed punishment

**Goal Setting**

As we have discussed in the goal setting theory, the comparison of effectiveness between the self-set goal and the counselor-assigned goal (in intervention design, it is the physician-assigned goal) on adopting health-promotion behaviors doesn’t have a clear answer. Some patients would have a deeper understanding of their capabilities and real-life difficulties than their physicians; these patients are more suitable to set their goals themselves. While some other patients would only set their goal to the minimum possible level which might have little help in improving their health, or they overestimate their capabilities to achieving their goal, causing frustrating emotion and could lead to discontinued involvement. The physician-assigned goal should be more suitable for these patients. Thus, we have two scenario components considering goal-setting:

5. Self-set goal
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6. Physician-assigned goal

Social Connection

The social support and reaction to an individual’s behavior is an important determinant in the behavior change process. However, in cultural research, individual level variances have been found in valuing other people’s opinion or judgment. For example, individualists would place more emphasis on autonomy and self-reliance (Grimm et al. 1999; Triandis 2001) while collectivists would be more comfortable with changing their opinions or behaviors by the impact of others (Cialdini et al. 1999; Triandis et al. 1985). To capture the differences in patients’ social connection preference, our designed application provides choices about sharing users’ behavior information with other users. In a real application, the information on missing or taken doses might violate patient’s privacy rights. To prevent such violation, we use the corresponding rewards and punishments information as proxy information of personal behavior.

For those so-called “individualists” who emphasize autonomy and control of their life without other people’s impact, personal information sharing about their medication-taking behavior and induced judgment could have a negative effect on their behavior change. While for those who like to be a member of a group and receive feedback from other people, information sharing could impact their behavior change positively. Moreover, shared rewards or punishments information will induce different feedback sentiment, for example, rewards information could have positive feedback while punishments information could have negative feedback. In other words, patients in need of encouragement should share different information from patients in need of regulation. Thus, we have the following four scenario components of social connection.

7. Disable social connection
8. Enable social connection, only sharing reward information
9. Enable social connection, only sharing punishment information
10. Enable social connection, sharing both reward and punishment information

Of course, these three segments of scenarios are not exclusive from each other. They cover different aspects to increase the intervention’s effectiveness. One complete scenario of intervention application could include one or more segment’s components. For example, a patient could set his own MA goal, receive a fixed reward for any dose he takes but no punishment if he doesn’t reach his period’s goal, and share only his reward information with others.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Detail</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fixed reward and no punishment</td>
<td>In each intervention period, patient will receive the same amount of reward. Also, patient will not be punished if he/she doesn’t achieve MAR goal.</td>
</tr>
<tr>
<td>2</td>
<td>Increasing reward and no punishment</td>
<td>Patient will receive an increasing reward in subsequent intervention periods. Also, patient will not be punished if he/she doesn’t achieve MAR goal.</td>
</tr>
<tr>
<td>3</td>
<td>Fixed reward and fixed punishment</td>
<td>In each intervention period, patient will receive the same amount of reward. Also, patient will be punished if he/she doesn’t achieve MAR goal.</td>
</tr>
<tr>
<td>4</td>
<td>Increasing reward and fixed punishment</td>
<td>Patient will receive an increasing reward in subsequent intervention periods. Also, patient will be punished if he/she doesn’t achieve MAR goal.</td>
</tr>
<tr>
<td>5</td>
<td>Self-set goal</td>
<td>Patient himself/herself will set their period’s goal.</td>
</tr>
<tr>
<td>6</td>
<td>Physician-assigned goal</td>
<td>Patient’s period’s goal will be set by physician.</td>
</tr>
<tr>
<td>7</td>
<td>Disable social connection</td>
<td>Patient will not be able to share his/her medication taking information with others.</td>
</tr>
<tr>
<td>8</td>
<td>Enable social connection, only sharing reward information</td>
<td>Patient will share his/her reward information with others.</td>
</tr>
<tr>
<td>9</td>
<td>Enable social connection, only sharing punishment information</td>
<td>Patient will share his/her punishment information with others.</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>10</th>
<th>Enable social connection, sharing both reward and punishment information</th>
<th>Patient will share his/her reward and punishment information with others.</th>
</tr>
</thead>
</table>

**Table 1: Scenario Components**

**Comparison of Scenarios**

Even though these ten different scenario components consider different intervention aspects, we can still have qualitative comparison within the three segments. We choose three angles to compare them. The first one is the possibility of quitting, which compares the level of obstacle that each component could cause to affect patients’ continued engagement in the intervention. The second one is the suitable patient type, which compares the patients’ characteristics that each component would be most effective for. Based on the assumption that each patient follows the most suitable scenario components, we consider the third angle, cost-effectiveness. Cost-effectiveness compares the cost of the intervention to reach the same health outcome. The comparison details are listed in Table 2.

**Possibility of Quitting**

Segment 1 (scenario components 1 ~4): The existence of punishment could cause a higher probability of annoyance, frustration, and other negative emotions compare to no punishment when patients fail to reach their goal. These negative emotions would strongly associate with patients’ dropping out behavior. However, if the rewards are calculated in an increasing pattern based on each period, the idea that “I will receive more if I continue engagement in the intervention process for the next period” will be a stronger incentive for patients compared to the incentive provided by a fixed reward. Thus, patients receiving fixed reward and fixed punishment will have a high possibility of quitting, while patients receiving increasing reward and fixed punishment will have the medium possibility of quitting because the increased reward would decrease the possibility of quitting. Also, patients receiving fixed reward and no punishment will have the medium possibility of dropping out because the exclusion of negative emotion caused by punishment would decrease the possibility. Patients receiving increasing reward and no punishment will experience both the incentive of increasing reward and exclusion of negative emotion caused by punishment, so these patients will have a low possibility of quitting.

Segment 2 (scenario components 5 and 6): goals do affect participants’ persistence of activities in a way that hard goals prolong effort when participants are allowed to control the time they spend on a task (LaPorte and Nath 1976). However, we don’t have enough evidence to compare the difficulty of self-set and physician-assigned goal, so we cannot compare the possibility of quitting in these two situations.

Segment 3 (scenario components 7 ~ 10): Sharing only the punishment information with others would lead to negative feedback to patients’ behaviors as well as could damage their personal image because the information represents that those patients cannot reach their preset goals. These negative effects combining with decreased self-efficacy would cause the high possibility of patients to drop out. Compare with this situation, sharing both reward and punishment information will lead to positive feedback from others in addition to negative ones, balanced personal image, and stable self-efficacy level. Thus, the possibility of quitting would decrease from high to medium. In another situation, patients will not receive any outside judgments if they do not share information with others. Since people have self-enhancement motive that involves a preference for positive over negative self-views (Sedikides and Gregg 2008), not sharing information with others will decrease the possibility of quitting from high to medium compared to only share punishment information. When patients only share reward information with others, the positive feedback they get will further decrease the possibility of quitting to a low level.

**Suitable Patient Type**

Segment 1: Patients with medium to high sensitivity to punishment should not receive punishment when they fail to achieve their goal because they are highly likely to stop enrolling in the intervention process otherwise. While for patients with low sensitivity, punishment can be applied as a supplement to rewards to avoid adopting unwanted behavior. Patients with medium to high sensitivity to reward change should receive an increasing reward. The diminishing effect of reward will cause them to feel the intervention is
less and less attractive if they are granted fixed reward. From the other aspect, patients with low sensitivity to reward change don’t need increasing the reward to keep a rather stable incentive level.

Segment 2: The suitability of these two goal-setting types is based on the accuracy of evaluation of patients’ ability and real-life difficulties. There should be a minimum MAR (e.g., 80%) that self-set goal needs to meet to prevent patients from setting their goals too low to actually promote their health.

Segment 3: Personality preference about group connection is the key factor in deciding information sharing styles. Patients who prefer a high level of autonomy and total control of their lifestyle are not suitable for sharing their MA information because feedback from others will not help their behavior change and they will drop out when they receive negative feedback. If a patient is non-adherent to medication because he/she lacks self-regulation, sharing punishment information will be a good choice because there will be more people help monitor and regulate his/her behavior in this way. For patients who don’t want others to know any information that would injure their self-image, only sharing reward information can help them receive social support without violating their wishes. There are also patients who would like to share everything in their life to form the feeling of connection. Sharing both reward and punishment information is an appropriate style for these patients.

Cost-effectiveness

We conduct cost-effectiveness analysis under the assumption that all patients follow their most suitable scenario components and they need the same time length of intervention to adopt a health-promoting behavior. Since the outcome is the same across all patients, so we only need to consider the cost of these scenario components to decide cost-effectiveness.

Segment 1: Implementing punishment will cost more than not implementing it in the application. Providing increasing rewards based on periods will also cost more than providing fixed rewards over time. Therefore, scenario 1 will cost the least, scenario 2 will have an increased reward cost additionally, scenario 3 will have punishment implementation cost additionally, and scenario 4 will have both increased reward and punishment implementation cost additionally. The cost-effective level is a reversed cost sequence: scenario 1 has high cost-effectiveness, scenario 2 and 3 have a medium level, and scenario 4 has a low level.

Segment 2: The physician-assigned goal involves more interaction and efforts from both patient and physician side so that physician-assigned goal will cost more than a self-set goal. Therefore, the self-set goal has high cost-effectiveness, and the physician-assigned goal has low cost-effectiveness.

Segment 3: The cost of social connection will increase with increasing shared information amount due to storage and maintenance cost. In this way, scenario 7 will have high cost-effectiveness, scenario 8 and 9 will have medium cost-effectiveness, and scenario 10 will have low cost-effectiveness.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Possibility of Quitting</th>
<th>Suitable Patient Type</th>
<th>Cost-effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Medium</td>
<td>Patients who have medium to high sensitivity to punishment, and have low sensitivity to reward change</td>
<td>High</td>
</tr>
<tr>
<td>2</td>
<td>Low</td>
<td>Patients who have medium to high sensitivity to punishment, and have medium to high sensitivity to reward change</td>
<td>Medium</td>
</tr>
<tr>
<td>3</td>
<td>High</td>
<td>Patients who have low sensitivity to punishment, and have low sensitivity to reward change</td>
<td>Medium</td>
</tr>
<tr>
<td>4</td>
<td>Medium</td>
<td>Patients who have low sensitivity to punishment, and have medium to high sensitivity to reward change</td>
<td>Low</td>
</tr>
<tr>
<td>5</td>
<td>N/A</td>
<td>Patients who evaluate their capabilities and difficulties precisely</td>
<td>High</td>
</tr>
<tr>
<td>6</td>
<td>N/A</td>
<td>Patients who cannot evaluate their capabilities and difficulties precisely</td>
<td>Low</td>
</tr>
<tr>
<td>7</td>
<td>Medium</td>
<td>Patients who would not like to share personal information with others</td>
<td>High</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Patients who would like to share their achievement with others</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>High</td>
<td>Patients who would like to have other people help regulate their behaviors</td>
<td>Medium</td>
</tr>
<tr>
<td>10</td>
<td>Medium</td>
<td>Patients who would like to share their daily life with others</td>
<td>Low</td>
</tr>
</tbody>
</table>

Note: comparison levels are within scenario segments

Table 2: Scenario Comparison

Discussion and Conclusion

For years, researchers and physicians have tried to increase the medication adherence rate among patients with chronic diseases to 80% or higher (Varshney 2009). Mobile health solutions work as a practical and inexpensive means to promote medication adherence. In previous research, a novel mobile intervention design which combines both rewards and punishments to enhance MA, especially for those patients who can remember but is not willing to take medication, was presented (Liu and Varshney 2016). In this research, we discuss theories that support the previously designed intervention process. Also, we design and discuss ten scenario components in three segments to illustrate several different applications of the intervention. In addition, we manage to qualitatively identify the suitable patient type of each scenario component and compare the cost-effectiveness of those components within segments.

Our research provides strong theoretical support for the application of one promising intervention in enhancing MA. The detailed scenario components description instructs the implementation of the intervention by considering individual differences. The cost-effectiveness analysis provides the potential for further classifying the interventions for the targeted patient type. Besides practically contributing to mobile health intervention by proposing and thoroughly analyzing a novel intervention, we make a theoretical contribution by extending related theories to explain the design of mobile intervention elements.

Limitations and Future Research

As with any research, this research has its limitations. In the original design, the intervention defines two time windows when doses can be taken to be effective. The predefined award will be provided to the patient based on during which of the windows the dose was taken. The reward is higher for the first window and lower for the second window (Liu and Varshney 2016). We simplified our scenario components to a single reward condition. Further research based on the fully designed intervention process is quite promising. Also, the comparison of scenario components is only qualitative and within segments. Gathering empirical data from a group of healthcare experts and/or real patients for evaluation of scenarios should be done in future.

REFERENCES


