Professional MBA
Entrepreneurship & Innovation

Understanding and Improving Treatment Adherence in Physical Therapy

A Master's Thesis submitted for the degree of
"Master of Business Administration"

supervised by
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Vienna, June 15th 2012

Affidavit

I, **Daniel Meierotto**, hereby declare,

1. that I am the sole author of the present master's thesis **Understanding and Improving Treatment Adherence in Physical Therapy**, 59 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
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Abstract

For decades researchers have been searching for ways to improve the level at which a patient follows a prescribed regimen. After all these years there has been little improvement as patients only follow through with approximately fifty percent of the prescribed regimen, be it prescription medicine or exercise programs. There have been several attempts to improve this level by using approaches such as reminders, pill counters, simplification of regimen, reducing the cost of medications, etc. However, these approaches, as good as they might be, do not typically address *why* a patient would not follow their assigned regimen in the first place. If the regimen is good for the patient and will lead to a speedy recovery, why are the adherence levels still so low?

The objective of this thesis is to distill existing literature related to the understanding of why patients do not adhere to treatments and how to motivate patients to adhere. Literature related to the psychological factors of adherence, motivation and patient beliefs will be reviewed. This understanding will then provide a foundation on which to build a framework for adherence. Concepts from persuasive technology will be explored as to how they can be used to help motivate patients carry out their exercises through the use of computers and other digital technology. Finally, an opportunity of offering this framework as a service that physical therapists can use will be evaluated with future applications in other medical fields. Throughout this thesis the research, application and feasibility has been in the context of rehabilitative services and physical therapy as these are medical fields where patients are typically asked to carry out some regimen at home.

This thesis proposes that by simply evaluating a patient's beliefs in their ability to carry out a regimen and the threat posed by the illness, health care personnel can be provided with a picture of how a patient will adhere. This information can be used to better educate and motivate the patient for adherence. Further trials and testing are needed in order to prove the accuracy of the adherence prediction.

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4. List of Abbreviations

WHO	World Health Organization
SMS	Short Message Service
HBM	Health Belief Model
PMT	Protection Motivation Theory
FBM	Fogg Behavior Model
GSM	Global System for Mobile Communications
GPS	Global Positioning System
SIRBS	Sports Injury Rehabilitation Beliefs Scale
PANAS	Positive and Negative Affect Schedule
EMR	Electronic Medical Record
CAPTE	Commission on Accreditation in Physical Therapy Education
PT	Physical Therapy
RP	Rehabilitation Program

1 Introduction

1. Background

Ageing populations, rising costs of care and a move to more preventive medicine are trends significantly affecting health care today. Treatment adherence is an area that, if improved, can lessen some pressures that these trends put on the health care industry. It has been reported that low adherence costs the healthcare industry $100 billion per year in unnecessary hospitalizations[1]. In addition, a 2007 study[2] estimated that there were 89,000 deaths of cardiovascular patients that could have been avoided had the patients fully adhered to prescribed hypertension medication.

1.1. Physical Therapy and Adherence

Physical therapy typically requires adherence to a physical exercise regimen. For many of us, physical exercise is recommended by our physicians as a preventive measure against future health problems. However, for someone who is in need of physical therapy, exercise is not only preventive but is critical for the efficacy of the rehabilitative treatment. These exercises can range from squeezing a ball and applying ice to using complicated rehabilitation devices such as leg braces or compression devices. Today, therapists are actively searching for new ways to motivate patients to carry out assigned regimen. For patients, at home exercises can be difficult and physical results do not always immediately take place.

2. PROBLEM

The level of adherence is surprisingly low with the World Health Organization (WHO)[3], reporting that adherence to long term therapy in developed countries averages around 50%. Regarding physical therapy, there have been several studies[4–6] that cover the level of a patient's adherence. One of the more recent studies related to physical therapy adherence[5] found that only 39% of patients fully adhered to the recommended regimen. Therefore, the problem to be solved by this thesis can be formulated as follows:

> *How can existing research related to adherence and persuasive technology be applied in order to improve treatment adherence and can this application be offered as a service?*

3. STRUCTURE

This thesis can be divided into three overall parts. It begins with a review of literature focusing on *why* patients do not adhere to treatments and a review of literature covering persuasive technology. The second part is an application of the research reviewed. This research is utilized to help understand how it might be possible to change a patient's adherence behavior once there is an understanding of a patient's beliefs. Finally, the feasibility of offering a service that delivers the applied research as a service will be explored.

2
Literature Review

1. Adherence

1.1. Terminology: Adherence or Compliance?

Before continuing on, the terms adherence and compliance must be addressed. There can be some confusion as to which term best describes a patient's act of carrying out the regimen specified by a health care provider. Essentially these two terms have the same high level meaning and in the context of this thesis, could be used interchangeably. However due to subtle differences and for the sake of consistency, the term adherence will be used.

Why Adherence?

Historically, the term compliance has been used[7], and some say[8] it can convey involuntary acquiescence on the patient's behalf whereas the term adherence conveys a more voluntary or faithful subscription by the patient. This subtle difference represents more than just syntax but perhaps a move to a patient centric view of health care. As this thesis focuses on how technology can motivate patients to adhere to goals set together by provider and patient, the term adherence fits better. Therefore, throughout this paper, the term adherence as defined in WHO's 2003 report on the topic[3] will be used:

> "The extent to which a person's behavior - taking medication, following a diet, and/or executing lifestyle changes, corresponds with agreed recommendations from a health care provider."

It is important to point out that those who do not show up for appointments ("dropouts") also are considered non-adherent. Grindley et al found that during the course of their study, dropout rate was 32.8%. Grindley et al considered drop outs to be no-shows and cancellations without reschedules.

So, when discussing adherence, it is important to note that it also covers simply showing up for an appointment. This aspect of adherence is not only unhealthy for the patient but also very costly for the provider due to lost revenue and rescheduling costs.

1.2.1. Reasons for Low Adherence

There is a wealth of studies addressing the reasons for lack of adherence. It has been reported that there are over 200 factors that can influence adherence[9]. Many of these are psychological factors but also include type of illness and other demographics. In order for health professionals to manage these factors, frameworks and models are necessary to understand how a patient will adhere or why they are not adhering. According to the Sluijs report on exercise compliance in physical therapy[4] some reasons for non-adherence can be as simple as a lack of time, lack of motivation and forgetfulness. However, a deeper psychological understanding of patient beliefs is needed before adherence can be improved.

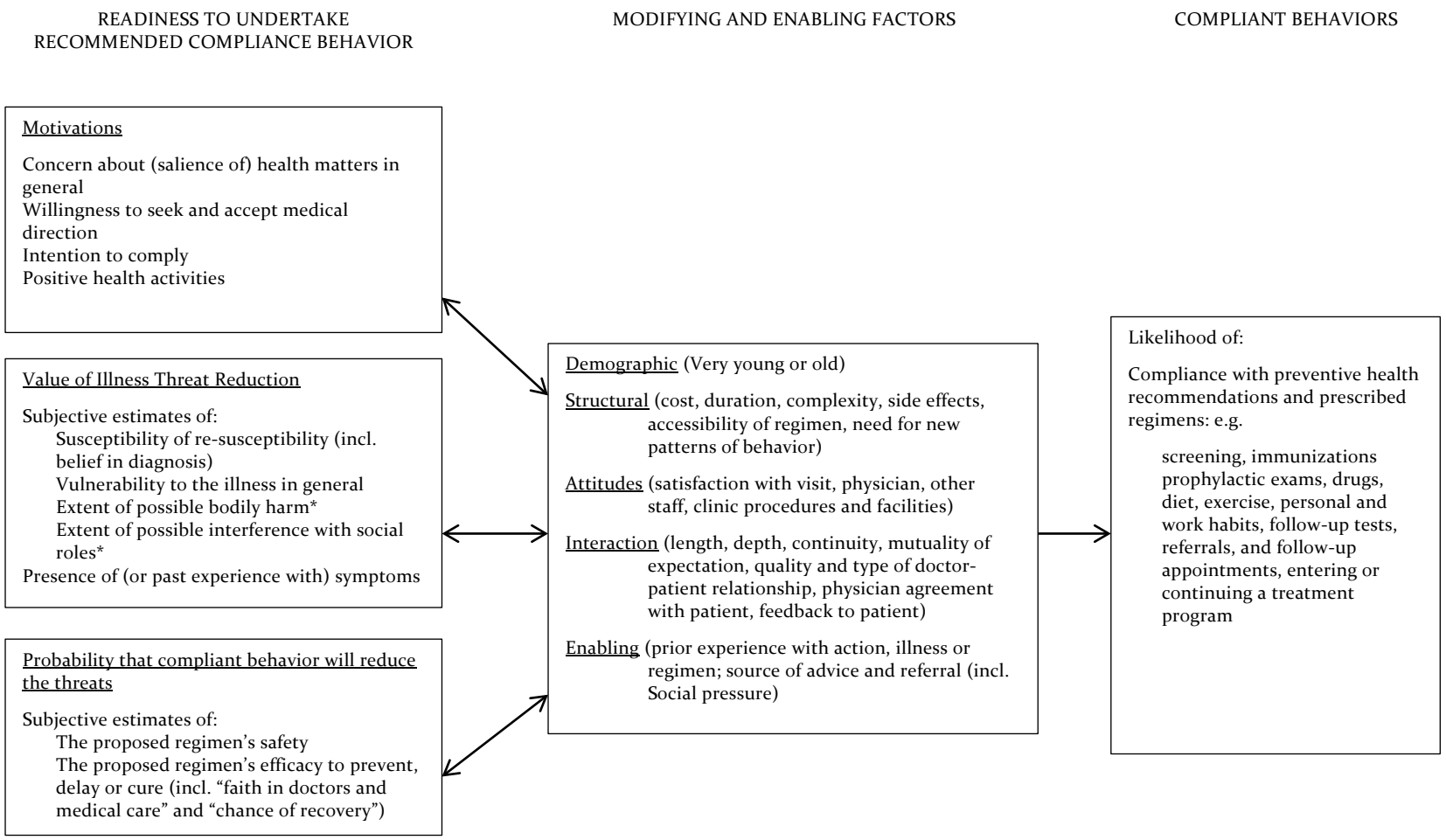

Figure 1 - The Health Belief Model (Becker and Maiman, 1975)

2.1. Understanding Patient Beliefs

One of the first social cognition models, the Health Belief Model (HBM) [10], [11] (see Figure 1), determines a patient's readiness to change by evaluating patient knowledge and perceptions of a given health issue. One might summarize it by stating that patients with an external locus of control are less likely to adhere to regimen and vice versa.

Building on the HBM, Rogers later developed the Protection Motivation Theory (PMT)[12]. PMT holds that people adhere to health behaviors depending on two high level dimensions, how well they can cope and how great the threat is. Each of these dimensions consists of two beliefs or perceptions (originating from the HBM). The coping dimension consists of the patient's belief in the efficacy of the treatment and the belief that they can carry out or get access to the treatment. The threat dimension consists of the perceived susceptibility (vulnerability) and the perceived severity of the health issue.

For example, if a patient were to perceive themselves as being highly susceptible to a severe health issue AND believed that a treatment exists and they are able to carry out the treatment, this patient would highly adhere to the regimen. This makes the PMT a useful predictor of patient adherence[13]. In essence, a health care professional would learn the patient's beliefs in advance, and then educate the patient so that their beliefs can be aligned for optimal adherence. The author has developed a simple diagram to help visualize PMT (see Figure 2 - Protection Motivation Theory).

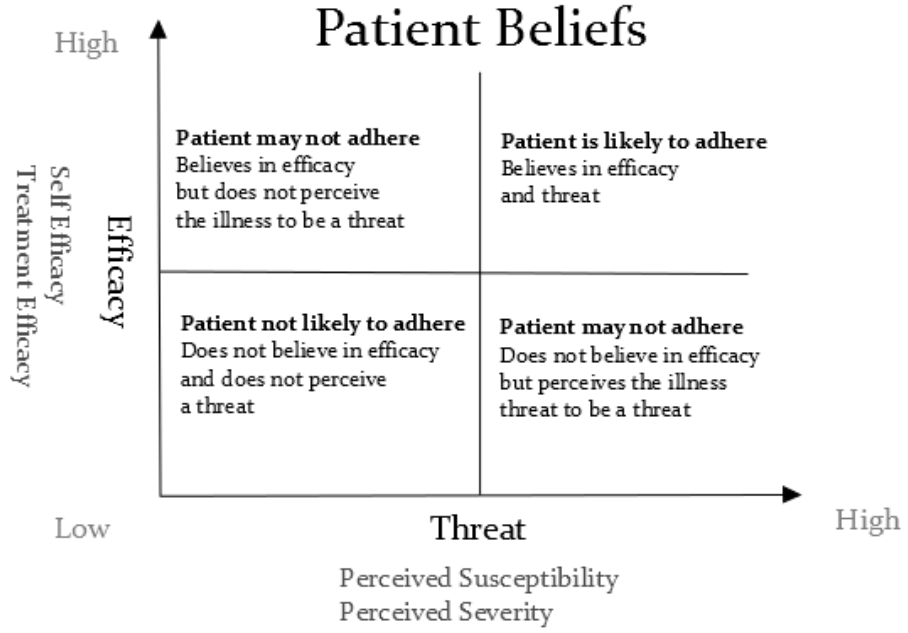

Figure 2 - Protection Motivation Theory

It follows then, that motivational strategies should be tailored to the patient[6], [14]. Scales[15] advises primary care physicians to first assess the patient's readiness to change and to adopt a suitable motivational strategy. For example, if a patient is ready to start exercising, then it would not be appropriate to emphasize the health benefits of exercising but rather to provide the patient with ways of starting their new lifestyle and an ongoing support framework. A general theme according to research is that providers need to make the prescribed regimen simple, they should listen to the patient and set shared goals[14]. Further research[16], [17] has found that when the doctor and patient work as a team and communication is strong, there are clear health benefits. An understanding of patient beliefs can provide physicians with a strong foundation for communicating clearly and effectively with the patient.

In summary, patient adherence is approximately 50% with patients reporting forgetfulness and lack of motivation as common factors. The patient's beliefs also tell us about how well they will adhere. Patients who feel they are in control of their health will adhere better than ones who do not. Practitioners should adjust motivational strategies to suit the patient's beliefs.

2. PERSUASIVE TECHNOLOGY

Before going into persuasive technology, in order to avoid confusion on the term "persuasion" and its meaning, Fogg's definition[18] will be used:

> "Persuasion is a non-coercive attempt to change attitudes or behaviors."

It is important to emphasize that persuasion does not involve coercion, manipulation or deceit. Also, as Fogg points out, persuasion is about an attempt to change someone, which implies a planned intent and not a side effect which is an important difference when discussing technology.

Persuasive Technology is linked with the psychology of persuasion. Human beings have a tendency to behave in a predictable manner when presented with certain decisions or situations, and these tendencies can be observed, distilled and programmed into various applications. So, persuasive technology focuses on how computers are used to influence the way humans behave.

In persuasive technology, there are some models that can be used to help understand and design systems for behavior changes. The Functional Triad and Fogg Behavior Model are described in the following sections and

will be used in chapter two to help frame adherence behaviors and design triggers that can be used to motivate patients to adhere.

Finally, since persuasive technology can be a rather broad and sometimes abstract subject, within this subject there are two other concepts that need discussion, Gamification and Social Networks. Gamification and Social Networks could be considered applications of persuasive technology and are described in sections 1.2.2. and 1.2.3. respectively.

1.2.1. Modeling Persuasion in Computing

The Functional Triad

The first model of persuasive computing to be addressed is a model of computers roles in persuasion, referred to by Fogg as the Functional Triad[19](see Table 1 - The Functional Triad). According to Fogg, computers can take on three roles. Computers can act as tools that enhance our capabilities and reduce barriers. Amazon one-click shopping is an example of a computer acting as a tool (by removing barriers users are more likely to purchase). Computers can act as a medium that provides an experience we can learn from. Any type of computer simulation is a good example of a computer acting as a medium and by experiencing possible outcomes we can be persuaded to take a certain course of action. Finally, a computer can take on a role as a social actor by using social cues to trigger behavior. An example of a computer as a social actor might be when a computer shows a message proclaiming that the user "did a good job" or appears to have a personality by asking the user, "What can I help you with?". This role is powerful because it can trigger automatic behaviors by simply using social cues. This grouping can be referred back to when evaluating the motivators in the adherence framework (next chapter) since it helps to frame our understanding of how to computers can be persuasive.

Table 1 - The Functional Triad (Fogg, 1998)

Function	Essence	Persuasive Affordances
Computer as tool or instrument	Increases capabilities	• Reduces barriers (time, effort, cost) • Increases self-efficacy • Changes mental models
Computer as medium	Provides experiences	• Provides first-hand learning, insight, visualization, resolve • Promotes understanding of cause-and-effect relationships • Motivates through experience, sensation

Computer as social actor	Creates relationship	• Establishes social norms • Invokes social rules and dynamics • Provides social support or sanction

THE FOGG BEHAVIOR MODEL

Fogg has also developed a model that is helpful in evaluating how a computer can change behavior. The Fogg Behavior Model (FBM)[20](see Figure 3 - Fogg Behavior Model) consists of two dimensions, motivation and ability. Put quite simply, as ability and motivation increase it becomes more likely that someone will perform the target behavior when a trigger is presented. These triggers can be used, depending on one's ability and motivation, to cause the behavior to happen. Triggers are perhaps one of the most useful aspects of the FBM.

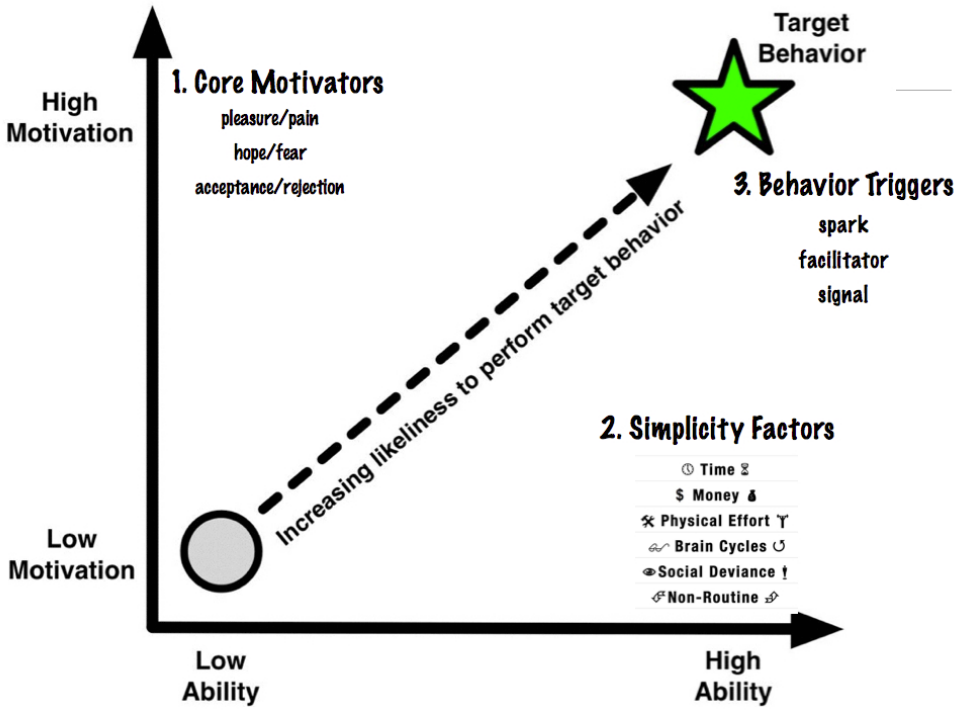

Figure 3 - Fogg Behavior Model (Fogg, 2009)

TRIGGERS

A simple reminder or an alarm is an example of a trigger. Triggers have three properties, they must be associated with the behavior, they must be noticeable and they must happen at the right time. In addition, there are three types of triggers, sparks, facilitators and signals. Sparks are triggers for those with high ability and low motivation, facilitators are for those with high

motivation and low ability and signals are for those with both high motivation and ability.

Due to the ubiquity of mobile computing today, triggers become much more powerful. For example, the GSM Association estimates[21] 6 billion mobile phone users as of October 2011 with an estimation of 12 billion mobile phone users by 2020. This proliferation of mobile devices makes it possible for computers to deliver triggers to nearly everyone. Additionally, due to GPS capabilities of mobile devices, location aware triggers can be designed, making them even more effective. In the past, static advertisements and public announcements (billboards, magazine/television ads, etc.) were used as triggers and are not nearly as effective do to them being out of context. Triggers delivered via a mobile platform with context awareness makes it possible to deliver triggers with optimal timing.

1.2.2. GAMIFICATION

Gamification is "the use of game design elements in non-game contexts"[22] and is another way computers persuade humans to change. Gamification adds a playful or fun side to persuasion. Gamification applied to health care is being explored in area including general wellness[23], [24], geriatrics[25], [26], rehabilitation for disabled children[27], etc. This research shows that although not a panacea, designing applications with game-like elements or underlying tones can be effective in increasing adherence. However, care should be taken when using game design elements as they cannot simply be applied to existing applications without a thorough understanding of the underlying principles.

Successful game design is linked[20, chap. 9] to research by Dr. Mihaly Csikszentmihalyi[29] related to happiness and creativity. Csikszentmihalyi has researched the concept of "Flow"(see Figure 4) which is when a person is in a certain state of concentration as a product of skill and challenge. One may think of Flow as being in the "zone". High challenge and low skill leads to anxiousness whereas high skill and low challenge leads to boredom. So, to be in the "Flow", the appropriate challenge must be assigned according to skill. Csikszentmihalyi states that being in the Flow is an intrinsic motivation and a key to good game design is to keep players in the "flow channel"[28]. This research is useful in the context of adherence and physical therapy because it can help physicians design motivation strategies and exercises that will be in the "flow channel" for the patient.

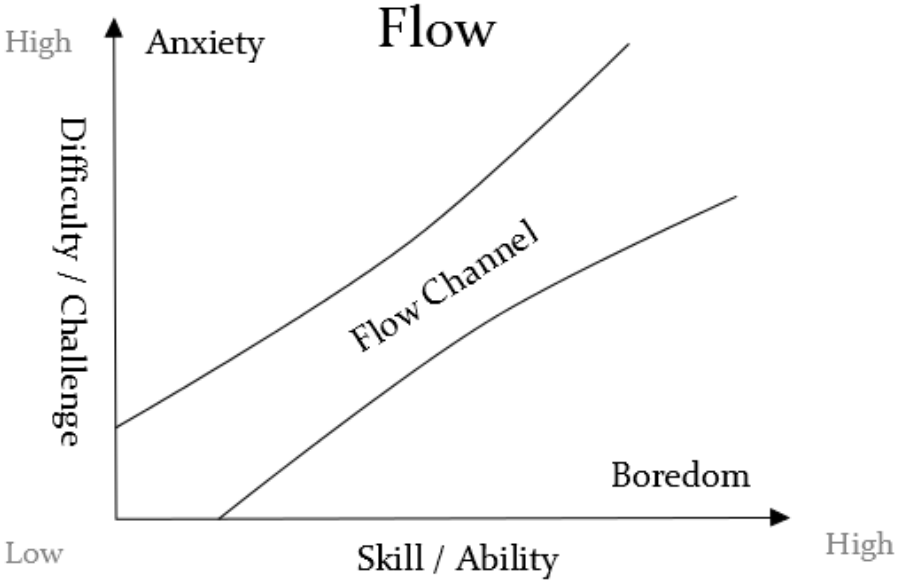

Figure 4 - Flow

Additionally, as of this writing, one can easily identify game-like elements in the top 10 grossing applications (“apps”) in the "Health and Fitness" category in iTunes (see appendix 1. for listing). All these apps employ gaming dynamics that have been designed to motivate users. For example, the app "Run Keeper" tracks progress, allows the runner to set goals, sends messages to the user motivating them toward their goal, and allows the runner to participate in a team ("e.g. street team”). All of these elements are taken from games and are used in a non-game context in order to motivate the runner. The overall success off these apps indicates a level of success by implementing game-based elements in health care contexts. Examples of elements of gamification are badges, leaderboards, levels, time constraints, clear goals, etc.[30].

Figure 5 - Elements of Gamification in Run Keeper

ELEMENTS OF GAMIFICATION AND MOTIVATION

There are many elements of gamification that, when used correctly, can give the user a game-like experience which can act as an intrinsic motivator. However, these elements cannot be just plugged in with the expectation that a game-like/motivational experience will follow. The underlying principles of these patters must be understood.

To better understand the elements of gamification, a simple approach is to frame them in the context of Maslow's hierarchy of human needs[31]. Specifically, the needs "belonging", "esteem" and "self-actualization" can be addressed, to a certain extent, by implementing game-like elements. In the book "Drive: The Surprising Truth About What Motivates Us"[32], Daniel Pink explores the top layer of Maslow's hierarchy of human needs[31], self-actualization, stating that these needs are what motivates many individuals today. He deconstructs this layer into three components, purpose, autonomy and mastery. These three groups fit well with the motivational aspects of gamification.

Finally, Skinner's[33] research on operant conditioning provides a basis of understanding how and why some game-like elements function, especially reward schedules. Skinner was able to correlate reward schedules with effects. For example, if the subject is to learn new behaviors, fixed

schedules work very well (for example, a training program that steadily becomes more difficult but with each level passed a reward is given). However, if the objective is to have the subject repeat a learned behavior, a varying or random schedule is best (for example rewards from a slot machine). This explains why gambling can be as addictive, the rewards are random. Variable reward schedules tend to be very powerful.

Below is a table of gaming elements that can be utilized in the context of promoting adherence. Each element is linked with the aforementioned research.

Table 2 – Selected Gaming Elements and related motivational theories

Element	Description	Theoretical Background
Appointment Dynamic	A dynamic where a user must perform an action at a certain time and place in order to receive some sort of reward	Operant Conditioning, Skinner's Radical Behaviorism
Points	A system of counting or ranking a user's achievements	Maslow's hierarchy of needs, *Self-Actualization* Pink's intrinsic motivators, *Mastery*
Status	A rank or level indicating a user's skill, progress or authority	Maslow's hierarchy of needs, *Esteem*
Progression	Also referred to as levels, as the user progresses through a game it becomes more challenging.	Maslow's hierarchy of needs, *Self-Actualization* Pink's intrinsic motivators, *Mastery* Csikszentmihalyi, *Flow*
Leaderboards	A list of users with highest points, skill or rewards	Maslow's hierarchy of needs, *Esteem*
Teams	Users participate in a team	Maslow's hierarchy of needs, *Belonging*
Meaning	An element that makes a game more than "fun" but implies something significant	Maslow's hierarchy of needs, *Self-Actualization* Pink's intrinsic motivators, *Purpose*

1.2.3. SOCIAL NETWORKS

Social networks can be used to influence or motivate users to adhere due to their ability to provide peer support. So, in this context social networks also act as a subset of persuasive technology. A study on weight loss programs[34] found that peer support via internet was as effective as in person peer support. In addition, studies have found that peer-to-peer support can also assist in smoking cessation[35] and managing diabetes[36], [37]. In a study on social influence and its effect on weight loss[38] it was found that participating in teams increased weight loss, and found that the larger teams further increased the weight loss. Additionally, studies[39], [40], [41] are finding that more and more individuals are sharing health details on social networks in order to cope with their problem. These studies are also promising in that they demonstrate willingness to use online platforms to store and share medical information. These results provide a basis for exploring peer support in adherence to rehabilitation regimen by using social apps.

In addition, social networks, such as Facebook not only create a framework for peer support but due to their ubiquity (millions of users check these sites daily and on many devices), offer a platform for interacting with users. This platform can be effective at delivering triggers to users.

SOCIAL NETWORKS AND OLDER ADULTS

As a majority of patients for physical therapy are middle aged and older adults, the possibility of social network usage and older adults must also be addressed. A study[42] performed by Gibson, et al. found that most older adults are very hesitant to using social networks with main concerns being privacy and the fear of identity theft. However, the study also found that when a *private* social network was offered, uptake among older adults was comparable to general social network uptake, and the older adults tended to use this site actively.

3. SUMMARY

In this chapter the foundational elements of adherence were described with the HBM being the basis for understanding how to address adherence. By using the Protection Motivation Theory in conjunction with HBM it is possible to clearly map what drives a patient's adherence to treatment. This understanding of beliefs enables health care providers to then take steps to effectively change the behavior of their patients.

In addition to understanding the patient's beliefs, the psychology of persuasion and it's relation to technology was also explored. This understanding makes it possible to design more effective motivational strategies that leverage the possibilities offered by computing. In this realm

two concepts were covered that can be utilized to persuade patients to adhere, “Gamification” and Social Networks. Each of these concepts can be traced to research on intrinsic motivation. By understanding these concepts, “Gamification” and Social Networks can be used appropriately and to maximum effect.

3 Developing an Adherence Framework

1. Overview

As described by the research in Chapter 2, there are methods that can be used to model a patient's adherence by using the Health Belief Model and its extension the Protection Motivation Theory. In this chapter, a framework will be discussed which can be used to model the patient's beliefs, how to act on this information as well as how to motivate patients to adhere after their visit. An approach will be outlined whereby these topics can be applied in a systematic way in order to get the most out of the research done in this area. This framework can be outlined into the following four activities:

- Determining and addressing patient beliefs
- Creating an individual motivation strategy
- Supporting adherence
- Reviewing and refining on regular intervals

This framework consists of concepts from adherence psychology and persuasive technology. The first activity mainly deals with the beliefs of the patient and takes place before and during the patient's first visit with the therapist. The other activities are related to motivating the patient using persuasive technology once the exercise has begun, usually after the first visit with the therapist. See Figure 6 for a visual representation of the steps of the framework.

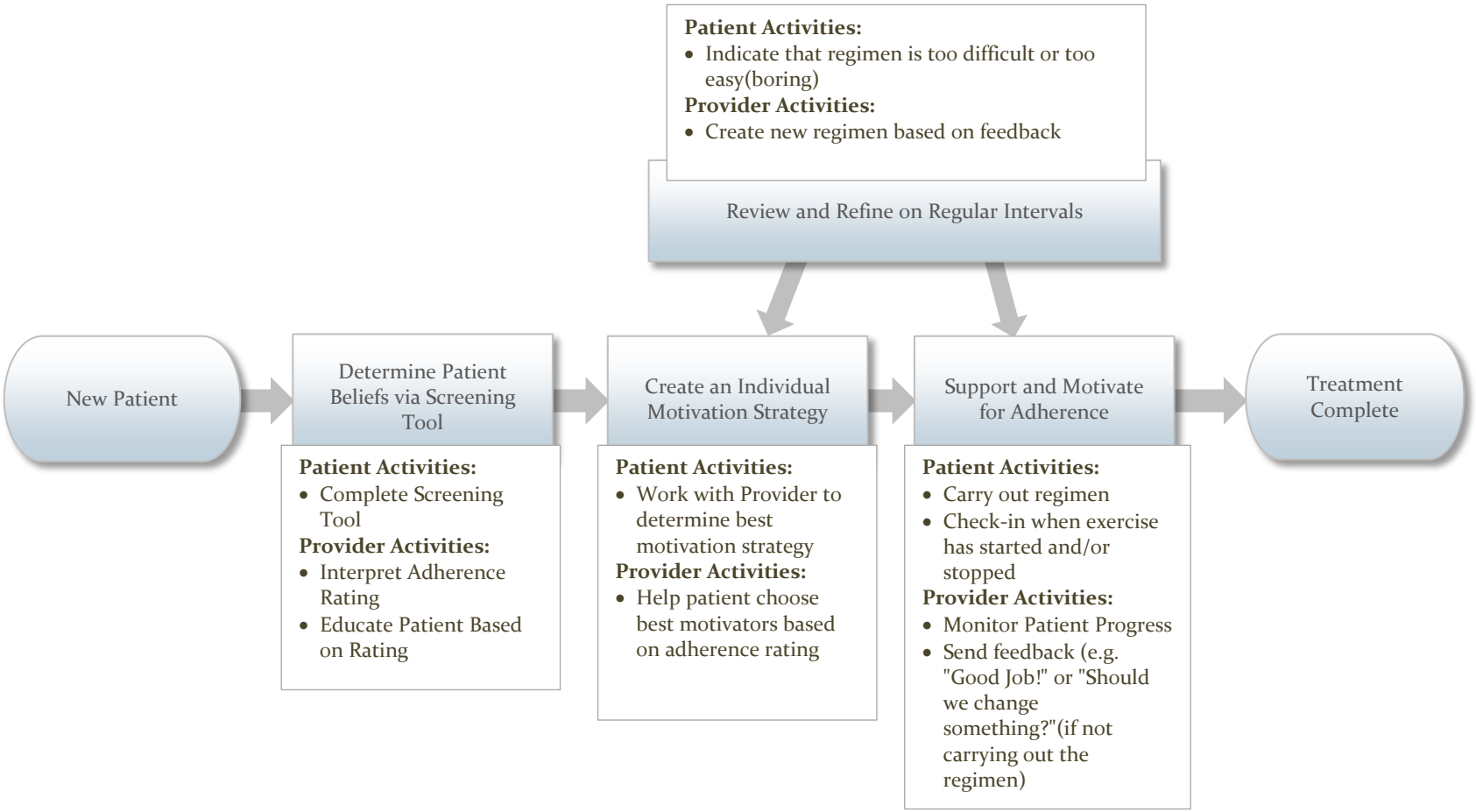

Figure 6 - Adherence Framework Workflow

2. DETERMINING AND ADDRESSING PATIENT BELIEFS

Referring back to the literature reviewed in chapter 2, it was found that practitioners must first evaluate the patient's willingness to change. Since adherence can also be predicted by asking the patient a few questions through the use of a survey, this is the first place to start developing an adherence system. From this survey, the patient's beliefs can be modeled and visualized for the practitioner and patient. During the first visit with the practitioner, this information is shared directly with the patient so that the patient is fully aware of their beliefs. These behaviors are the essence of what is to be changed (if they are not the adhering type) or harnessed (if they are the adhering type).

Several studies have shown that the Protection Motivation Theory (PMT) can be reasonably accurate at predicting of adherence. Based on PMT is the Sports Injury Rehabilitation Beliefs Scale (SIRBS) developed by Taylor and May[43]. SIRBS is a screening tool with 19 questions in the five categories of patient beliefs from PMT, Perceived Susceptibility(Vulnerability), Perceived Treatment Efficacy, Perceived self-efficacy, Rehabilitation value and Perceived severity. Taylor and May found that when patients completed a survey that quantified their beliefs in these five areas they were able to moderately predict adherence.

Grindley and Zizzi built on this research[44] by creating a study using a survey that added two more components to SIRBS. First they added a Positive and Negative Affect Schedule (PANAS) which is a 20 item self-report measure of positive and negative effect developed by Watson, Clark and Tellegen[45]. PANAS is useful in determining the mood of the subject with the negative effects having a higher correlation with stress, dysfunction, and anxiety than the positive effects. Second, Grindley and Zizzi added a barriers checklist, where a patient can choose possible barriers to meeting with the therapist or exercising (for example "scheduling problems" or "lack of support from family or employer").

By adding these additional sections to SIRBS, Grindley and Zizzi were able to improve the prediction of paint patient beliefs. They found that gathering this information from the patient took about 5 minutes. According to these findings, Grindley and Zizzi's hybrid screening tool seems like a logical and feasible approach to gathering patient beliefs. Over time, as more data is gathered, the survey can be refined. See Table 3 for complete survey.

Table 3 - SIRBS Hybrid Screening Tool (Grindley et el, 2008)

	PMT Category	Question
Sports Injury Rehabilitation Beliefs Scale (SIRBS), (Taylor/May, 1996)	Perceived susceptibility / vulnerability	My recovery from injury may be hindered if I do not complete the rehabilitation program (RP).
		In order to prevent a recurrence of this injury, my RP is essential.
		The way to prevent my injury from worsening will be to follow my RP.
		A successful and lasting recovery may not be possible if I do not complete my RP.
		I am making it more likely that I will be reinjured by not doing what my RP involves.
	Perceived treatment efficacy	The RP designed for me will ensure my complete recovery from this injury.
		Completion of my RP will guarantee that I recover from my injury.
		Following the advice that I have been given will have a very large impact upon how quickly I recover from this injury.
		I have absolute faith in the effectiveness of my RP.
	Perceived self-efficacy	I am very capable of successfully completing all aspects of my RP, even if it involves being less active or something which may be discomforting.
		I consider myself able to stick to my RP even though it may include activities which I do not enjoy.
		I will have no serious difficulty in following the instructions of my RP.
		I believe that I will stick with my RP despite any difficulties I may encounter.
	Perceived severity	As injuries go, mine is serious.
		I see this injury as a serious threat to my sport/exercise involvement.
		I fear that this injury will affect my long-term sport/exercise involvement.
		This injury is too serious to not follow medical advice.
	Rehabilitation value	Being fully recovered is important to me.

	(PANAS falls under self-efficacy dimension of PMT)		
PANAS (Watson et al, 1988)	Positive affect	Interested	Determined
		Enthusiastic	Active
		Proud	Attentive
		Strong	Inspired
		Alert	Excited
	Negative affect	Nervous	Upset
		Distressed	Scared
		Irritable	Hostile
		Jittery	Guilty
		Afraid	Ashamed
	Barriers Checklist (barriers fall under self-efficacy dimension of PMT)		
Common Barriers (Grindley et al, 2008)	Lack of cooperation or support (from employer or family)		
	Fear of reinjury		
	Not being able to pay for treatment or insurance restrictions		
	Fear of pain or further discomfort		
	Not having enough time		
	Having to care for child or family members		
	Scheduling problems		

All SIRBS related questions are responded to with a 7-point scale with the anchors "very strongly disagree" and "very strongly agree".

Transparency is important here, as therapists can also use the models to show a patient how other similar patients perceive the efficacy and threats. This transparency can also assist in offsetting any false-consensus effect and use conformity to persuade the patient to adhere. For example, the practitioner could show the patient that there are many other patients like themselves that believe in the efficacy of the treatment and/or that believe that there are real threats to their health if they do not carry out the exercise. The goal is that the patient has as much knowledge and awareness of their health situation as possible. It is at this stage that the practitioner can nudge the patient from low adherence to high adherence through simple education. This is most useful if the patient does not believe there is a serious threat or they do not believe in efficacy of the treatment. If the patient does not believe in their own efficacy (self-efficacy) motivational tools will be offered to improve this dimension.

One can also take in to account that the patient may not have been truthful on the survey, since they may feel that they should respond according to the therapist's expectations. However, even if this is so, the therapist can ask the patient to confirm this information. This confirmation can be very persuasive due to the cognitive dissonance it creates. For example, if the patient indicates that they believe in their ability to carry out the exercises, but later they do not exercise, a simple reminder of their original intentions can change their behavior. Several studies[46][47][48][49] have found this approach valid.

As an aside, it is important to point out that a psychological profile of the patient is being created. This assumes that the health practitioner will be able to interpret and feel comfortable discussing this profile with the patient. In cases where the practitioner does not feel comfortable addressing these issues directly with the patient, a mental health professional is recommended.

1.2. ADHERENCE RATINGS

Before enumerating the ratings, a recap of the dimensions is in order; the coping dimension is the level of belief in the efficacy of treatment and self-efficacy with the threat dimension being the level of belief that the health issue is severe and they are vulnerable. The following is a scale of adherence prediction in order to simplify discussions and understanding of a patient's beliefs:

[A] High adherence predictor	High Coping and High Threat
[B] Medium adherence predictor	High Coping and Low Threat
[C] Medium adherence predictor	Low Coping and High Threat
[D] Low adherence predictor	Low Coping and Low Threat

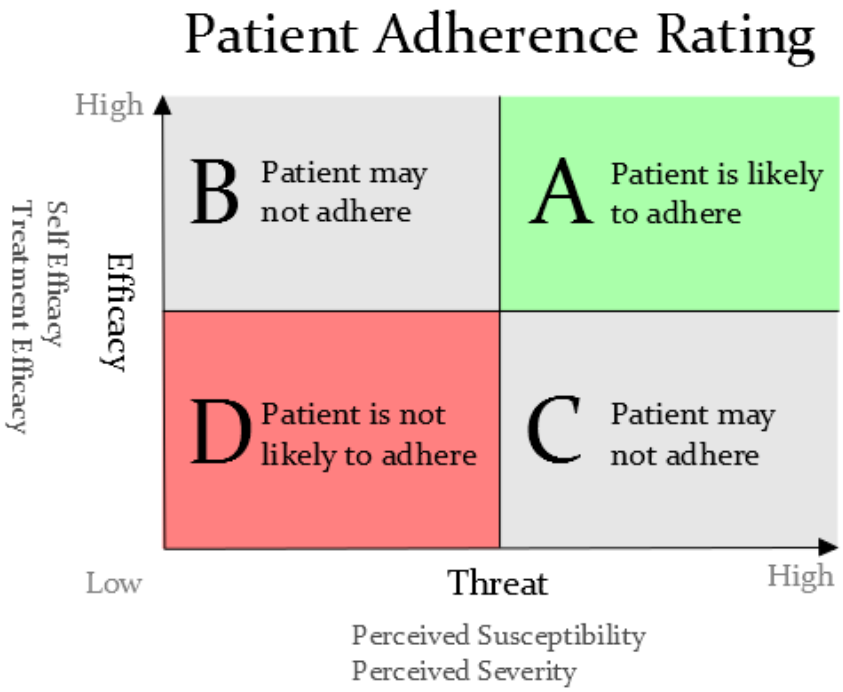

Figure 7 - Adherence Rating Scale

Once the adherence rating has been set it is important to act on it. By empowering the patient with knowledge of their beliefs and information that challenges these beliefs, one might be able to "nudge" the patient into a higher adherence level. What follows are some common sense approaches that the therapist can take in conjunction with the lower adherence predictors; B, C, D. In all cases, it is helpful to show how patient beliefs align with others like them. From a practicality perspective, it might be understandable that the therapist does not want to undertake lengthy consultations on these topics in advance of therapy, so it is also suitable to discuss these points during therapy.

Discussion Points for Adherence Predictor "B" Patients

These patients may not believe in the seriousness of the injury, the long term effects if no rehabilitation is performed, etc. So the therapist should emphasize how serious the consequences are for the patient's health if no rehabilitation is performed, and/or how rehabilitation can prevent future occurrences, etc.

Discussion Points for Adherence Predictor "C" Patients

These patients may not believe that the treatment is effective or that they will be able to perform the exercises. Here the practitioner should spend more time discussing the benefits of the treatment, how it works, etc. In order to

increase the patient's belief in their ability, the practitioner can start by prescribing straightforward exercises that the patient understands and believes. Responses from the SIRBS screening tool related to barriers can be used to identify what the patient thinks are barriers, such as fear of pain of scheduling issues. These issues can be addressed individually. At this point the practitioner can offer online tools that can help them remember when to exercise, participate in teams, etc. These tools will be covered in the next section.

DISCUSSION POINTS FOR ADHERENCE PREDICTOR "D" PATIENTS

See all discussion points for Predictor B and C.

2.2. CREATING AN INDIVIDUAL MOTIVATION STRATEGY

The next step is to define a motivation strategy. As stated earlier, the practitioner should develop a regimen together with the patient. This is part of an underlying theme of empowering patients (which improves self-efficacy). For patients with a low efficacy dimension (adherence predictor "C"), motivation can be a key factor in attaining a high adherence, especially if the self-efficacy is low. This is an area where tools and apps can have the largest impact. Other beliefs, such as treatment efficacy, perceived vulnerability and severity can be increased simply via education. So this section will focus on increasing self-efficacy. Again, all other factors of PMT (vulnerability, severity and treatment efficacy) must be addressed via education and counseling during or shortly after a patient's first visit. If these factors are not addressed from the start, it will likely not be possible to persuade patients to carry out their regimen by using persuasive technology or any other means.

When developing a motivation strategy again the patient must be involved. Most of the motivational elements involve some form of reminders and tracking (leader-boards, team membership, points of some sort, etc) and these elements will only be useful if the patient is fully on-board and is able to choose what is best for them. In addition, it would be effective if the patient also developed a goal together with the therapist. For example, if the patient had a hip replacement and had difficulties walking, the goal might be "to go for a walk in the park with my grandson in 6 weeks". By setting this goal, the therapist can structure an exercise regimen and motivational elements appropriately that will help the patient achieve their goal. Continuing the case of the patient who had the hip replacement, this patient might choose from a list of recommended strategies such as SMS messages to remind them to exercise, a "Hip" team of patients with similar backgrounds/demographics who they could meet up with to do exercises, an app for tracking their progress, etc. By giving the patient a choice of

150 recommended motivation strategies they can develop a strategy that best fits their lifestyle and personality.

The library of elements can be developed by the therapist over time but as a starting point a list of motivational elements has been developed. This list was designed by evaluating how computers can be persuasive and based on the gaming elements defined in section 1.2.2.

Table 4 – Library of Motivational Elements

Element	**Description**
Teams	This motivator is recommended for patients with low self-efficacy adherence ratings (predictors B and D). Being part of a team creates intrinsic motivation due to its social aspects. As mentioned in earlier, team membership can increase adherence. According to one study larger teams are correlated to greater influence.
Reminder	This motivator may be helpful for high adherence patients (predictor A) as it can help trigger exercise and motivate. Patients that start and complete their exercises on time can be rewarded with points or other means.
Rewards	This motivator may be helpful for high adherence patients (predictor A) as it can help trigger exercise and motivate. Patients that start and complete their exercises on time can be rewarded with points or other means.
Family and Friends Support	Patients who report a possible lack of family support in the self-efficacy "barriers" dimension of the survey might benefit from enlisting their family or friends as "official" supporters of their rehabilitation.
Milestones	Patients with low self-efficacy related to completing the program or low belief in the importance in the completion of the regimen may benefit from this motivator. As patients complete exercises the progress is constantly shared with them, motivating them to continue and breaking regimen into smaller, manageable segments.

Personal Goals	Again for patients that have low belief in the self-efficacy dimension, especially related to their ability to follow through with the regimen, this motivator can be helpful. Patients work with a provider to develop goals that have personal meaning. For example, to be able to go skiing in December I must complete the regimen or to be able to run in the half-marathon in September I must complete this regimen. This motivator can be emphasized by making these goals public (publish to Facebook, Twitter, etc.).

The motivators above are examples of tools that therapists can use to help their patients carry out their regimen. Over time, this list can be re-configured individually as the therapists' experience with the system increases.

3.2. SUPPORTING ADHERENCE

At this point, the patient adherence rating has been determined, the patient has been educated in order to position the patient at the highest level of readiness for change and the therapist has helped the patient choose a motivational strategy that fits their lifestyle. The next step is to support the patient's adherence to the assigned regimen.

At this phase the motivational elements defined earlier would be carried out. For example, reminders would be triggered or exercise sessions with selected teams might take place or positive reinforcement (rewards, points, etc.) might be given to the patient for carrying out the regimen.

The therapist should also monitor the progress of the patient and provide support. It has been found that positive messages from the physician can greatly increase adherence as found in a study on the correlates of adherence[4] described in section 1.2.1. Feedback messages can be as simple as a text message stating "Good job staying on track with your plan!" For example, if a patient has missed two planned exercises, the therapist might send a personalized text message the patient stating "I noticed you didn't exercise last week, should we change something?" The level of feedback can be adjusted based on the patient's adherence predictors with support logically being higher for those patients with lower self-efficacy. Going back to the research on motivation, a variable reward schedule may be the most effective, with random praises given to patients who carry out their regimen.

4.2. Reviewing and refining on regular intervals

Like any strategy, regular review is necessary, and adaptations need to be made as circumstances change. Perhaps the patient is not able to perform the exercises at the given time, or the exercises are too difficult or too easy. This flexibility can ensure that the patient stays within the "flow channel" described in section 1.2.2. Ideally, the patient would feel neither boredom nor anxiety in carrying out the regimen. By evaluating the difficulty of the regimen against the skill or ability of the patient the therapist can ensure that the patient is at the highest level of readiness to carry out the regimen. By monitoring these dimensions we can ensure that any triggers or motivational elements are as effective as possible. These adjustments and reviews would help patient and provider to continue as a team.

3. Summary

In this chapter a framework was proposed based on findings in adherence research and persuasive computing. This framework should be carried out by the patient and therapist working together as a team, with an emphasis on communication. The framework allows for a high level of flexibility in order to meet the needs of individual patients. The next chapter will cover the possibility of offering a service for physical therapists based on this framework.

4

An Adherence Application Opportunity Analysis

As described in the previous chapters, there are promising solutions for increasing patient adherence. This chapter focuses on the feasibility of offering a software solution as a service based on the adherence framework defined in chapter 3.

1. RHYTHM

Throughout the remainder of this chapter, the name “Rhythm” will be used to identify a software solution aimed at delivering the aforementioned adherence framework to physical therapists. Rhythm is software as a service targeting Physical Therapists and other rehabilitation services with the possibility to support general outpatient, "adherence heavy", medical practices as a second phase. This service provides customers with research driven tools that can increase patient treatment adherence.

2. PROBLEM

As described in early sections, it generally accepted that there is a problem with low adherence, with reports of adherence levels at ranging from 30 to 70 percent. However, there is evidence that these figures can be increased by applying the research carried out over the past several years. Rhythm makes research in the medical adherence area accessible for the therapist by providing a simple and understandable adherence framework in the form of a web based application.

3. FEATURES

1.3. PATIENT ADHERENCE PREDICTION

Research indicates that it is possible to predict a patient's adherence by evaluating their beliefs in their ability to cope and their belief in the threat of the health problem. This has been modeled in the Health Belief Model and the Protection Motivation Theory. The SIRBS screening tool, developed based on PMT is offered by Rhythm. Rhythm can be used to send a SIRBS survey to patients and once the survey has been submitted, Rhythm generates an adherence prediction scale for the patient, as well as recommendations for the patient and a comparison with other patients. This information can be then used to give the therapist an idea of the how to properly educate the patient for optimal adherence. By addressing the patient's beliefs in advance, the therapist can minimize psychological factors that prevent adherence.

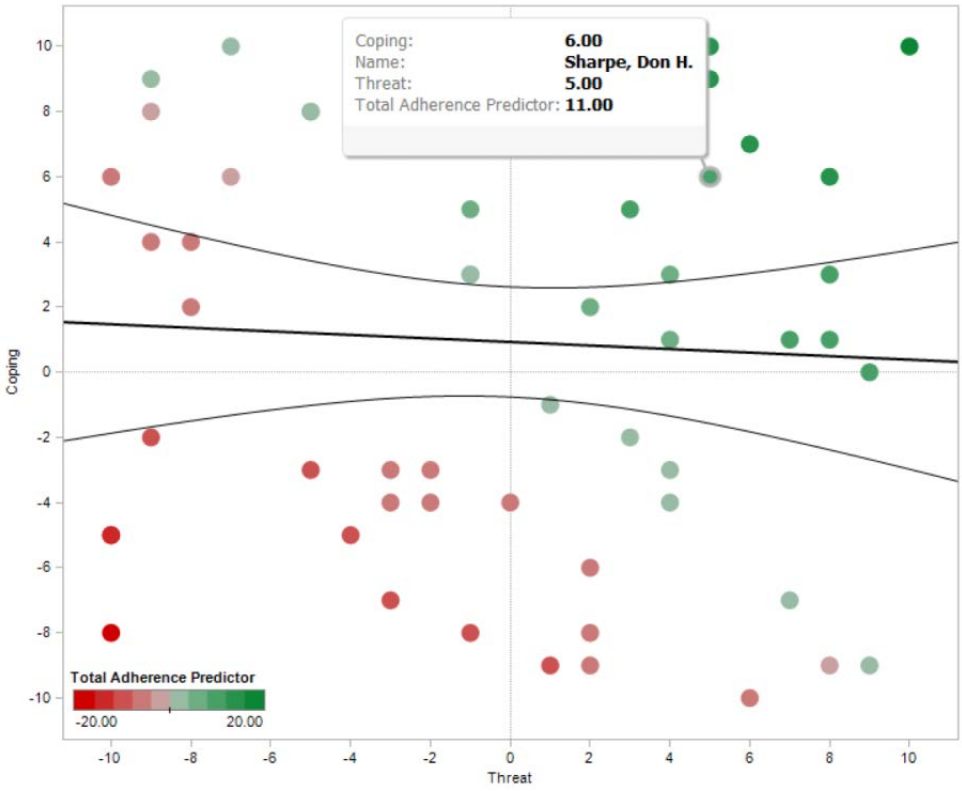

Figure 8 - Example of Patient Adherence Predictor Chart comparing to other patients - based on screening tool results

Another benefit of the adherence prediction system is that over time, as more patients are entered into this system, predictions become more accurate, due

to new correlations between other aspects of patients that can be identified (age, type of illness, etc.).

2.3. Patient Adherence Motivation and Feedback

Part of the Rhythm adherence framework is motivating the patient to exercise. Rhythm provides the patient and therapist with a library of motivational elements that can be combined to help motivate the patient to adhere. These elements have been captured from studies on persuasive computing, as defined in chapters 2 and 3.

Below is a listing of the motivational elements from section 2.2. as implemented in Rhythm:

Table 5 - Motivational Elements as Implemented in Rhythm

Motivational Element	**Implementation**
Teams	Patients can be a member of a team with people similar to them. For example, similar injury, demographics, etc.
Reminder	Agree to a dates, times, and optionally places (work, home, park, etc.) for exercises. If the patient is able to perform the exercises at the specified time and place, points are awarded. This can be combined with the leaderboard. In addition, if the patient chooses, the system can remind them that it is a good time to exercise based on predefined rules (e.g. if I am at home on Saturday afternoon, remind me to exercise). This is possible if the patient has a smart phone with GPS enabled.
Rewards	The rewards and badges can be defined by the therapists based on patient demographics. At the system launch a core set of motivational dynamics will be offered. Based on usage new motivational dynamics can be added.
Family and Friends Support	A friend or family member can be enrolled in the regimen together with the patient for more support. Family members can share goals or create similar goals.
Milestones	A goal, level or stage can be defined and once the patient reaches it (after performing a predetermined number of exercises, for example) points or prizes can be awarded. New exercises can also be "unlocked" once intermediate goals are met. Patients can also publish their goals on social networks so friends and family can cheer them on throughout the term of the exercise regimen.

Personal Goals	A goal that can give the exercise plan more meaning. (Go skiing this year; take a walk with my grandson, etc.)
Leaderboard	Compete with other patients for best adherence record

3.3. Patient Exercise "Check-in"

Patients have the ability to "check-in" when they have completed or started the exercise. A "check-in" is a signal from the patient indicating that they have started the exercise. If the patient does not have access to a smart phone or PC, a simple text message with the text "started" can be sent. By giving the patient this ability, the therapist can passively monitor the progress of the patient (e.g. are they carrying out the regimen?). Rhythm provides the therapist with an overview of this information on a regular basis (daily, weekly, etc.). The ability to capture data about the progress of the patient and their regimen is an important link as it gives therapists the ability to provide feedback and alter regimens as needed.

4.3. Follow-ups

Due to the lack of time and resources available, therapists are not always able to follow up with patients after treatments. However, patient follow ups haven been proven to increase patient wellness. Therefore Rhythm offers the therapists with an automated but personalized approach to checking in with patients after visits. Rhythm sends patients an email or SMS to the patient after the visit asking how the patient is doing and if they have questions or need any further assistance. If the patient responds with feedback, the message is queued in a special inbox. Providers can then review the feedback at their convenience. This approach prevents their email from being overloaded and prevents these messages from being overlooked.

5.3. Appointment Suggestions and Reminders

Certain types of therapy are recommended at longer intervals and can be forgotten by the patient, Rhythm helps patients remember their appointments by sending them a text message before their visit. In addition, if a patient has not visited in a while and the therapists suggested regular therapy, Rhythm can check in with the patient to see if they would like an appointment

4. UNIQUE SELLING PROPOSITION

Rhythm puts an emphasis on the patient and provides therapists with tools based on research on patient adherence. By modeling and visualizing patient beliefs, therapists are able to better educate and motivate their patients. Therapists will find that by augmenting their skills as therapists with a better understanding of patient beliefs they will be able to provide a better overall experience for the patient. In addition, this understanding can help the therapist and the patient work together as a team even after an in-person visit has taken place. This leads to better patient relationships which increases retention of patients, resulting in less cancellations, more referrals and most importantly, healthier patients.

5. COMPETITIVE PRODUCTS

The fundamental concept of Rhythm is that it is focused on patient adherence in the Physical Therapy sector. It is possible that the system could be branched into other types of outpatient medical services where adherence and patient relationship management are important (e.g. cardiovascular care, dental/orthodontics, optometry, mental/behavioral health centers, etc.)

Competitive products are any web based solution that that:

- provides physical therapy adherence mechanisms
- has solutions for patient - therapist communication/feedback
- addresses behavioral change
- is priced between $50 and $200 per month

1.4.1. COMPETITIVE COMPANIES

General physical therapy practice management services could be evaluated as competitive products as some offer patient communication, reminders and exercise plans. However, in the area of physical therapy, most of these services are focused mainly on providing patient billing and scheduling and nothing to help patient adherence. Therefore these products have been excluded as competitors.

In a broader sense, there are solutions available that assist patients in remembering to take their medicine, remind them to exercise, etc. There are also solutions that address general behavior change, such as Stickk. These companies are also potential competitors.

Below are some key competitors offering features that could crossover with Rhythm. Competitors were identified when significant feature crossover occurred. A feature comparison chart has been developed in order to assess the feature coverage of product:

Table 6 - Competitor Software Products and Features

Feature	Rhythm	Health Month	Intelecare	FitBit	StickK
Adherence Predication	✔				
Patient Exercise Tracking	✔			✔	
Electronic Medical Records & Back office functionality					
Appointment Reminders	✔		✔		
Adherence Motivation	✔	✔		✔	✔
Focus on Behavioral Psychology	✔	✔		✔	✔
Customer Relationship Management			✔		
Specifically Targets Physical Therapy Offices	✔				
Features that address adherence	✔	✔	✔	✔	✔

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So that the backgrounds of the companies in this area can be better understood, each offering has been summarized below:

Table 7 - Competitor Backgrounds

Competitor	Description	Details
Health Month www.healthmonth.com	Web based personal health tool. Allows users to set goals and provides social support mechanisms.	Year Founded: 2010 Location: San Francisco, CA Number of Customers: 50,000 Industries Served: Consumer
Intelecare www.intelecare.com	Service that focuses on adherence by reminding patients when to take medications.	Year Founded: 2005 Location: New York, NY Number of Customers: > 3 million Industries Served: Insurance, Hospitals
FitBit www.fitbit.com	Creates devices that assist consumers in tracking activity. Integrates with many other applications and services.	Year Founded: 2010 Location: Chicago, IL Industries Served: Consumer Electronics
stickK www.stickk.com	Service that enables users to make 'commitment contracts' in order to persuade themselves to achieve a given goal or behavior change	Year Founded: 2007 Location: New Haven, CT Industries Served: Consumer

PHYSICAL THERAPY INDUSTRY SPECIFIC SOFTWARE

According to capterra.com, there are 33 providers of "physical therapy software" which has features such as patient tracking, scheduling, EMR, evaluation notes and billing. Of all competitors, MindBodyOnline is the strongest in the area of practice management. MindBodyOnline is also the only known competitor with clients both in US and Europe. This company is more "horizontal" than the others, as they also target Yoga, Beauty Salons,

Gyms, etc. However, this firm and most others have a core focus on the documentation side of the physical therapy industry.

In addition, as electronic medical record (EMR) systems become a federal requirement (see section 2.6. below), there will likely be some emerging standard systems, such as the free EMR practice fusion (www.practicefusion.com). An emerging standard such as Practice Fusion will make it very difficult for other practice management systems, as they will be required provide new additional value (e.g. more than medical records/documentation as these requirements will be met by Practice Fusion or some other standard EMR system). Therefore, it is important to focus on meeting adherence needs of the health care industry, beginning with physical therapy.

Finally, a major differentiation between Rhythm and other solutions is that Rhythm focuses on helping the provider learn patient beliefs about their condition as well as making this information clear to the patient themselves. This critical first step builds a foundation on which to change behavior. All other solutions addressing adherence begin by attempting to change behavior without a basis of understanding of beliefs. It is entirely possible that Rhythm could be used to first help patients and providers first understand the beliefs, by using Protection Motivation Theory, then recommend using a tool like Fitbit or HealthMonth to serve as the motivational element.

6. Assessment of the Opportunity

During first phase of the implementation of Rhythm, the physical therapy industry will be targeted. In general, the Physical Therapy Industry is starting a growth trend in the United States due to the aging baby boomers. Private physical therapy practices will be first addressed. To begin with the United States will be the focus followed by Austria and Germany due to local knowledge of these markets.

1.6. MARKET OVERVIEW

Table 8 - Physical Therapy Industry – Projections (IBISWorld, 2012)

	2012	2016(projected)
Total Market Size	$28 billion	$29 billion
# of employees	293,303	327,851
# of establishments	89,239	123,351
Growth(2007-2012)	5.2%	

2.6. INDUSTRY REVENUES, COSTS AND TRENDS

REVENUES VS. EXPENSES

Although growth rates have recently decreased, the growth rate of 5.2% annually is healthy. In addition, estimates from IBISWorld[50] and CAPTE[51] indicate that the industry is set for more growth starting in 2011.

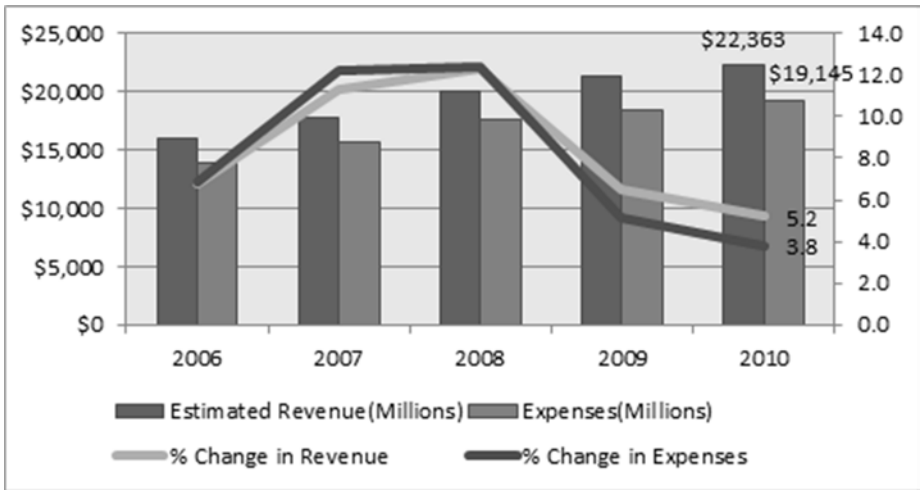

Figure 9 - Revenues vs. Expenses (Physical Therapy Offices) - Source: 2010 US Census

PROFITS

The Physical Therapy industry has maintained increasing profits as revenue growth rates declined by managing costs.

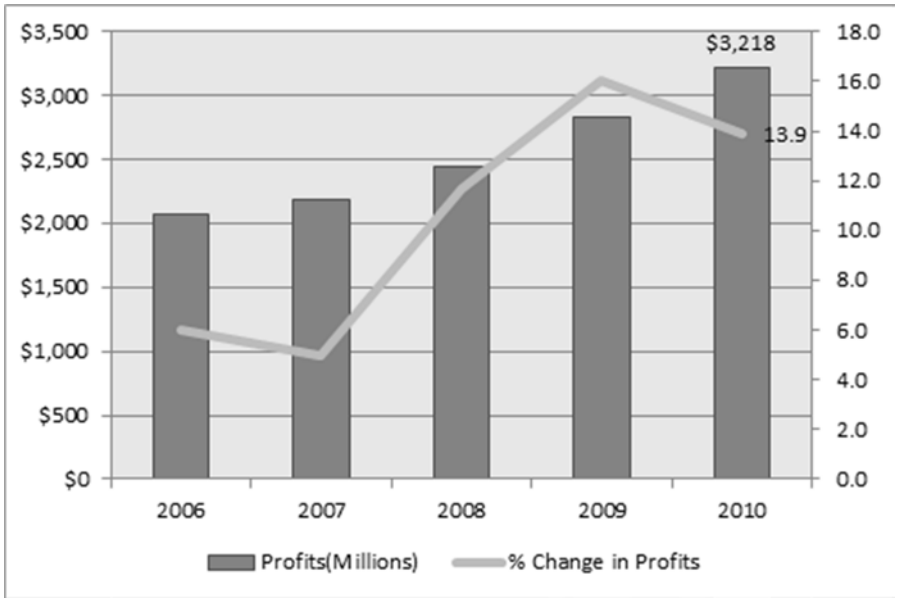

Figure 10 - Profits (Physical Therapy Offices) - Source: 2010 US Census

SOFTWARE EXPENDITURES

Total software expenditures for the ambulatory care industry is $2.4 billion. Average annual software expenses, according to 2010 US Census estimates for the Ambulatory Health Care Sector per establishment is approximately $3,500[52]. According to 2002 census figures, the Physical Therapy software spending is fairly relative to its parent, Ambulatory care.

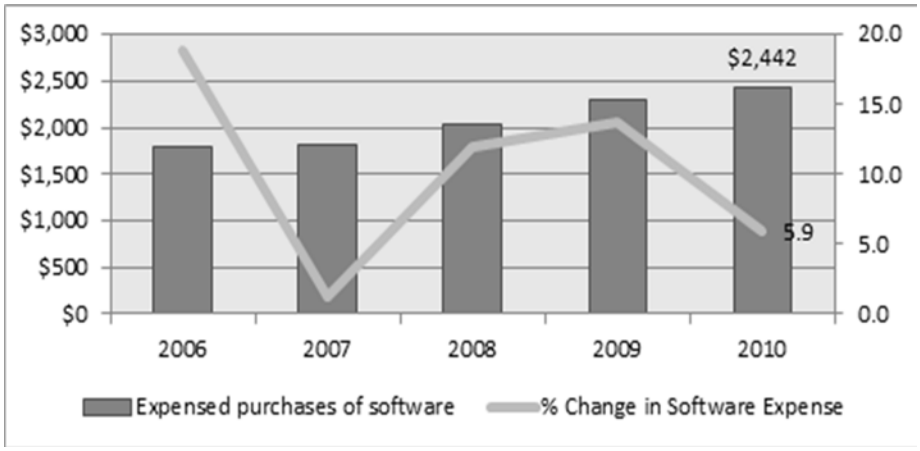

Figure 11 - Software Expenses (Ambulatory Health Care) - Source: 2010 US Census

INDUSTRY TRENDS

The Commission on Accreditation in Physical Therapy Education (CAPTE) estimates[51] a steady increase in PT graduates through 2015, indicating a steady growth of the physical therapy industry.

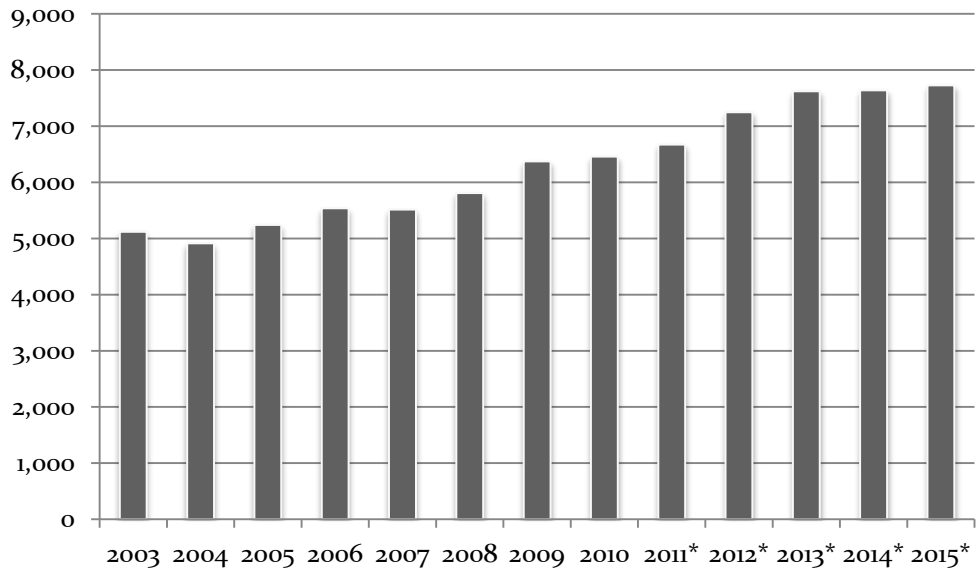

Figure 12 - Graduates from Physical Therapy Programs(source CAPTE)[1]

200 UTILIZATION OF BENEFITS

A 2007 article[53] on the utilization of health insurance benefits stated that Canadian health insurance company, Great West Life, indicated an increased usage of physical ("Physio") therapy as patients realize more benefits of physical therapy. The article states that from 2002 to 2005 there was a 5 – 10% annually in costs related to paramedical services. Although the data is a bit older, it corresponds to the trend of more physical therapy needs due to an aging population and increased awareness.

OTHER PHYSICAL THERAPY TRENDS

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- The American Physical Therapy Association reports a shortage of physical therapists at 19,344 with a projected shortage of 25,295 by 2020[54].

[1] * Estimated

- The US Bureau of Labor Statistics reports that employment of physical therapists is expected to grow 39%, much faster than the average for all other occupations from 2010 to 2020[55].

US FEDERAL MANDATE FOR ELECTRONIC MEDICAL RECORDS BY 2014

Another trend in the physical therapy industry will be a move to electronic medical records (EMR) by 2014 as part of President Obama's Health Care overhaul, the Patient Protection and Affordable Care Act. A move to standardized EMR system will be beneficial for Rhythm as the entire market will be on EMR system which will make it easier for the adoption of other electronic systems as complements such as Rhythm.

7. OTHER MARKETS

The physical therapy industry is a starting point for this opportunity due to knowledge of this market as well as its niche within the health care industry. However, the theme of adherence prediction and motivation is one that the overall healthcare industry can relate to. Therefore, once the adherence ratings and motivators have been tested and proven in the Physical Therapy industry, other verticals must also be explored. When evaluating other health care industries, it makes sense to group them into disease categories in order to provide a better focus. As focusing on the pharmaceutical industry in general, or outpatient healthcare would be far too broad.

Referring back to the literature covered earlier, one would note that the type disease is itself a factor that affects adherence. As each of these diseases has different characteristics, targeting them individually would also provide better adherence prediction. This strategy would also be in-line with the patient centric approach of Rhythm.

The following are two key segments that have well defined research on adherence as well as conferences, opinion leaders and other platforms that can enable market penetration. In addition, adherence has been an important topic in each of these diseases.

1.7. HEART DISEASE

As the top disease affecting Americans, according the WHO, this disease affects an average of 30% of the population. Prevention includes behavior changes such as exercise, healthy eating and smoking cessation. For those affected by high blood pressure, medication is often prescribed, but according to a 1993 report on adherence more than 60% of cardiovascular patients failed to adhere to their regimen[56]. Non-adherence is well documented, making this segment in high demand of a solution for this problem.

2.7. DIABETES

According to a 2010 report by the Center for Disease Control and Prevention[57], the number of Americans with diabetes is nearly 26 million. Diabetes is chronic, with significant lifestyle changes required. Adherence to the regimen is critical for the patient. A study regarding patients with Type 1 Diabetes found that intensive treatment reduced the risk any cardio vascular disease event by 42 percent[58]. These results show the importance of adherence in Diabetes management.

3.7. OTHER DISEASES

Other chronic diseases that require evaluation are obesity and HIV/AIDS. These diseases like heart disease and diabetes require understanding of patient beliefs in order to change behaviors, making these diseases also candidates for an adherence rating platform.

4.7. HEALTH INSURANCE INDUSTRY

The insurance industry is another market segment that can be explored. One key problem is that the trust patients have in the insurance industry is quite low[59]. This lack of trust would limit the effectiveness of any platform offered to patients via the insurance industry. However, the insurance industry is one of the key stakeholders of patient treatment adherence. Therefore, involving the insurance industry in some way can be explored in the future (partnership, sponsor, etc.)

8. PRICING

In order to identify pricing for Rhythm, it is important to first focus on cost savings Rhythm can provide so that value-based pricing can be used.

REDUCING DROPOUT COSTS

As mentioned in previous chapters, dropout rates for physical therapy offices have been recorded at 32.8%. To be clear, dropouts are considered those who cancelled or did not show up for appointments without rescheduling. In 2007, average expenses per visit were reported to be $130[60]. As mentioned above, annual revenues for the physical therapy industry are $28 billion. This means dropouts could be costing then industry as much as $9 billion per year in lost revenue or approximately $100 thousand per practice per year (89,239 practices as of 2011, IBISWorld).

By examining patient beliefs, it is possible to predict dropout rates to some degree, as Grindley et al reported on using the SIRBS screening tool in conjunction with PANAS and a barriers checklist. Even though the ability to predict dropouts my decrease them by only 2-3% this would present an annual cost savings of approximately $2,000 per year per practice. A 10 percent reduction in dropout rates would present a savings of approximately

$10,000 per year per practice. Trial runs would be necessary to identify reliable statistics and dropout prediction and prevention rates.

Reducing Low Adherence Costs

According to a 2007 report on adherence by the National Council on Patient Information and Education[61], poor adherence costs the overall health care industry approximately $177 billion annually. In order to provide a rough cost for the physical therapy industry, this number can be extrapolated to approximately $5.3 billion as the physical therapy industry accounts for approximately 3% of the overall health care industry (in terms of revenue). In order to put this in terms of physical therapy practices, it could be estimated that low adherence costs practices roughly $50 thousand annually.

These figures may have some cross-over with dropouts, as dropouts are also a cost associated with non-adherence. However, if anything, they emphasize the fact that a low adherence costs practices a significant amount of income each year. As the above calculations are based on averages, high volume clinics and practices would logically see much larger costs associated with dropouts and low adherence.

The above information provides information needed to use value-based pricing. Assuming Rhythm can save a practice on average $10,000 annually (approximately 10% of dropouts), an estimate for pricing might be 20% of savings, or $2000 per year/$160 per month. Pricing should be tiered based on the size of the practice, as larger practices typically will incur more cost savings by using Rhythm. For example, 3 pricing tiers could be offered, $80 per month for small practices(1-5 therapists), $150 per month for medium size practices(6-10) therapists and $500 per month for institutions(unlimited therapists).

9. Market Potential and Projected Revenue

1.9. Evaluation of AdWords Marketing Channel

As this service will offered as an online service, overall market potential can be estimated by the amount of traffic to the site based on internet searches. Google's AdWords tool (adwords.google.com) can be effective in estimating traffic. The AdWords tool (adwords.google.com), estimates 2000 daily searches on the terms similar to "treatment adherence" with 200 daily impressions. This channel would cost approximately $500 per month.

With estimated 5% conversion rate of conversion to customer, 300 new customers could be added per month, generating monthly revenue of $30,000 based on $100/month subscription price.

Testing would need to take place in order to confirm actual conversion rates. See chart below (see Figure 13) projecting monthly revenue based on 1, 3, 5, 7 and 10 percent conversion rate.

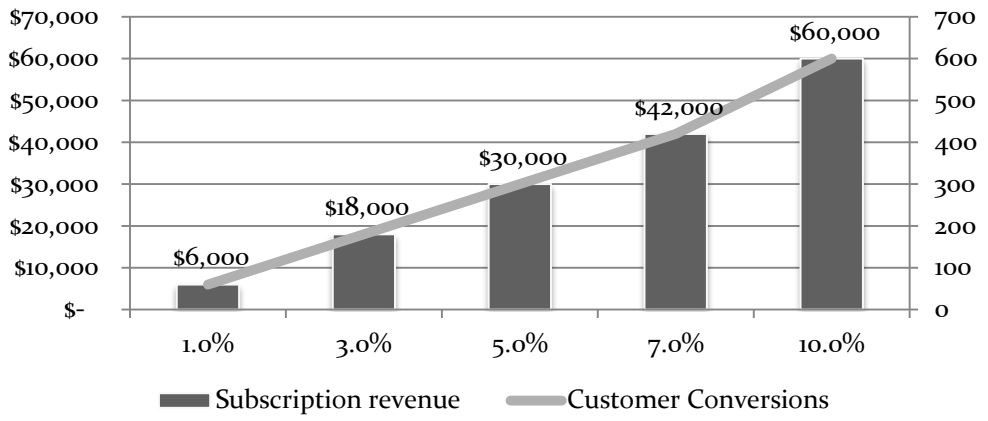

Figure 13 - Monthly Customers and Revenue based on Conversion Rate

Other marketing channels would also need to be explored such as affiliate marketing, trade shows, conferences and direct sales.

10. SUMMARY

Offering an adherence platform appears to be feasible provided that cost savings can be achieved by predicting low adherence patients who may drop out. The physical therapy industry is in a growth phase which makes it a good place to test and refine this solution. In addition, it appears, based on the literature that this industry is in search of solutions that can improve patient adherence. In order to proceed with this opportunity, the framework and service must be tested by partnering with physical therapy offices with early adopter traits (e.g. those who could deeply understand the need and be ready and willing to participate in solutions). Therefore next steps for this analysis are to seek out these enterprises and begin testing.

5 Conclusion

1. Summary

The health care industry in the U.S. and around the world is facing tough challenges and is in need of practical solutions. Improving adherence is a way that the industry can both increase patient health and operate more efficiently. In addition, there is a consensus that cooperation among patient and provider, better communication, shared goals and understanding are all qualities of next generation health care.

This thesis distilled existing research on adherence into a practical, easy to use framework with the goal of providing health care practitioners with a better understanding of patient beliefs. This understanding sets a foundation for open communication and team work between the patient and provider. This framework is also a way to harness the wealth of valuable research already performed in this area and make it accessible in everyday health care scenarios.

The possibility of offering an adherence prediction framework as a service appears to be feasible. The physical therapy industry as a first step will be used as an incubator for this framework and later a launch pad into other medical fields.

2. Discussion

The original goal of this thesis was to research and define ways in which to motivate patients to adhere to a treatment or regimen. However, during this research, evidence was found that shows that it may be much more effective (and feasible) to use the Protection Motivation Theory to address adherence issues *before* the regimen even takes place. By gaining this intelligence, the provider can easily address important underlying issues with the patient that ultimately will provide for a better treatment.

It is the author's hope that doctors, armed with this new information, can better understand and communicate with their patients. Patients, under the duress of whatever health issues they are experiencing will find a more satisfying experience. It is understandable that patients are unable to clearly communicate how they feel about a their health issues, especially in today's fast paced society with alerts, reminders, messages, emails, etc. providing ever more distractions. The adherence framework described in this thesis might be able to help improve this communication.

3. LIMITATIONS AND OUTLOOK

In order to prove the effectiveness and accuracy of the adherence prediction framework and motivational tools outlined in this thesis, trials will need to be performed together with physical therapy offices. Correlations between patient demographics, disease or injury type and SIRBS results also need to be further explored since new correlations will make the predictions more accurate.

Due to the possibilities of a broad application of this framework within the health care industry, once the application has been proven within the physical therapy industry, trials can also begin in areas related to cardiovascular care and diabetes care due to the importance of adherence for patients affected by these diseases.

6 Bibliography

[1] M. C. Sokol, K. a McGuigan, R. R. Verbrugge, and R. S. Epstein, “Impact of medication adherence on hospitalization risk and healthcare cost.,” *Medical care*, vol. 43, no. 6, pp. 521-30, Jun. 2005.

[2] D. M. Cutler et al., “The value of antihypertensive drugs: a perspective on medical innovation.,” *Health affairs (Project Hope)*, vol. 26, no. 1, pp. 97-110.

[3] WHO, “ADHERENCE TO LONG-TERM THERAPIES: EVIDENCE FOR ACTION,” World Health Organization, 2003.

[4] E. M. Sluijs, G. J. Kok, and J. van der Zee, “Correlates of exercise compliance in physical therapy.,” *Physical therapy*, vol. 73, no. 11, pp. 771-82; discussion 783-6, Nov. 1993.

[5] D. Chan and F. Can, “Patients ’ adherence / compliance to physical therapy home exercises,” *Fizyoterapi Rehabilitasyon*, vol. 21, no. 3, pp. 132-139, 2010.

[6] S. F. Bassett, “The assessment of patient adherence to physiotherapy,” vol. 31, no. July, 2003.

[7] P. R. B. Haynes, *Compliance in Health Care*. The Johns Hopkins University Press, 1979, p. 534.

[8] K. E. Lutfey and W. J. Wishner, “Beyond ‘compliance’ is ‘adherence’. Improving the prospect of diabetes care,” *Diabetes Care*, vol. 22, no. 4, pp. 635-639, Apr. 1999.

[9] D. Meichenbaum and D. C. Turk, *Facilitating Treatment Adherence*. Springer, 1987, p. 310.

[10] M. H. Becker and L. A. Maiman, "Sociobehavioral determinants of compliance with health and medical care recommendations.," *Medical Care*, vol. 13, no. 1, pp. 10-24, 1975.

[11] N. K. Janz and M. H. Becker, "The Health Belief Model: A Decade Later," *Health Education & Behavior*, vol. 11, no. 1, pp. 1-47, Jan. 1984.

[12] R. W. Rogers, "A Protection Motivation Theory of Fear Appeals and Attitude Change," *The Journal of Psychology*, vol. 91, no. 1, pp. 93-114, Sep. 1975.

[13] I. M. Rosenstock, V. J. Strecher, and M. H. Becker, "Social Learning Theory and the Health Belief Model," *Health Education & Behavior*, vol. 15, no. 2, pp. 175-183, Jan. 1988.

[14] A. Atreja, N. Bellam, and S. R. Levy, "Strategies to enhance patient adherence: making it simple.," *MedGenMed : Medscape general medicine*, vol. 7, no. 1, p. 4, Jan. 2005.

[15] R. Scales and J. H. Miller, "Motivational techniques for improving compliance with an exercise program: skills for primary care clinicians.," *Current sports medicine reports*, vol. 2, no. 3, pp. 166-72, Jun. 2003.

[16] R. L. Street, G. Makoul, N. K. Arora, and R. M. Epstein, "How does communication heal? Pathways linking clinician-patient communication to health outcomes.," *Patient education and counseling*, vol. 74, no. 3, pp. 295-301, Mar. 2009.

[17] M. Leonard, S. Graham, and D. Bonacum, "The human factor: the critical importance of effective teamwork and communication in providing safe care.," *Quality & safety in health care*, vol. 13 Suppl 1, pp. i85-90, Oct. 2004.

[18] B. J. Fogg, G. Cuellar, and D. Danielson, "Motivating, influencing, and persuading users," in *The human-computer interaction handbook: fundamentals, evolving technologies and emerging applications*, 3rd ed., CRC Press, 2003, pp. 133-147.

[19] B. J. Fogg, "Persuasive computers," in *Proceedings of the SIGCHI conference on Human factors in computing systems - CHI '98*, 1998, pp. 225-232.

[20] B. J. Fogg, "A behavior model for persuasive design," *Proceedings of the 4th International Conference on Persuasive Technology - Persuasive '09*, p. 1, 2009.

[21] GSMA and A. Faylor, "GSMA Research Demonstrates that Mobile Industry is creating a Connected Economy," 2011. [Online]. Available: http://www.gsma.com/newsroom/gsma-research-demonstrates-that-mobile-industry-is-creating-a-connected-economy/. [Accessed: 28-May-2012].

[22] S. Deterding, D. Dixon, R. Khaled, and L. Nacke, "From game design elements to gamefulness: defining 'gamification'," in *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*, 2011, vol. Tampere, F, pp. 9-15.

[23] T. Park, C. Yoo, S. P. Choe, B. Park, and J. Song, "Transforming solitary exercises into social exergames," *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work - CSCW '12*, p. 863, 2012.

[24] M. Ahn, S. Kwon, B. Park, K. Cho, and S. P. Choe, "Running or Gaming," pp. 1-4, 2004.

[25] K. M. Gerling, "Exploring the Potential of Gamification Among Frail Elderly Persons," *CHI 2011 Workshop on Gamification*, pp. 1-4, 2011.

[26] B. D. Schutter, "Designing Meaningful Play within the Psycho-Social Context of Older Adults," *Engineering*, pp. 84-93, 2010.

[27] H. A. Hernandez et al., "Design of an exergaming station for children with cerebral palsy," in *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12*, 2012, p. 2619.

[28] J. Schell, *The Art of Game Design: A book of lenses*, vol. 54. Morgan Kaufmann, 2008, p. 489.

[29] M. Csíkszentmihályi, *Flow: The Psychology of Optimal Experience*. HarperCollins, 2008, p. 336.

[30] S. Deterding, "Meaningful Play," *Google Tech Talk January 24 2011*, pp. 1-154, 2011.

[31] A. H. Maslow, Robert, P. D. Frager, and J. Fadiman, *Motivation and Personality*. HarperCollins Publishers, 1987, p. 293.

[32] D. H Pink and D. H. Pink, *Drive: The Surprising Truth About What Motivates Us*. Riverhead Hardcover, 2009, p. 256.

[33] B. F. Skinner, *About Behaviorism*. Vintage, 1976.

[34] J. Harvey-Berino, S. Pintauro, P. Buzzell, and E. C. Gold, "Effect of internet support on the long-term maintenance of weight loss.," *Obesity research*, vol. 12, no. 2, pp. 320-9, Feb. 2004.

[35] C. S. Malchodi, C. Oncken, E. A. Dornelas, L. Caramanica, E. Gregonis, and S. L. Curry, "The effects of peer counseling on smoking cessation and reduction.," *Obstetrics and gynecology*, vol. 101, no. 3, pp. 504-10, Mar. 2003.

[36] D. H. Joseph, M. Griffin, R. F. Hall, and E. D. Sullivan, "Peer Coaching: An Intervention for Individuals Struggling With Diabetes," *The Diabetes Educator*, vol. 27, no. 5, pp. 703-710, Sep. 2001.

[37] T. C. Keyserling et al., "A Randomized Trial of an Intervention to Improve Self-Care Behaviors of African-American Women With Type 2 Diabetes: Impact on physical activity," *Diabetes Care*, vol. 25, no. 9, pp. 1576-1583, Sep. 2002.

[38] T. M. Leahey, R. Kumar, B. M. Weinberg, and R. R. Wing, "Teammates and Social Influence Affect Weight Loss Outcomes in a Team-Based Weight Loss Competition.," *Obesity (Silver Spring, Md.)*, Feb. 2012.

[39] S. Jamison-Powell, C. Linehan, L. Daley, A. Garbett, and S. Lawson, "'I can't get no sleep'," in *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12*, 2012, p. 1501.

[40] J. H. Frost and M. P. Massagli, "Social uses of personal health information within PatientsLikeMe, an online patient community: what can happen when patients have access to one another's data.," *Journal of medical Internet research*, vol. 10, no. 3, p. e15, Jan. 2008.

[41] P. Wicks et al., “Sharing health data for better outcomes on PatientsLikeMe.,” *Journal of medical Internet research*, vol. 12, no. 2, p. e19, Jan. 2010.

[42] L. Gibson, W. Moncur, P. Forbes, J. Arnott, and C. Martin, “Designing Social Networking Sites for Older Adults,” *Focus*, vol. 44, no. 0, pp. 181-189, 2010.

[43] A. H. Taylor and S. May, “Threat and coping appraisal as determinants of compliance with sports injury rehabilitation: an application of Protection Motivation Theory.,” *Journal of sports sciences*, vol. 14, no. 6, pp. 471-82, Dec. 1996.

[44] E. J. Grindley, S. J. Zizzi, and A. M. Nasypany, “Use of protection motivation theory, affect, and barriers to understand and predict adherence to outpatient rehabilitation.,” *Physical therapy*, vol. 88, no. 12, pp. 1529-40, Dec. 2008.

[45] D. Watson, L. A. Clark, and A. Tellegen, “Development and validation of brief measures of positive and negative affect: the PANAS scales.,” *Journal of personality and social psychology*, vol. 54, no. 6, pp. 1063-70, Jun. 1988.

[46] V. Fointiat, “‘I KNOW WHAT I HAVE TO DO, BUT…’ WHEN HYPOCRISY LEADS TO BEHAVIORAL CHANGE,” *Social Behavior and Personality: an international journal*, vol. 32, no. 8, pp. 741-746, 2004.

[47] J. Stone, E. Aronson, A. L. Crain, M. P. Winslow, and C. B. Fried, “Inducing Hypocrisy as a Means of Encouraging Young Adults to Use Condoms,” *Personality and Social Psychology Bulletin*, vol. 20, no. 1, pp. 116-128, Feb. 1994.

[48] C. B. Fried and E. Aronson, “Hypocrisy, Misattribution, and Dissonance Reduction,” *Personality and Social Psychology Bulletin*, vol. 21, no. 9, pp. 925-933, Sep. 1995.

[49] L. S. Son Hing, W. Li, and M. P. Zanna, “Inducing Hypocrisy to Reduce Prejudicial Responses among Aversive Racists,” *Journal of Experimental Social Psychology*, vol. 38, no. 1, pp. 71-78, Jan. 2002.

[50] IBISWorld, “Physical Therapists in the US: Market Research Report,” 2012.

[51] The Commission on Accreditation in Physical Therapy Education (CAPTE), "2010-2011 Fact Sheet - Physical Therapist Education Programs," 2011.

[52] U.S. Census Bureau, "Industry Summary - Health Care and Social Assistance - NAICS 62," 2010.

[53] L. Kulchycki, "Benefits Trends: Full Service," *Benefits Canada*, p. 49, Oct-2007.

[54] American Physical Therapy Association and M. E. Goldstein, "Workforce Model Description and Figures," 2012.

[55] Bureau of Labor Statistics U.S. Department of Labor, "Physical Therapists : Occupational Outlook Handbook : U.S. Bureau of Labor Statistics," *Occupational Outlook Handbook, 2012-13 Edition, Physical Therapists*, 2012. [Online]. Available: http://www.bls.gov/ooh/Healthcare/Physical-therapists.htm. [Accessed: 26-Jun-2012].

[56] R. L. Kravitz et al., "Recall of Recommendations and Adherence to Advice Among Patients With Chronic Medical Conditions," *Archives of Internal Medicine*, vol. 153, no. 16, pp. 1869-1878, Aug. 1993.

[57] U.S. Department of Health and Human Services, "Centers for Disease Control and Prevention. National diabetes fact sheet: national estimates and general information on diabetes and prediabetes in the United States, 2011," 2011.

[58] D. Nathan et al., "Intensive Diabetes Treatment and Cardiovascular Disease in Patients with Type 1 Diabetes," *The New England journal of medicine*, vol. 353, no. 25, pp. 2643-2653, 2005.

[59] T. Lacki, "Measuring the Value of Trust in Healthcare Measuring the Value of Trust in Healthcare," 2012.

[60] S. R. Machlin, J. Chevan, W. W. Yu, and M. W. Zodet, "Determinants of utilization and expenditures for episodes of ambulatory physical therapy among adults.," *Physical therapy*, vol. 91, no. 7, pp. 1018-29, Jul. 2011.

[61] National Council on Patient Information and Education, "Enhancing Prescription Medicine Adherence : A National Action Plan," 2007.

7 Appendix

1. Top 10 Grossing Apps in iTunes in the health and wellness category

Accessed June 9th, 2010

1. **Nike+ GPS**
   Health & Fitness
2. **P90X**
   Health & Fitness
3. **Zombies, Run!**
   Health & Fitness
4. **5K Runner: couch to 5K workout**
   Health & Fitness
5. **Jillian Michaels Slim-Down Solution -**
   Health & Fitness
6. **Calorie Tracker - LIVESTRONG.COM: .**
   Health & Fitness
7. **MapMyRUN+**
   Health & Fitness
8. **FitnessBuilder**
   Health & Fitness
9. **Cyclemeter GPS Bike Computer**
   Health & Fitness
10. **Calorie Counter PRO by MyNetDiary**
    Health & Fitness

Figure 14 - iTunes Top 10 grossing "Health and Fitness" apps