I, Hao Gao, hereby submit this original work as part of the requirements for the degree of Master of Design in Design.

It is entitled:
Portable Pillbox: An Empathic Design Approach to Medicine Adherence for Chronic Adolescent Illnesses

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Portable pillbox: an empathic design approach to medicine adherence for chronic adolescent illnesses

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Master of Design
In the School of Design of the
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by
Hao Gao

Committee Chair: Steven J. Doehler
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Abstract

Adolescent patients have difficulty taking medication on time in the correct dosage which is a major cause of treatment failure and illness. A need has existed for a portable solution that could measure adherence to a treatment regimen daily even hourly for outpatient who has pediatric chronic illness and encourage them to stay on adherence. This thesis investigated medication adherence and system, procedures and products that can assist in facilitating compliance under Empathic Design guideline. Empathic Design process was followed and applied into medical design area. The constant interaction with main users created a bond between the patients and the principal investigator. Based on the previous work of this Project MAD, the role of the portable pillbox has been defined in the existing system. Design criteria was set according to the key needs found. 2 versions of portable pillboxes were designed and 3 concepts were created for patients with different needs. Then an evaluation session and ergonomic testing have been carried out. The favored concept is Concept 3 (Main device + Portable pillbox + Smartphone) and the size of portable pillbox has been determined.
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Introduction

1.1 Problem statement

Patients have difficulty taking medication on time in the correct dosage which is a major cause of treatment failure and illness especially for young patients. A need has existed for a portable solution that could measure adherence to a treatment regimen daily even hourly for outpatient who has pediatric chronic illness and encourage them to stay on adherence. This thesis will investigate medication adherence and system, procedures and products that can assist in facilitating compliance under Empathic Design guideline.

1.2 Medical adherence

It has been long known that patients do not routinely follow the instructions for the use of medication or other aspects of treatment. (Cramer, Mattson, Prevey, Scheyer, & Ouellette, 1989)

Previous studies (Lars Osterberg & Terrence Blaschke, 2005) (Nasseh, Frazee, Visaria, Vlahiotis, & Tian, 2012) have estimated that 30–50% of drug prescriptions are never taken, resulting in significant complications and deterioration of patient health. A 76% discrepancy rate was found between what medicines patients were prescribed, and what medicines they actually took. (Hayes, Hunt, Adami, & Kaye, 2006) This inefficiency of medication adherence now is one of the major causes of illness and of treatment failure in the USA. The extent and impact of the problem are expected to grow as patients live
longer lives, often requiring management of one or more chronic conditions with multiple medications.

Furthermore, clinical trials to assess the safety and efficacy of new drugs necessarily rely on proper medication adherence by study participants to obtain accurate data. (Hafezi et al., 2015) Thus, accurate assessment of medication adherence is important to patients, caregivers, and researchers.

Researchers have constantly found that improved medication adherence is associated with greatly reduced total health care use and costs. They have found that even with increased pharmacy costs, improved medication adherence produces substantial medical savings as a result of reductions in hospitalization and emergency department use. That means that any programs and initiatives to improve medication adherence in chronic disease patients are worth consideration by insurers, government payers, healthcare centers and patients. (Roebuck, Liberman, Gemmill-Toyama, & Brennan, 2011)

Facing such a grim situation, as a designer with social responsibility, we need to do something and make a difference.

1.3 Population: adolescence

Adolescence has been defined by the World Health Organization (WHO) as the period between 10 and 19 years of age. (Viner, 2004) This paper applies to individuals from 11 to 15 years of age.
Adolescence is a large group of population who suffer from illness especially chronic condition. Table 1 shows prevalence of chronic conditions among adolescents according to survey carried out in school populations by self-administered questionnaires. (Viner, 2004)

<table>
<thead>
<tr>
<th>Areas</th>
<th>Age group</th>
<th>Prevalence</th>
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<td>France (1993)</td>
<td>11–19 years</td>
<td>8.3% (F) 9.0% (M)</td>
</tr>
<tr>
<td>British Columbia, Canada (1992)</td>
<td>13–19 years</td>
<td>11.0% (F) 7.0% (M)</td>
</tr>
<tr>
<td>Switzerland (1992)</td>
<td>15–20 years</td>
<td>11.3% (F) 8.3% (M)</td>
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*Table 1: Prevalence of chronic conditions among adolescents according to surveys carried out in school populations by self-administered questionnaires*

Adolescence take responsibility for their medications at different ages. A child with a chronic condition such as asthma usually is able to manage their medication earlier. Generally, the situation of infants and toddlers is very much determined by parents and caregivers. In contrast, older children may take complete responsibility for their own medications. In addition to the many factors that influence adherence in adults, there are some unique challenges faced in the pediatric age group. (Chappell, 2015)

Qualitative research (Woodgate, 1998) shows that adolescents experience extra effort, restriction, pain, and additional worries because of chronic illness. Qualitative research
with young people with a variety of chronic illnesses has also suggested a number of themes for health professionals to address when working with young people: (1) treat me like a person; (2) try to understand; (3) don’t treat me differently; (4) give me some encouragement; (5) don’t force me; (6) give me options; (7) have a sense of humor; and (8) know what you are doing. All these needs reveal the requirement of empathy towards adolescence in every aspect of the treatment process. (Viner, 2004)

1.4 Chronic conditions in adolescence

There are many issues involved in the definition of chronic health conditions, including duration, age of onset, limitation of age-appropriate activity, visibility, expected survival, mobility, physiological functioning, cognition, emotional/social impairment, sensory functioning, communication impairment, clinical course, and uncertainty about the outcome. (Viner, 2004)

In this paper, the principal investigator focused on common chronic conditions happens in adolescence like asthma, diabetes and inflammatory bowel disease since adolescence who have these illnesses usually have to take a large quantity of medicines and that’s one of the major challenges they have to face.

1.5 Medical adherence situation of adolescence

Approximately 30 to 70 percent of patients with chronic illnesses have poor adherence because of extended treatment duration, multiple medications and periods of
symptomatic remission. (Gardiner & Dvorkin, 2006) Nonadherence is widespread (averaging 24.8%) and can occur for many reasons. (DiMatteo, 2004) Non-adherence has been associated with unnecessary medication, toxicity, treatment failure, increased incidence of medical complications and increased morbidity, resulting in poorer quality of life and overuse of the healthcare system. (Chappell, 2015) For instance, one study looking at adherence and pediatric asthma identified an association between decreased medication adherence and readmission for acute exacerbation. (Auger, Kahn, Davis, & Simmons, 2015) Similarly, another study looking at medication adherence among pediatric patients with sickle cell disease showed that non-adherence was associated with more vascular occlusive crises and hospitalizations. (Walsh et al., 2014)

1.6 Health care costs for adolescence and the cost of non-adherence

In 2010, the United States spent $2.6 trillion on health care, an increase of 3.9% from 2009, and 17.9% of its gross domestic product. Although there is no single strategy for effectively controlling costs, researchers have begun to focus on the 83% of health care resources consumed by individuals who have a chronic medical condition. (McGrady & Hommel, 2013)

The number of children and adolescents diagnosed with a chronic medical condition has been steadily increasing over the past 20 years. (McGrady & Hommel, 2013) Increases in the prevalence of chronic medical conditions have only increased the already disproportionate health care expenses accounted for by children and adolescents who
have a chronic illness. In 2009, the estimated economic cost of non-adherence in the U.S.—including wasted drugs, treatment of complications, and hospitalizations—was nearly equal to the total spending on prescription drugs—$289 billion versus $301 billion. (Hafezi et al., 2015) That’s a significant waste of money which was intended to help patients.

Researchers have constantly found that improved medication adherence is associated with greatly reduced total health care use and costs. They have found that even with increased pharmacy costs, improved medication adherence produces substantial medical savings as a result of reductions in hospitalization and emergency department use. That means that any programs and initiatives to improve medication adherence in chronic disease patients are worth consideration by insurers, government payers, healthcare centers and patients. (Roebuck et al., 2011)

1.7 MAD (Medical Device Adherence) project

In summer 2014, Cincinnati Children’s Hospital Medical Center (CCHMC) came to Live Well with this project. PhD. Kevin Hommel, director of Center for Health Technology Research at CCHMC was in charge of this project that required a tool to create adherence for patients. The project was targeted for children between 11 and 18 years old who suffer from chronic conditions and had to be treated with big quantities of pills a day. The other factor that was really important for CCHMC was that the device should have a system to track every drug dose that the patient takes; this information will be highly valued to medical providers and researchers.
A main unit, website for doctor, an application for parents based on the platform of smartphone, and an application for adolescent patients, the main user, have been developed.

The main unit is a medical management center. It is in charge of sorting, storing, dispensing, refilling medicines, recording and managing adherence history. It also would remind the user to take medicine when it is time according to the setting.

![Main device](image)

*Figure 1: Main device*

The main unit is stationary which is designed to be put on the counter, since patients usually take their medicine at home in most cases. On one hand, their dosages normally are supposed to be taken at morning and night when they are at home; on the other hand, they are not allowed to take medicine to school in any form.
However, there is a need for a portable solution when they are not at home, for example, being out for a day, staying at friends’ home for a night or going for a short trip. In situations like those mentioned above, taking the whole unit with them would be inconvenient and unnecessary. So this portable solution is the missing link in this system. This paper is going to address the portable solution.

Methodology

2.1 Empathic design

Empathy is simply about achieving greater awareness, an extended imagination, and sensitivity to another person’s world in a powerfully memorable way. (Fulton Suri, 2003). Empathy serves to inform and to inspire designers to create products that fit the user’s needs. (Kouprie & Visser, 2009)

Consider the situation in this project, a multi-disciplinary design team consisting of marketers, engineers, product designers, interaction designers, etc. The team has received a brief to design a medical adherence product for adolescence who have chronic conditions, but none of them belongs to the user group himself. How does the design team make appropriate design choices for others who are unlike themselves?

The problem of understanding the user and his or her experience has a central place in design history. (Sanders & Dandavate, 1999) The design literature of the past two decades has explored several ways of bringing contextual and affective factors into design. One stands out from those in recent years is empathetic design. By “empathic design”
designers attempt to get closer to the lives and experiences of potential users, in order to increase the likelihood that the product or service designed meets the user’s needs. It is the critical component that deepens the designer’s understanding of users who may be very different from the designer. It allows the designer insight into intangibles such as feelings, emotions, dreams, aspirations, and fears that can provide the designer with critical cues, triggers, and inspiration that provide the foundation for more balanced functional and supra-functional products. (McDonagh et al., 2013)

Simply put, empathic design strategies support designers to “step into the user’s shoes” and “walk the user’s walk” in order to design products that fit the user’s life. (Fulton Suri, 2003)

2.2 Empathic design development

The adjective “empathic” in relation to design was introduced in the late when companies started to realize that only listening to customers’ responses on questionnaires was not enough to develop successful products.

When empathic design first appeared in business literature in the late 1990s, it was described as a cultural shift. Researchers in various disciplines hailed the importance of emotion as not only a valid subject of study, but as one that was crucial to design research. (Battarbee, Fulton Suri, & Gibbs Howard, 2014) Empathic design was presented as a process that involved observation, data collection and analysis, and iterative
prototyping. Most significantly, the discipline was identified as a way to uncover people’s unspoken latent needs and then address them through design. (Leonard & Rayport, 1997) This led to the view that designers should be more sensitive to users, be able to understand them, their situation, and feelings: to be more empathic.


2.3 Empathic Horizon:

The term “empathic horizon” (McDonagh-Philp & Denton, 1999) is used to indicate the limits on a designer’s individual ability to empathize beyond certain characteristics of his or her group, such as nationality, background, age, gender, culture, experience and education.

Besides being a quality of the design process, empathy is described as an ability people have, and differs for individuals. McDonagh defines empathy as ‘the intuitive ability to identify with other people’s thoughts and feelings – their motivations, emotional and
mental models, values, priorities, preferences, and inner conflicts’. When designing a product for elderly people, the designer does not have knowledge about being aged from his own experience. Every individual has his or her own unique experiences and these define his or her empathic horizon. (Kouprie & Visser, 2009)

Next to ability, the willingness of the designer plays a role. “Design empathy requires direct and personal engagement and is dependent on the designer’s willingness” (Battarbee, 2004). One can think of the designer’s personal connection with the user that motivates him (e.g. a special interest into the user group, because it is familiar to him), his emotional state that hinders him (e.g. tired, or a workshop at the end of the day) or his commitment to the project (e.g. how much the designer is responsible for the project). This suggests that the situation determines to a large degree the level of empathy which can be achieved. (Kouprie & Visser, 2009) Employing an empathic design research strategy enables the designer to expand his/her empathic horizon. It provides the designer with more relevant data and creative product outcomes as they apply what they learn and create together with the life-expert-users in the design process.(Denton & McDonagh, 2003)

2.3.1 Empathic horizon of the principal investigator

The principal investigator is a Chinese student designer and has been immersed in industrial design for 7 years. He’s a male and 24 years old now. Under traditional Chinese culture and education, the principal investigator graduated and got his bachelor degree of design in China in 2014 and now the principal investigator is in University of
Cincinnati for his master degree. The principal investigator has participated in two projects in different degree with Children’s hospital before joining this project MAD which were all about pediatric medication decision guide.

The principal investigator wasn’t sickly during his adolescence. However, he had experience of visits to hospital for himself. Besides, both of his grandfather and grandmother were doctors which gave him chance to exposed to medical world when he was a child. What’s more, tragedies happened to his family also arouse his awareness and empathy to all kinds of patients. All of these gradually become his motivation to join in the MAD project and do a research about it. In this project, the principal investigator had chances to interact with several adolescent patients. Experience like that gradually built up his empathy to the patients. Their optimistic mentality towards their condition deeply touched him. As a designer who has the chance to do something for them, the principal investigator has the willingness to make a difference for them.

2.4 The process of empathy in design practice

Kouprie & Visser (2009) proposed a framework that can be applied to design practice. The framework shows a process consisting of four phases. It is based on the principle that a designer “step into the life of the user”, “wanders around for a while” and then “steps out of the life of the user” with a deeper understanding of this user. These phases are (1) discovery, (2) immersion, (3) connection and (4) detachment. This paper followed this framework.
2.4.1 Discovery

Since the willingness of the designer determines to a large degree the level of empathy he or she achieves, the first phase in the framework “discovery” is needed to support the designer’s curiosity and motivation. Generally, gathering inspiration and information about patients and their experiences and contexts. (Kouprie & Visser, 2009)

2.4.1.1 Discovery in process

In summer 2014, Cincinnati Children’s Hospital Medical Center (CCHMC) ranked number three in the country for best children’s hospitals in the US, came to Live Well with a project. PhD. Kevin Hommel, director of Center for Health Technology Research at CCHMC, was in charge of this project that required a tool to create adherence for patients.

Since the beginning the team decided to take an empathic approach to develop this product. Performing research by going through literature reviews (Studies of pediatric chronic illness, researches of Empathic Design) and product benchmarking prepared the team understandings of the patients’ needs and situation and knowledge of empathic design.

2.4.2 Immersion

The second phase “immersion” might be the most important phase in realizing an empathic process. In this phase, the designer takes time to wander around in and be surprised by various aspects of the user’s world. This phase requires time. Without this
phase, the knowledge about the user’s world will not increase. In design practice, this phase is often not given sufficient time. Designers can be reluctant to immerse themselves, as this activity is not directly solution focused, and therefore the activity may not be perceived as relevant beforehand. By explicitly having the task to wander around, to immerse, without making judgments and implementations the designer becomes open-minded and experiences the user’s world for a while. (Kouprie & Visser, 2009)

2.4.2.1 Immersion in process

Conducting interviews with physicians, researchers and pharmacist, as well as in-home and Skype observation and interviews with CCHMC patients, all of this interactions helped the team to develop the require empathy to begin understanding the problem and the situations that a child between 11 to 15 years old could live as a chronic patient and understand the context were these persons are living.

2.4.3 Connection

After having been deeply immersed, the designer can make emotional resonances by including his own experiences. The second and third phases are closely related, but by dividing them into two, we emphasize the explicit phase of bringing in the designer’s own experiences in order to understand what the user feels and what it could mean to the user. (Kouprie & Visser, 2009)

2.4.3.1 Connection in process
In this stage, the team seek potential design directions and solutions and pose “what if” questions. Of course “generating new ideas” and “exploring a design space” are easier said than done. Fortunately, creativity is not magic, especially in user experience design. There are many effective idea generation methods, ranging from brainstorming and mood boards to decks of specialized cards and innovation games.

The team synthesized the information and found opportunity areas by creating scenarios and storyboards. Those scenarios and storyboards helped the team not only explain their findings but also were a powerful tool to translate that empathy to CCHMC leaders.

The team created several concepts in co-creation sessions with patients, using activities like “it will be nice if...like...” where the patient mentions a characteristic for a pill dispenser device and compares that to another object. For example, the team asked “Sorting pills must be... like...”. The answer “Sorting pills must be SIMPLE like BRUSHING TEETH.” Or “Taking pills out of home must be ACCESSIBLE, like A REFRIGERATOR”. This type of activities gave the team the chance to understand better what does adjectives like simple or accessible means and by having a mental image like simple as brushing teeth gave the team so much more information than just asking “how does sorting pills must be?”.

2.4.4 Detachment
In the last phase, the designer becomes the designer again and can use his increased understanding for generating ideas that better fit the user’s world. (Kouprie & Visser, 2009)

2.4.4.1 Detachment in process

With all the knowledge from the steps above, designers could perform design as they usually do. Although the design process was completed by designers alone, in stages like co-creation design session, concepts validation/evaluation and size validation, the team brought in patients again to get their opinions and advices.

2.5 Summary

Discovering and understanding users' needs is core for all kinds of design. All the steps above are about this core. By doing so, designers are closely exposed the situation the users facing and able to think and solve problems from user's standpoint.

One thing was considered key for the development of this project was the constant interaction and validation of ideas with patients during the whole design process. The constant interaction gave the team opportunity to dig out the potential but urgent needs of the patients and kept the team on the right track.

**Interview**

3.1 Population
From the previous interview in this project, it was found that, in general, the younger the patients are, more pills they have to take. When they were young, they were normally in early stage or first diagnosed. They had to take a large amount of pills during that time. So the principal investigator chose adolescence from 11 years-old to 15 years-old as target population.

In this study, the principal investigator interviewed 10 patients, 8 parents and 5 doctors. They were all from Children Hospital. Most of the interviews were face-to-face interviews. Two interviews were completed through Skype. Each interview last around 30 minutes. All interviews were recorded with permission.

See transcripts in appendix.

3.2 Interview Guide

See appendix.

3.3 Findings from interview

3.3.1 Patients

From the interviews, a significant difference between younger and older patients was found. Even though the target population is from 11 to 15 years old, distinct difference can be found among them. The difference may come from how much homework and stress they have to deal with from school according to their answers when they were asked about their routines.
3.3.1.1 Age group: 11-13 years-old

**Habit:** Boys in this age usually spend a lot of time on video games at their casual time. Sometimes they would be so concentrated on gaming that they would totally forget to take their medicines. Part of the reason is they don’t have much stress from school. And few of them do intense exercise like football and basketball because of their conditions. Girls don’t play video games. They have various habits in which there is no specific pattern found, for instance, one mentioned she likes shopping and all the fashion stuff; one mentioned she is in an academic team.

**Treatment:** Most of them have 2 doses per day currently. One is morning dose and one is evening dose. They take the morning dose before they go to school and take the evening dose when they get home or around dinner. One young girl is home school. So she takes all her doses at home. A special situation is mentioned that one boy needs his eye drop every couple hours. So his eye drop should be around. one patient mentioned he took liquid medicine once which was stored in fridge. It was easy to forget to take that medicine because it was stored at different location than the other medicine in the pill box. They all have to pay a visit at hospital every few weeks or every few months depends on their condition.

**Medicine management:** Usually mother is the one who takes care of their medicines. Mom usually refill the 7-day pillbox at the beginning of the week
(Sunday night, in general). Mom read the information/instruction of the medicine on the pill bottle. It is obvious and parents also agreed that whether their children can take their medicine on time largely depends on their parents in this age group.

**Medicine Adherence:** The major reason causes this younger group skipping is simply forgetting. Moms play an important role here to make sure their children taking their medicine either by reminding them when it’s time or checking the pillbox directly.

“The pill is too big”, “Not feeling well”, “Taste bad” are normal reasons mentioned by patients in this age group. They have problems taking medicines especially in their early stage. Several kinds of pills are too big to swallow. They have to be cut which makes them taste even worse. A girl who had this problem had to take her medicine with apple sauce or ice cream. However, an interesting fact is that apple sauce or ice cream can be a trigger for her to remember taking her medicine.

Situation usually get better when taking pills becomes a routine or when patients are getting older. However, treatment/prescription changing from time to time also makes it difficult for some patients. They have to adapt to new treatment every several months.
Usually, they skip once or twice a month during weekdays. But situation during weekend is much worse. Part of the reason is they don’t follow their routine during weekends. Sleeping late is the major reason makes them missing their morning doss. In this situation, some of them would take their dose when they realize, some of them would just skip it until next dose. However, according to doctors’ instruction, whether a patient should take the next dose or double doses if they missed the previous dose, this is considered urgent and patients should call the doctor. Because doses can be combined but each medication is different and acts differently.

**Preference:** Boys like cool and techie things. They hope their pillbox can be a cool digital device. Two of them mentioned in the interview they would like to have a screen on their pillbox. They don’t care much about the size or the dimension of the pillbox as long as it works. Girls like pretty and lovely things. They want their pillbox to be colorful and make it their own style. They think the pillbox should not only be big enough to hold 1 or 2 doses but also can be put in their purse or slip into their pocket.

3.3.1.2 Age group: 14-15 years-old

**Habit:** Both boys and girls are busy with school work in this age group. They have to go to school on time. so usually it is rushing in the morning especially for girls. This becomes the major reason for them skipping medicine. Boys don’t have much time playing games anymore. they spend more time at school and
homework. So it happens less that they forget to take meds because of gaming. Some of them do sports like softball and Ping-Pong. One mentioned he plays football.

**Treatment:** Most of them have 2 doses daily currently. One is morning and one is evening. They take the morning dose before they go to school and take the evening dose when they get home or around dinner. One of them only takes one type of medicine weekly because his condition is stable now. Generally, conditions of this age group are better than the younger one. So they take less medicine, and pay less visits to their doctors.

**Medicine management:** Since they are older, they have the ability to manage medicines by themselves. And their conditions are more stable than the younger’s.

Their treatment don't change all the time. So they can remember when they need to take their medicine without reminder from their parents at most time. They can refill the pillbox by themselves. but it doesn’t necessarily mean parents are not involved. Parents still would check in from time to time. The normal way is asking their children directly “Have you take your meds?” They have more chances to go to a trip or a sleepover. They usually put one or two doses in one or several plastic bags. they only take the whole piece of 7-day pillbox with them if it is a trip longer than 3 or 4 days. the reason is the pillbox is normally big and
fragile. it is not necessary to take it if it is just one day. and the patients are concerned about it may open in their backpack. they wouldn’t like to see pills scattered there.

**Medicine Adherence:** Forgetting is still a major reason for skipping. It may be caused by “busying with school work” or “too tired, just want to go bed”. “I prefer to take medicine at home” happens in this age group. Usually they don't carry their med with them. They don’t have this habit that taking meds outside. It is easy to forget even when they have meds with them. Also, they feel awkward when they take meds in front of people. One girl described her experience that she felt a lot of people staring at her when she was taking meds at a restaurant. She doesn’t like this. They also don’t like their friends seeing them carrying a pillbox. “I had a change in daily routine” is another big issue here. Because they are less relying on moms’ reminder, when there is a slight changing of routines, for instance, they get up late in the morning, they may forget to take their meds.

**Preference:** Needs in this group are more practical. “Big enough to hold pills and small enough to be put into backpack” is mentioned again. Those have the needs to take meds with them want their pillbox to be “Sturdy and closed security”. They would like to customize their pillbox by labeling it or putting stickers on it to make it their own style. In the meantime, they want their pillbox to be camouflage. Privacy is needed by them. they don’t want to be bind with their condition. There are already enough things about medical in their life. Boys don't
mind if the pillbox would be a little bit bigger. And they didn't mention about the appearance. However, girls want it to be fancy and in a right size. “A pillbox doesn’t look like a pillbox” is what they want.

3.3.2 Doctors

3.3.2.1 The way to check medical adherence

Right now, doctors check patients by conducting surveys at patients’ visit. Surveys are completed on tablet (self-report). Doctor will discuss adherence with patients, if necessary. Doctor asks why they aren’t taking medicine they are supposed to take and assesses the needs from there.

In general, they would do following steps:

1. Address underlying reason - the main reason they skip their medicine (The WHY)
2. Prescription - prescription can be adjusted to improve patient’s adherence (drop number of daily dosing down, if possible and necessary)
3. Helping patients understand the “WHY” - typically, the Doctor talks to the patient directly but parents are often in the room and then if necessary, the social worker or psychologist will get involved

3.3.2.2 Preference of receiving adherence reports

Most of doctors believe that a summary before a patient’s visit would be most helpful unless there is something very outside of the normal range. The reason
they stated is they are normally too busy to check every patients’ adherence situation every day even every week. They have to deal lots of patients at the same time and the priority usually is the one who in hospital. However, they still care about the patients and would like to be the first one to know if anything abnormal happens. They suggested a “flagging system” by creating a threshold/parameters for what is normal and alerting mechanism to notify them if it is outside of that range. So they can quickly react to and address important issues.

Back to the reminder before the next visit, doctors believe this system must be embedded in the medical record. All branches of Children’s Hospital use an Electronic Medical Records(EMR) system called Epic. Doctors can access to all the information about each patient in this system. They think if this adherence monitoring system can be embedded in Epic would be best and convenient for them, otherwise they think they wouldn’t use it since they are already on Epic and using two different systems or changing to a new system would be too complicated and inconvenient for them.

3.3.2.3 Feedback and follow-up to patients

Feedback would be given based on the need/issues at visits. According to the doctors, patients in Children’s Hospital can use an application on smartphone called MyChart as a way to access to their Electronic Medical Records(EMR). As the same situation for doctors as mentioned above, patients have already been
using this application for years. Developing a separate new application for patients or using another different platform would be inconvenient for them. The ideal way still would be that information given to patients through MyChart. Then doctors do a follow-up phone call if necessary. The follow-up would be more of a question – “what’s going on?”, “Why are you not taking your meds?”.

Doctors also suggested a way which can satisfy patient’s need and reduce their workload in the meantime: If patient has been consistently taking medication for a period of days and there is no big issue happened, the system (MyChart, or any other EMR application patients use) would send an automated message to patient regarding their adherence.

An emergent example: if a patient missed the previous dosage, he is not sure whether he should take the next dose as scheduled or double doses. This situation is considered urgent by doctors. Patients should call their doctor at once because doses can be combined but each medication is different and acts differently.

So the ideal process would be:

1. Patient realizes he missed last dosage;
2. He is not sure whether he should take the next dose as scheduled or double doses;
3. He sends an emergency request through MyChart asking what he should do;
4. Doctors receive this emergency question and give quick feedback to the patient;
5. Patient follows the instruction.

Or, if there is program or cloud service which has all the database about medicines and programed well, the process can be:
1. Patient realizes he missed last dosage;
2. He is not sure whether he should take the next dose as scheduled or double doses;
3. He opens MyChart and presses the button called “missed my dose”;
4. The program would analyze the pills combination and calculate the amount of medicine and give instruction to patient;
5. Patient follows the instruction;
6. The program logs this incident and sends the log to doctors;
7. Doctors receive this log and give additional instructions if necessary.

3.3.3 Parents

3.3.3.1 The way to check medical adherence

The current ways parents using are either asking their kids directly or directly check their pillbox. The reason is they don’t have other means to track their kids’ medical adherence at hands. And in most of the families, mom is the one who doing the job of filling pillbox up. So the easiest way for parents is to check the pillbox to see whether their kid has taken their medicine.
However, both ways can’t provide enough information about the medical adherence. They all rely on the honesty of their kids. Asking them directly and checking pillbox only show the fact that whether they have taken the medicine. There is no details about when they took their medicine or whether they took the right doss. Also, there is a chance that children would lie to their parents to avoid being blamed or punished.

The efficiency of these ways also depends on how often parents ask their kids, or check the pillbox. If a child needs to be remind every time when he should take his medicine (It happens at weekends or when children are focusing on doing something), whether they can take their meds on time totally depends on their parents. However, parents are also not reliable all the time. They can be busy or forget. In this case, their kids will miss their dosage unfortunately.

3.3.3.2 The way to encourage patients staying adherent
The reaction parents will do depends on how well their child is doing. If their children are old enough to manage themselves or they are doing ok, parents will take simple methods like just asking and telling them “make sure get your meds”.

If the children are not doing well as they always forget, their parents will remind them in different ways, for example, telling them to take their medicine when they should (no games unless he takes his pills), or put their medicine where they can see (next to his toothbrush) so they would remember to take it when they see it.
If the children have difficulty taking their medication, parents usually tell them the importance of taking medicine. Other means are applied like cutting the pill in half (too big to swallow) or taking medication with apple sauce or ice cream (bad taste).

3.3.3.3 Preference of receiving adherence reports
Most of the parents would like to receive the reports daily, no matter their kids are doing well or not. Even though they trust their kids can take medicine on time, they would like to check the report every day. However, in some cases, kids only take their meds once a week, so their parents prefer to receive the report weekly.

Some parents mentioned that, when kids were first diagnosed, they had to take a large amount of medicine which was very difficult for them. But situation would be much better when child get used to. What’s more, when their condition gets better, patients don’t have to take so much medicine, parents would feel less stress.

3.3.3.4 Feedback to patients
With this information, most of parents choose talking to their children about their medical adherence either by phone or face to face. Most of them see this a backup plan to remind their child taking meds on time. They want to make sure their kids taking meds timely. That’s the reason they would like to receive the reports daily, or even every dosage when kids are not doing well.

3.3.3.5 Feedback from doctors
This is another issue depends on patients’ situation. If patients are getting better or stable, parents don’t expect this kind of feedback happens frequently. Because they understand doctors are taking care of a lot of patients and usually busy. Also it is unnecessary to have feedback if everything is fine. In this situation, they would like to get feedback from doctors every 6 month or every year (at their visits).

But if patients are not doing ok, their condition are getting worse, or they have problem with taking medicine, parents hope they can get feedback from doctors timely. They would like to know anything abnormal.

3.4 Summary
3.4.1 Patients

- Simply forget is the main reason they skip their medicine;
- Routine changes affect a lot (weekdays vs. weekends);
- Patients with different genders have different preference about portable pillbox;
- “A medical thing (the portable pillbox) is not necessary looks like a medical thing”;
- Performance of younger patients depends on their parents a lot, and usually they need to take more pills than older ones;
- Most of the patients don’t do pill sorting/refilling, moms do.
- The pillbox in their mind should be small enough to be put in backpack/pocket and big enough to contain pills for at least one day;
- Portable pillbox should be sturdy and close securely; right now, a plastic bag is their first choice;
- Privacy matters;
- New treatment adaption

3.4.2 Doctors

- Adherence report is welcome but too frequent would be useless;
- Doctors prefer a “flagging system” by creating a threshold/parameters for what is normal and alerting mechanism to notify them if it is outside of that range;
- Notify them if anything abnormal/emergent happens, so they can provide quick feedback to patients;
- All information/communication should be done through their existing internal software(Epic) instead of using another software/platform.

3.4.3 Parents

- Asking kids and checking pillbox are the only ways they have to check medical adherence, but both of them are not reliable;
- Parents, especially mother, is in charge of refilling-sorting pills;
- Adherence report is welcome and a daily report would satisfy most families;
- Parents want to have quick feedback from doctors if anything abnormal/emergent happens.
Design process

Based on the findings from previous researches and interviews, designing started. First step, the role of the portable pillbox in the existing system was defined. The purpose was to answer the questions below and the needs from interviews above to figure out what the portable pillbox should do and could do. Then a concept map has been done. (4.1)

1. How does the portable pillbox fit into the system?
2. What features should the portable pillbox have to meet patient’s needs?
3. How does the portable pillbox work?
4. Is there any potential opportunity to improve medical adherence by this connected system?
5. What’s the difficulty there to realize the concept?

In this concept map and the original concept from the project, there is an application based on smartphone for patients. So smartphone is considered and included in the system which is supposed to be an important entry for several important features about Medical Adherence. From the observation and interviews conducted in last session, a fact was noticed that smartphones were widely used even for young patients in this age group. Every patient participated in the interview has a smartphone which verified the concept feasible. However, the samples in this study is small because of time and resource limitation, even everyone has a smartphone doesn’t speak of the truth necessarily. Facts must be considered that there are patients don’t have a smartphone (too young to use, or financially affordability), or patients don’t like the idea that their portable pillbox can connect to their phone. For them, another concept is needed in which
smartphone is unnecessary but it still fulfill the original objective to improve medical adherence. So 3 different composition concepts were created. (4.2)

Then two types of physical portable pillbox were designed. Dimension of adolescence’ hands was considered. (See Appendix.) Five sizes of rough prototypes were 3D-printed for ergonomic testing.

To verify and get feedback from users about the concepts, an evaluation session has been conducted. A poster of concepts comparison has been made for presentation. (See Appendix.)

4.1 Concept development

Needs of patients, doctors and parents found from interviews were analyzed and organized. An ideation session about how to solve the problem/needs was carried out and a concept map was done. However, some of the features mentioned in the concept map were already included in the existing system, like reminders from smartphone/main device and reward system, even they were not completely the same thing. Some of the features were too big and beyond the scope of this thesis, like the Adaption System. Although it was considered a good feature from the feedback of patients and caregivers, it was given up. Then a feature concept has been determined in which all the features retained was detailed.
Figure 2: Summary of patient’s needs
Figure 3: Summary of patient’s needs

<table>
<thead>
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<th>problems</th>
<th>needs</th>
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<td>asking kids and checking pillbox are</td>
<td>a reliable way to check adherence</td>
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<td>the only ways they have to check</td>
<td>a back-up mechanism to make sure patient</td>
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<td>medical adherence, but both of them are not</td>
<td>take meds on time</td>
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<td>reliable</td>
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<td>parents, especially mother, is in</td>
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<td>emergency special situation</td>
<td>a way to get</td>
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<td></td>
<td>quick feedback from doctors</td>
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</table>
Figure 4: Summary of doctor’s needs
Figure 5: Detailed feature concept map (see large version in appendix)

Figure 6: Detailed feature concept (see large version in appendix)
4.2 Portable pillbox design

See appendix.

4.3 Pill organizing concepts

4.3.1 Composition

Figure 7: Composition

Concept 1 consists of a generic pillbox and a mechanical portable pillbox.

Concept 2 consists of a generic pillbox, an electronic portable pillbox and a smartphone.

Concept 3 consists of a main unit (developed by this project before), an electronic portable pillbox and a smartphone.

4.3.2 Sorting/storing/refilling

Figure 8: Sorting & storing & refilling

In Concept 1 and 2, users have to do sorting and refilling by themselves. In general, the process would be:
1. take pills out of the original pill bottle from pharmacy
2. sort pills for 7 days
3. put each dosage into generic pillbox

In most families, mother is the one who in charge of doing sorting and refilling. According to the interview, sorting/refilling is considered risky by parents. So parents initiativey undertake this job in order to avoid the occurrence of errors. Because of the limited capacity of the generic pillbox, only pills for 7 days can be stored (14 dosages) which means users have to do sorting every 7 days.

In Concept 3, the main device has features of sorting, storing and dispensing. With this device, the process would be:

1. scan the bar code on the original pill bottle from pharmacy
2. pour all the pills into the assigned column

There is a camera on the top of the side screen which can read the bar code and recognize the type of medicine. What users have to do is pouring pills into this device. It will dispense certain amount of pills according to the setting. So sorting pill becomes easier and safer. Hopefully, patients themselves can do sorting with this device as learning is part of the process of improving medical adherence.

4.3.3 Setting alarms
In Concept 1, users can set reminders by the portable pillbox. The front side of the pillbox is a watch face. And there are two circles respectively in white and black outside the watch face which correspondingly stands for morning alarm and evening alarm. In each circle, there is an indicator. Sliding the indicator to a specific number of time to set alarm. There are only two alarms can be set at the same time. If schedule of taking medicine doesn’t change, users don’t have to reset it every day.

In Concept 2, the electronic portable pillbox can talk to users’ smartphone through Bluetooth. Alarms can be set in the application on user’s phone. Multiple alarms can be set at the same time. Users can set different alarms for each day to fit their personal schedule. For instance, one patient is supposed to take medicine at 9:30 AM every day. But one day he has a flight to catch. So this patient can advance or postpone this dosage to fit his schedule on that day. Settings for the other days won’t be affected. All the setting will be saved at Cloud(server) and shared with caregivers (Parents and doctors).
In Concept 3, users set alarms in the same way as Concept 2. Besides, users can set alarms on the touchscreen of the main device. The process and working principle are identical as the application on the phone. Settings will be stored at Cloud(server) and synchronized to all the devices of users and caregivers.

4.3.4 Reminders

For Concept 1, users will receive reminder from their portable pillbox. Since it is designed to be affordable and low-tech, sound reminder would be the best choice both efficiently and economically.

For Concept 2, users can get reminders from portable pillbox or smartphone, or both of them, depends on their preference. Reminders can be set in three ways, sound, vibration and light. Smartphone has sound and vibration as it usually does. Users can customize the way of reminder to fit their needs.

For Concept 3, besides the ways mentioned in Concept 2, the main device could provide sound reminders as well.
4.3.5 Dispensing

Dispensing in Concept 1&2 are similar. The process would be:

1. Get a certain dosage(s) out of the general pillbox;
2. (A): If this dosage is for now, patient takes it;
   (B): If this dosage is for later and the patient is going out, patient puts pills into the portable pillbox and takes the portable pillbox with him.

Dispensing in Concept 3 is slight different, the process would be:

1. Press the cap of a certain column on the main device according to the instruction on the screen;
2. Pills will be dispensed and delivered to the patients by the main device;
3. (A): If this dosage is for now, patient takes it;
   (B): If this dosage is for later and the patient is going out, patient puts pills into the portable pillbox and takes the portable pillbox with him.

4.3.6 Medical Adherence Management
There is no Adherence Management for Concept 1. Only Concept 2&3 have this feature. It is hard to realize this function for Concept 1 to have the same experience with Concept 2&3 when affordability is considered.

With Adherence Management, all the history of medical adherence will be logged automatically and stored on Cloud(server) which includes but not limited to whether users have taken medication; the actually time they took medicine; the number and type of medicine for that specific dosage; patient’s emotion and feedback for that day. All of the caregivers have access to this history through their own clients (Doctor: website on PC, Parent: application on smartphone) with patient’s permission.

4.3.7 Cloud service
Cloud service has been mentioned several times in paragraphs above which is for Concept 2&3. This feature is about to share information among different platforms. But each stakeholder has their own platform with different function to best meet their needs.

Doctors have a web-based client. They can access to Medical Adherence information of patients. It would be a more reliable and detailed way to get authentic adherence information compared to tests on tablets. Based on this information, doctors can overview patient’s condition before visits or adjust prescription according to patient’s condition and behavior/performance. Also, doctors are able to receive patients’ emergency questions and give them quick feedback through this client. What’s more, from the perspective of Big Data, medical adherence information is valuable for medical research.

Parents have an application on smartphone. They have access to:

1. Adherence history about patient;
2. Schedule of dosages on calendar;
3. Getting reminders for each dosage;
4. Getting adherence report every day (frequency is customizable);
5. Medicine reserves and refilling notification;
6. Details about every medicine on prescription;
7. Emergency report to doctors;
8. Reservation with doctors.

Patients have an application on smartphone. They can do:
1. Setting reminders;
2. Pairing with portable pillbox and sending settings to it;
3. Adherence history management;
4. Schedule of dosages on calendar;
5. Getting reminders for each dosage;
6. Feedback about their emotion and feeling;
7. Details about every medicine on prescription;
8. Emergency report to doctors.

With the main device, patients and parents can do:

1. Refilling;
2. Sorting;
3. Setting reminders;
4. Adherence history management;
5. Schedule of dosages on calendar;
6. Getting reminders for each dosage;
7. Details about every medicine on prescription;
8. Getting reminders for each dosage;
9. Reservation with doctors.

4.3.8 Accessory
Figure 14: Accessory

This is a feature available for the electronic portable pillbox in Concept 2&3. Several examples of cases and stickers have been designed for young patients which comes from popular cartoon characters. With them, patients can decorate their portable pillbox according to their preference and make it their own style. By doing so, their portable pillbox can be more personal and interesting to the themselves. In the meantime, making this medical thing doesn’t look like a medical thing meets the need of camouflage. To an extent, if people can’t recognize it as a pillbox, it has protected user’s privacy.

4.4 Design evaluation

To figure out which concept meet needs of target users better and perform an ergonomic assessment, an evaluation session has been conducted. Five patients (Age from 11 – 15 years-old) have been invited to participate in this evaluation.

First, patients were introduced the background and progress of the MAD project. Then they were presented the three concepts. After that, there was a short Q&A session aiming to make sure the patients understand and identify the difference among the three concepts. Then patients were asked to pick one concept which works best for them in
their mind. Several following questions were asked to figure out the reason of their decision.

The second part was ergonomic assessment for the size of the portable pillbox. Five prototype of portable pillboxes in different sizes have been 3D-printed. Patients were asked to touch, feel and grab the prototypes and put them into their pockets or bags. Then they were asked to choose one works best for them. Several following questions has been asked to figure out the reason of their decision.
4.5 Evaluation results

Figure 15: Concept evaluation results

<table>
<thead>
<tr>
<th>Concept</th>
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<th>Concept 3</th>
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Figure 16: Size evaluation results

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<tr>
<td></td>
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<td>E</td>
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4.6 Analyze

4.6.1 Concepts

2 of 5 patients voted for Concept 1. One of them didn’t have a smartphone which was his primary motivation to choose Concept 1. When he was asked what if he had a smartphone, Concept 2 became his choice. His mother chose Concept 3 as she was fond of the dispensing/sorting feature. The other one who chose Concept 1 actually had a smartphone. He explained that all he wanted was a pillbox with a reminder function which could notify him to take medicine when he should. So Concept 1 was enough for him. However, his mother didn’t agree with him and chose Concept 3. She explained that he missed a lot of dosages in the past and she thought the features of pill sorting/dispensing and reminders from multiple platform would make a difference.

Only one patient chose Concept 2. The reason she stated was that she liked the idea that the portable pillbox could connect to her phone and remind her as programmed. She also loved the medical adherence management feature which could help her log the emotion and reaction after she took medication. She believed it matters as she had an experience that she felt bad after she took her medication. So she explained that logging the emotion and feeling after taking medication and sending them to doctors would make it possible that she could get help from doctors if there’s anything wrong. Her mother agreed with her and chose Concept 2 as well.

The other two patients selected Concept 3. On one hand, they were all fond of the sorting/dispensing feature. Compared to the others, they all had an experience taking a
large amount of pills every day either currently or in the past. Sorting pills was considered a time-consuming and highly important even risky activity by them. And most of the patients were using generic pillbox which only could contain pills for 7 days. This means users have to do sorting every week. However, the main device in Concept 3 has large capacity for one month which could save their time and efforts to a certain extent. On the other hand, they believed that the electronic portable pillbox is better than the one in Concept 1. They estimated that the portable pillbox can hold pills for 2 days even though they were informed it was designed for 2 dosages. With the Cloud function (Users are able to set multiple alarms on their mobile phone or main device, and the settings will be synchronized for patients and caregivers), they can customize the way to use it depends on their situation and needs.

4.6.2 Sizes

Patients were asked in which size portable pillbox would work best for them. They were supposed to pick one from five. However, answers given by patients and parents were ambiguous. Most of them pick more than one size, like “I prefer size B, or size C”. They were asked to think back when they had to take large quantity of pills every day. But currently, they all took less pills than before. This might be the reason they had more than one answer. They considered situations of both past and current and picked a bigger one for past and a smaller one for now. One said “It depends on the pills I have to take. Size B is perfect for me now, but it is not big enough for the days in the past.”. In this situation, when they have answers more than one, the principal investigator asked them to rank their options to help him understand which one fit them better in general, like first
choice and second choice. From the result, Size C is clearly the winner. It has most votes as first choice and most votes in total.

4.6.3 Summary

The fact that Concept 1 has the same votes as Concept 2 is beyond expectation. Although Concept 1 was done to cover patients who don’t have a smartphone, the needs may larger than the principal investigator thought as patients choose this concept not only for this reason. Concept 1 deserves more attention in next steps.

Concept 3 has most votes for its most comprehensive features. Sorting/dispensing feature of the main device is welcomed by parents especially as they are the ones who are most familiar with those processes and understand the benefits. Adherence Management and reminder system empowered by the Cloud service are favored by patients and parents which would totally change the traditional way of adherence managing. And the portable pillbox got more attention from patients as they are the most immediate beneficiaries.

Conclusions

5.1 Benefits

Adolescent patients have difficulty taking medication on time in the correct dosage which is a major cause of treatment failure and illness. Project MAD (Medical Adherence Device), for encouraging adolescent outpatient who has pediatric chronic illness to stay on adherence, initiated by Cincinnati Children’s Hospital Medical Center (CCHMC) and Live Well, has been
conducted for years. A portable solution that could measure adherence and fit in to the system was planned but hadn’t been done.

Based on the previous work of this project, the principal investigator designed 2 versions of portable pillbox and created 3 concepts with them for patients with different needs. Empathic Design process was followed and modified to be applied into Medical Design area and this specific project which turned out very helpful.

Empathic design bridges the gap between the designers and end user and allows designers to put themselves in the end user’s shoes, which helps for better understanding of consumer needs. As a graduate design student without much medical experience and from a different culture, the principal investigator was far away from the adolescent patients who have pediatric chronic illness. It was difficult for him to understand what they want. However, Empathic design process created a bond between the patients and the principal investigator. The principal investigator felt more and more motivated and could think as they think with the process going. For instance, during the process, the principal investigator tried to experience what the patients experienced. He took a plastic bag of candy with him as the patients did and set alarms on his mobile phone to remind him of taking them at certain time to simulate what patients did. Although it was not a part of the design process, it was motivated by the willingness and gave the principal investigator experience which couldn’t be described by words. It was an alternative way for the “Immersion” stage since the special nature of the situation that medicine adherence was issue with wide time dimension. Privacy was a concern. However, real needs have been revealed during the constant interaction with the patients which was key for this project.
An evaluation session has been done. The favored concept is Concept 3 (Main device + Portable pillbox + Smartphone) and the size of portable pillbox has been determined. The feedback of patients from evaluation supports the hypothesis that a portable solution is needed and has the potential to improve medicine adherence of adolescent patients. Concepts welcomed by the patients and parents verified the products and the system meaningful.

It is believed that, with the system of Medical Adherence Device, adolescent patients with pediatric chronic illness can improve their medical adherence.

5.2 Next steps
Limited by time and resources, only 5 families participated in the evaluation. The result of evaluation cannot be used for quantitative analysis. In next steps, more patients and parents should be recruited for evaluation to get more objective results and opinions.

More important, functional prototype should be done and sent to users for long-term functionality test. Follow-up observation and surveys should be done with adolescent patients to prove whether Medical Adherence Device could improve adherence and how much it can improve. Also, from the testing in real situation, potential defects can be discovered and help the next round of design.
References


Appendices

1. Interview guide
   i) Interview guide for patients
      • Please tell us a little bit about yourself?
      • What’s your treatment about? (time, dosage, anything special) Explain your daily treatment for me.
      • Please describe your routine when taking your pills away from home for example at School. (How to prepare/organize, where do you keep them, how many do you take etc.) How does this change if you are going somewhere besides school such as a sleep over?
      • How does this change if you are going on a trip?
      • What do you keep your pills in? And where do you store them when you are out (or in school)? Why?
      • What might cause you to skip your meds during the day? How often?
      • Can you distinguish all the pills in your pillbox? Have you ever take wrong dosage because of your mistaken about the pill types?
      • In an ideal world how would a pill box work best for you?
      • What images or objects would help you to remember to take your pills?
      • If one of your belongings are going to have a reminder function, which do you think it would be? For taking pills? If something you own (something you wear/use on your daily basis) could alert you to take pills, what would it be?
      • Do you prefer storing your pills by types (one type of pills in one section) or by potions (all pills for one potion in one section)?
      • What pill bottle information is most useful? When is it most useful? How often do you refer to it?
      • Please pick 6 cards from here, which are the reasons that cause you to skip your medications. Then please rate them.
         o Simply forgot to bring my medication;
         o I was busy with schoolwork;
         o I was doing sports;
         o I couldn't find my pills;
         o I prefer to take medicine at home;
o I had a change in daily routine;
o I forgot the instruction of taking my medicine;
o I don’t like the feeling of taking medicine in school;
o There are too many pills;
o I feel the medicine doesn’t help my condition.
o I don’t like people see me taking medications;
o Others.

ii) Interview guide for parents

- What's your current way to check your kid's medical adherence?

- How do you encourage your kid to stay adherent? How often?

- How often would you like to receive adherence reports? hourly? daily? weekly? or you prefer you check them by yourself?

- Besides medicine taking, what helpful information would you like to see in the report?

- In which way would you like to receive the reports? notification from mobile phone? email? Or others?

- What would you do with this information?

- What's the best way to give feedback to your kid for his/her adherence report? What's the feedback about? (what feedback would you give them?) How often would you give them feedback?

- How often do you expect doctors could give feedback about your kid's medical adherence report? In which way?

iii) Interview guide for physicians

- Do you ask about adherence now?

- How do doctors address adherence?

- Would you like to receive adherence reports?

- How does follow-up communication occur now?

- Can a patient take the next dose or double doses if they missed the previous dose?
2. Transcripts
   i) Patient A

   Investigator (I): So you’re taking at least 5 vitamins, right?
   Mom (M): yes.
   I: Ok, cool. So for those medication, is there current way to check your kid’s medication adherence?
   M: Well, I just asking him. And hope he tells me the truth about taking them. So he takes xxx, and he takes multi vitamin. Daily for those 2. And he takes vitamin D weekly.
   I: for past, is there a way to check your kid’s medication adherence?
   M: Well, when he was first diagnosed, we had a pill, like a weekly pill, cut a thing, we put them there. Or sometimes, it just, you know, 3 times a day. So certain times a day. We just use a standard pillbox, pill basket, to keep him up.
   I: How do you encourage your kid to stay adherent?
   M: Now he puts it on bathroom next to his toothbrush. That seems to be the best way. Because he gets up, goes to the bathroom. It’s morning routine. So that works better. Before, we kept it on microwave oven. So when we are in the kitchen, you would think that it a trigger. But it was not a trigger.
   I: Would you like to see and how often would you like to receive adherence reports?
   M: Yes. Especially if he had a large amount to take, more than just, if he had something to be taken several time a day. I think it would be very helpful. Especially to know for sure he is taking. I want to see it daily.
   I: How would you like to receive this information?
   M: Text would it be.
   I: And if you get that information, what would you do with it?
   M: well, it would be a good way to know he is taking his medication. It would be open discussion to make sure he’s taking his medicine timely.
   I: OK, that’s great. So you said you would use it to open discussion between two of you, do you think it will help increase his adherence. And with that feedback, how often do you think you would have that dialogue?
   M: Probably daily. Especially when he wasn’t taking it.
   I: Sure. How often do you expect or want doctors to give feedback?
   M: I would say biweekly.
   H: Would you like they fellow up and give feedback?
   M: Yes, kind through the “My Chart” thing would be a good feedback.

   I: Tell us about yourself.
   I: Are you getting your license soon?
   P: Soon. They do 15 and half.
   I: Mom has already told us you taking two pills once a day. And then in the past, you were taking a lot more medication, right? Can you tell us what is it used to be like?
   P: Hard.
   I: What made it so hard?
P: Just remembering all.
I: What do you think make it hard to remember, what was the typically reason to forget?
P: Just forget,
I: So you just be busy with things, and not have the pill with you, or leaving them in another place, or something else?
P: Just don’t remember.
I: Okay. So what was your routine like? Morning, afternoon, and night.
P: Morning and night, twice a day.
M: No, you have three. You had afternoon, after school. You probably don’t remember that all. That was right after diagnosed.
I: Is there a time you go away for a night, and you are taking your medication with you?
P: Yes.
I: So what did you do with your pills? How did you take them with you?
P: I usually put them on a plastic bag.
I: In that case, did you do one bag for morning and one bag for evening or just in one bag?
P: I usually stay there for morning, a little bit afternoon, so I only use one bag.
I: So did you ever have instance where you would be longer than maybe meeting one or two doss?
P: Yes.
I: What did you do with those cases?
P: Take it a little bit larger. (Mom: One bag for morning and after, if stay longer, he would just skip next doss.)
I: What if you are on a trip?
P: A box, prefill it and go.
I: Did you take it in school ever?
P: No.
I: How often do you skip medication?
P: Probably twice a week.
I: Is there one doss do you think you skip more than the other?
P: All three.
I: Is there a particular reason you find it hard?
P: I guess it just because the pill was larger.
I: Can you distinguish all the pills in your pillbox?
P: Yes.
I: would you know them by names?
P: Probably not.
I: Would you know like, I take these 3 in the morning and take these 3 at night?
P: Yes.
I: Do you think you ever take a wrong pill at wrong time?
P: No.
I: In an ideal world, how would a pill box work best for you?
P: Probably just have morning and afternoon sections.
I: So morning and afternoon, or morning and night, or all three?
P: All three.
I: Would you like it to be labeled like that? (Showing the sample) Do you want it labeled or you want label them by yourself?
P: Pre labeled.
I: Ok. Will this fit your doses?
P: Yes.
M: I think if it is back to the very beginning, which he probably doesn’t remember, but… I don’t think that would fit. Now, the things he is taking now would be ok. I think it is for normal person’s dosage. But if it is for who at the beginning, I think it would be the whole piece. Just because the pills are much larger and weird shaped. I don’t think this can hold it off.
I: We kind of thought the same thing. This is just the first round. Do you like to store pill by dose or by type?
P: All by morning and noon.
P: I think it is the perfect size. And I like the shape.
I: If you would pull it out, if it is ok your friend was there?
P: Yes.
I: What would trigger your memory to take medication? A girl told us apple sauce.
M: Probably a devil or something.
P: Anything with hospital. Maybe fountain and water.
I: If something you own could alert you to take pills, what would it be?
P: Maybe just the phone and text.
I: Do you want the app on the phone?
P: Yes.
I: What pill bottle information is most useful? Why is it most useful?
P: Just the name. I don’t know what else on the bottle.
M: Well, because he only takes the 2, it’s just for normal for him to know the big white… I always look at the name and amount. Like how many in there. And how much he supposed to have. How many time a day. So I look it all to make sure to get prescription. Something like that.
I: How often do you think you refer to that?
M: I look it every time like a new one. But I don’t look after refill.

I: Forget to bring medication with you?
P: Yes.
I: Was busy with school?
P: No.
I: I was doing sports?
P: No.
I: I couldn’t find my pills?
P: No.
I: I prefer to take medication at home?
P: I guess so.
I: I had a change in daily routine.
P: Yes.
I: I forget the instruction of taking my medication.
P: No.
I: I don’t like the feeling of taking medication at school.
P: No.
I: There are too many pills.
P: No.
I: I feel the mediation doesn’t help me.
P: No.
I: I don’t like people see me taking medications?
P: No.
I: Main reason?
P: Probably just out of daily routine.

ii) Patient B
Investigator(I): Is there a current way to check your kid’s medication adherence?
Mom(M): We just have those little plastic boxes, you know. Monday through Friday.
Or Sunday through Saturday. Every day before leaving to school, I make sure every boxes given to her.
I: am/pm?
M: am, mid-morning, there are four or five I think.
I: you fill it on every Sunday?
M: Now we doing it every couple days, cause like, I fill them up today, because it’s been changing her medicines.
I: Whenever you go somewhere, you take it with you, or you just keep it home?
Patient(P): Keep it in the hotel.
I: How do you encourage your kid to stay adherent?
M: Some pills, you have to encourage her.
I: What does it usually look like? What’s your way to encourage her?
M: We tell her take it for her new lever to keep it healthy. Some of the pills are big.
So we’ve been cutting them. And I think, because we cut them, they taste worse.
She’s always pretty good about medicine. I mean just past couple weeks. She has been taking meds since she’s a baby. It never been an issue for her.
I: Would you like to see and how often would you like to receive adherence reports?
M: She was on medicine daily. And we always take morning, and then evening meds, and we usually 12 hours a parts. I guess it’s just a little reminder every day to make sure we’ve taken them.
I: How would you like to receive this information? Do you have smartphones?
M: Yes, probably the best way would be text. I have to check my phone more often. Until a month ago, I never keep my phones on… probably text.
I: And you had that information, how would like to use it?
M: At least I would know, especially I wasn’t with her, you know, to reminder her to take her medicine.
I: How often do you expect or want doctors to give feedback?
M: It really wouldn’t matter if they really follow her or not. It’s best work for them. But if she wasn’t take her medicine, I think it would be good for them to let us know.
I: Tell us about yourself.
P: I'm almost 12. I'm sassy. I like shopping, I love pretty things.
I: Do you have any siblings?
P: Yes, younger, 2 and a half years. She's annoying. I call her sexy old.
I: What grade are you in?
P: I'm in 6 grade.
I: You like school?
P: Sort of...
I: What's your treatment like? Anything special?
P: In the past, I just like have xxx and xxx, and a lot of pills. Morning and after dinner. 5 in the morning, and 2 at night. Now morning, night and evening, it's like 30...
I: Do you take the whole box with you when you spend a night a friend's home?
P: No, we did have a pillbox before. So I memorized and take them in a plastic baggie. And for the morning and night. I just put them in my bag. I would put every doss into different bags. But if it is long trip or vacation, I will take the whole bottle with me. Just in case.
I: When you do skip the meds, what is the reason for that?
P: Sleeping late, rushing, it just depends when I get up, I took it.
I: How often do you skip medication?
P: Never missed, some are just late. Just scary... You can't risk it.
I: Can you distinguish all the pills in your pillbox?
P: I know the difference, but don't know the name.
I: Do you think you ever take a wrong pill at wrong time?
P: No.
I: In an ideal world, how would a pillbox works best for you?
P: Sparkly, colorful, have my name on it, it would have Starbucks...
I: What about how it works?
P: It need be bigger (than the sample). Maybe a little tight.
I: If it could fit your pills for one night, would be comfortable taking that giving your friends saw you, wouldn't feel comfortable?
P: Yes, that would be good.
M: Right now would be a little small, down the road would be perfect.
P: I would like to have them labeled am or pm. Maybe pretty on the inside. I would like to show my friends how cool it is.
I: If something you own could alert you to take pills, what would it be?
I: What would trigger your memory to take medicine?
P: I don't know. All sort of things. Drinks.
M: She takes meds with sweet tea.
I: Doss or type?
P: Doss, a lot easier.
I: What pill bottle information is most useful? What is it most useful?
P: Milligrams, I like to look at my name on it.
M: Doss, time of the day.
I: How often.
P: The first time we get it.
M: Maybe the first few days we get it and then we kind of know.

I: Forget to bring medication with you?
P: Yes.
I: Was busy with school?
P: No.
I: I was doing sports?
P: No.
I: I couldn’t find my pills?
P: No.
I: I prefer to take medication at home?
P: Maybe.
I: I had a change in daily routine.
P: No.
I: I forget the instruction of taking my medication.
P: No.
I: I don’t like the feeling of taking medication at school.
P: No.
I: There are too many pills.
P: No.
I: I feel the medication doesn’t help me.
P: No.
I: I don’t like people see me taking medications.
P: Sometimes is true.
I: Sometimes is restaurant, don’t stare at me… maybe…
P: Anything else?
M: Oversleep, late on the bed.

iii) Patient C
Investigator(I): What’s your current way to check your kid’s medication adherence?
Mom(M): We use a pillbox. Monday through Sunday, day and night.
I: How do you encourage him to stay adherent?
M: I just tell him. Like make sure you get your meds. And he’s pretty good about it.
I: How often do you have to remind him every day?
M: Maybe once or twice. I think he is pretty routine to it because he is doing this so long.
I: How many pills each time?
M: 3 in the morning, and 2 at night. Plus, he takes xxx morning and night.
I: Ok. If you could, how would you like to receive report? How often?
M: By text. I want it daily. Or each time he took.
I: Each time he accesses to his bottle?
M: Yes.
I: OK. Besides medication adherence, what helpful information would you like to see in the report?
M: You mean just at home or in the school too?
I: Anywhere if you could track.
M: How is he feeling, because I always don’t know.
I: Anything else?
M: No…
I: If you get these reports, in which way would you like to give him feedback?
M: Just talk to him about it. Because he doesn’t have a phone or anything. But when he got a phone, when he’s older, we can communicate by phone.
I: How often would you like to get feedback from doctors?
M: I mean just at the visits, but if it becomes a problem to whether you take it, you know, starts discussing it more.
I: Do you think they should be able to check in on between visits, and they should touch base you.
M: Absolutely, I would love this kind of thing, especially they can know how his feeling. His stomach starts hurting today…
I: And they could reach out to you?
M: Yes. Instead of me calling them all the time.
I: Sure.

I: A little bit about yourself?
Patient(P): I play Minecraft, Call of duty… play football…
I: Tell us about your treatment.
P: 3 in the morning, 2 at night. I take…
I: So when you go away from home, do you go sleepover at grandma’s house or friend’s house, something like that?
P: I…
I: Do you take your medication with you for the night? Or do you take you it before you go?
P: I take it with me for the night,
I: How do you take the medication with you when you go?
P: I have it in my pill bottle. I have plastic bag. I put it in my cloth. And when I get there, with a glass of water, I take it.
I: Do you or your mom do the packing?
P: We take the whole bottle.
I: Do you separate them by 7 days and morning and night?
M: Yes. He just cares about the baggie.
I: Do you feel you have a bad time when you go there? Do you remember?
P: I can remember.
I: Ok. Do you feel that the changing routine, if you are going your friend’s house makes is difficult?
P: Not too bad.
I: Does is change when you going on a trip?
P: No, follow the same thing.
I: You don’t have to take meds at school, right?
P: No.
I: Have you ever skipped your medication before?
P: Yes.
I: What’s your reason?
P: When I in a rush, just forget.
I: How often do you think that is?
P: Not often.
I: Can you distinguish…
P: Yes. Because one is green pill. And you have one bigger than other. And you have one almost the same size. And…
I: So you know the shape and size of pills you take day and night. Do you know the names of them?
P: Not all of them.
I: Do you every take the wrong pill by mistake?
P: No.
I: If you could design a pillbox works best for you, what do you think it would look like?
P: Camouflage. Separated. One side have pills and one side have something else. Big enough to take other stuff.
I: How many pills do you think it would best for you?
P: I have no clue. 2 day’s amount maybe.
I: 3 in the morning and 2 at night, so that 10?
P: yes.
I: Do you want them to be separated by morning and night?
P: Yes. I would like my pillbox work like Xbox, having a screen/TV also.
I: OK. What image or object would remind you to take medication?
P: Somebody bring medicine to somebody.
I: If something you own could alert you to take pill, what would it be?
P: Really don’t know.
I: Do you like storing pills by type or by doss?
P: By doss.
I: What pill bottle information is most useful?
P: How to use it. How much to take it.
I: How about mom?
M: Just different between day and night. The information on bottle will be rugged off. You can’t see the lettering. So sometime I have to use a marker to write on the bottle.
I: How often would you like to refer to them?
M: Every time he takes it. Only pills he takes morning and night is one morning and one at night.
I: So it’s same quantity in the morning and night. But you pulling the meds out twice.

iv) Patient D

Investigator(I): is there a current way to check your kid’s medication adherence?
Mom(M): just asking him and I fill him pillbox.
I: so you still doing the Sunday to Saturday?
M: yes, we are still in that traditional box right now.
I: ok, how do you encourage your kid to stay adherent? Is there a specific method now?
M: no games unless he takes his medication.
I: how often are you doing that?
M: mostly at night, he’s really good about morning, because that’s a part if school day routines, I do ask, just as a reminder before we leave for school, “did you take your medication?” and he always says “yes”. But at night, when he’s involved in video gaming, I have to make him take a break and say “hey, take your meds, and you can keep playing whatever.”
I: cool, ok, if you could, how often would like to receive adherence report?
M: what do you mean?
I: so basically, it can be anything you want it to be. But if it would tell you exactly how well he’s been taking his medication either per time or a day. Would like to see that information? How would you like to see that information? And how often would you like to see that information?
M: probably a couple times a week I guess. Mostly my biggest thing would be he’s on that drug sets, like a 7-day drug, so that treatment goes 7 days, that our kind of … ones. So I would like to be able to know that he took that. Usually I was home, but I’m now working. So I have to kind of stay up on him to make sure he takes that, because that’s what keeps him consistency. I would say daily or every three times a week, something like that. To see where he is and how he taking his meds. To make sure he is taking them.
I: Do you have a specific way to receive that? Like Phone? Email?
M: Perhaps texts. Because that’s easy for me, we get his reminds from school which is really cool cause he is in his fresh man going. Like when he has an assignment or anything, the teachers are using a program call Remind. And so every day they put in what new due stuff in it, what’s due tomorrow, what due down the street. And it tells, it just a reminder that the kids get the text, and the parents get the text. It would really well to keep him up to date on his working stuff like that.
I: So what’s the best way to provide Marshall’s feedback meaning? If you received that information, how would you like to have a dialogue with him? It would like that just giving them the report, or would you like him to receive them too. How would you like to see that?
M: Him having the reminder are great too. You know kind like the school stuff. Parent and teachers get in both. Keeps him on plan. He didn’t have a phone. But he is using one now. And we still always have a conversation. “Do you have this?” “Do you see it?” It is kind of a backup plan that hit his phone too.
I: How often do you expect or want doctors to give feedback? And have those conversations with Marshall?
M: I don’t know whether it is necessary that doctor check in every week. He goes to see doctors every six months. Maybe in the middle of that process, so they can know what’s going on, what we know before the appointments come on. Would you develop the device that parents connected to the router or their home phone? So that the child doesn’t take the medication, it shuts the router down. Force them to get up. Can’t play games, can’t watch TV. Can’t do their phone, can’t YouTube, everything is gone, till they get up. Till they get their medication.
I: It sounds like what you are saying is that it would be best for you if you were just, the doctor only really reaching to some abnormality like an outlier from his normal schedule… Other than that, you can monitor that on your own.
M: The biggest thing is what I feel doctors have their work every day. So they are keeping eyes on things in levels. We may not get information until down road. They are going through many patients anyways. So it’s kind of nice to have something to keep us date on, communicate with us.

I: Tell us about yourself?
Patient(P): I play a lot of computer games. So if there is a way that install something on the computer, like there is a little pop-on on the bottom at the right corner that says “you need to do this”.
I: So that’s like a notification integrated with video game system or computer.
M: An app you could install on your phone, computer or tablet or something like that has automatic reminder schedule pop out at curtain times.
P: Just like your phone is on silent, you don’t hear the text message, and you’re doing something on the computer, it will pop out on the computer, so remind you in two different ways.
I: That’s really cool.
M: Kind of force you to answer it before it goes away… Such a technology world. This generation is so far behind above anything with computer. So they all have noses in something.
I: What’s your treatment like? Anything special?
P: Sometimes my eye starts itching. I have to take my eye drops to stop it itch. With the device, it could have a small holder for certain thing, like your daily medication, you can take out whatever you want… (eye drop just needs to be on the counter.)
I: Anything else going on?
P: It could also remind me don’t forget to take this amount… don’t forget take one of this pill or 4 of this pill. Like exactly how much you need that medication.
M: It would be nice if it could kind of, since you have a way to program things, if there is a program for children with Marshall’s condition, probably other kids have cancer… because kids are active when they get into gaming or doing the thing, it can remind you need to stay hydrate. It would be nice for a lot of parent that something you can program to that specific child’s condition, to say “hey, remind me of you need food…” (nutritional, healthy recommendations…) because he got small meals every day, you know, we have big issue with hydration. He need fluids now. So if it can pair with program with little signals, through that machine, for those specific needs. It would help elder Children take care for themselves. Because a lot of kids going to… go back other remission because they are not keeping… It would be nice to alert them. Because I know there is a time, he’s got sick, because we think he’s hydrating, but he’s not. That could be very dangerous. It kind helps them maintaining their normal state.
I: What do you keep your pills in?
M: day and night pillbox. Am/pm.
I: are you taking anything to school with you now?
M: No, the only thing they keep there now is for emergency. So he actually gets his medication before he goes to school. They don’t let kid take medicine, not even an aspirin.
I: not even with nurse?
P: They do with nurse.
I: When you do skip the meds, what the reason for that?
P: Just forget. That the reason reminds system will help me a lot. Because I will be doing, like my gaming, and I’ll completely forget, and my mom will tell me “take your pills”, but I’ll be in the middle of something, I’ll be concentrated on that, completely forget the medication.
M: That reminds me of, he struggled in school last year. When they have reminding system, he made a difference. Because kid’s minds are so split these days. So they don’t concentrate on anything. And now having those reminder, it just keeps telling you “I got do this” what would be the same for kids, especially teens with conditions.
I: How often do you skip medication?
P: I tried not to. Usually during the weekends. I’m not on a routine. So Probably once every 2-3 weeks for routine days. At weekend, twice as that time.
M: He once skipped the whole weekend which is not good. Before we realized he did…
I: Can you distinguish all the pills in your pillbox?
P: Yes.
M: The only confused is there two kinds of pills are both yellow, but one is smaller than the other. So, of course he assumed took a pill, he would be not sure whether he has taken that yet.
I: In an ideal world, how would a pillbox works best for you?
P: Probably be square, little screen on the back, can fold out, and show the interface. There are seven cylinder in the front for each day, on the inside, can programed as which one is for day, which one is for evening, which one is for night… You can fill those areas. With it, there is timer on it. OK, it is morning, it will open like flap, and the pill will slide down into a cap, cylinders on that day. You’ll know the pills with right dose… day and night confused…
I: How about a portable case just for 2-3 nights, how would want that to be designed?
P: It’ll probably have a clip on the side. You don’t want to lose it. You can fill it up. There is a screen on the front. And it will be battery power to charge from the main port. It will have the same system of the reminder coming to your phone or everything. The screen will say the pills for that day. Cause this is just would be smaller version connected to the main base.
I: Still separated by morning and night?
P: Yes. It drops all the pills at one time.
M: Everything has to travel, has got to have a lock on it.
I: If something you own could alert you to take pills, what would it be?
P: Smart watch. Samsung, Google Glass…
I: What pull bottle information is most useful?
P: name, date, RX number, refill number, doss…
I: how often do you refer to it?
M: I do every time I fill up the pillbox. Because even we are on a routine since he’s 9 years old, you second guess yourself. Because you want to make sure you get it right.
M: Right before I walk out the door, I take my medication. I grab my bag, put on my shoes and leave. But on the weekend, I sleep later, I wake up and eat breakfast and go straight to my … and I just completely forget to take pills. I had the same thing in the summer.

H: Privacy?
M: His friends know he has the condition. But yes, he doesn’t broadcast he has disease. There is a cool design to it. The kid knows it. But not necessarily everybody else know it. They don’t want be bind to their condition. I think he really has a problem. He supposed to be hydrate in school years. Because you deal with a whole other world.
P: Last year, we went to Washington. I had to take my medication. My friend didn’t care really. They know I have the medical issue. That doesn’t change really who you are. I know someone doesn’t want them to know I have this. You can design it, or put a different decal on it to make it like your style.
M: there is an idea. With all the iPhones, they were cased. Make the same shape, same size. That way, they can carry in the phone holder. And they make the cases, and they are all changeable. Be adapt.

v) Patient E
Investigator(I): if I could, how often would like to receive adherence reports?
Mom(M): yes. I probably would. Email, probably. Once a week. Xx does have a pill but he takes once a week. That’s I don’t put that out. Just write on the calendar. (An app would work too.)
I: Besides medication adherence, what helpful information would you like to track?
M: Just if he took it. How his feeling, pain, that a good one? We’re pretty open. You know, he talks to me. You know what he knows. It would be good to have something to we could track when we go over his check ops.
I: And if you did receive this information, what would you exactly plan to do with this information?
M: Doctor.
I: If your doctors have access to this information, how often would you like your doctor follow up?
M: Every year or every six months, when we follow appointments unless he would see an issue. With the information he received to contact us. Anything abnormal.

I: Tell a little bit about yourself?
Patient(P): I’m on second year high school.
I: Playing sports?
P: Not really.
I: Music or anything?
P: No.
M: He plays soft ball.
I: That’s something.
P: Xbox.
I: I’ll tell you that’s a talent… Tell me a little bit about your treatment. Mom says you are taking pills, one in morning and one at night. Anything else?
P: Come here every two months.
I: So if you think back when you use it, was it a little bit different?
P: Yeah, like more frequent, take more medication.
I: How about routine change, like go out of the town at the weekend?
P: Just take my meds with me, and I’ll remember it.
I: How do you take meds with you?
P: the pill case, the plastic thing.
I: So you just prefill the 7-day case, mom do that?
M: Yes.
I: If you are rushing in morning, do you forget your morning doss?
P: No.
M: Well, it depends how long we will be gone. Cause sometimes I have to take the medication, you know, that’s only 7 days, so if we are gone for 8 or 9 days…
I: Do you take the box and the bottle then?
P: Yes. Because the box is the way tracking he whether take his meds for that day and the pills for that box.
I: So if you are going out for 2 weeks, would you take 2 singular pills for that like weekly doss or would you take the whole bottle with you?
M: I usually take the whole bottle. Just in case there is an issue.
I: Have you ever taken it at school?
P: No.
I: What’s the reason for skipping your meds?
P: Not feeling well, forgetting.
I: How often?
P: It probably happens weekly.
I: which one is worst, morning, after, evening?
P: Probably my afternoon.
I: Can you distinguish all the pills in your pillbox now?
P: I know the names.
I: How about in the past, you take four meds?
P: No.
I: Have you ever mistake with the pills?
P: Yes. They have the same color.
I: In an ideal world, how would a pillbox work best for you?
P: Something like small…
I: Do you like it to be divided by dosses?
P: Yes.
I: Mom do you think it is ok?
M: Yeah, I mean as the age is now, I think it would age appropriate. Like he said, he knows which one is am and which one is pm. But for some younger might not know.
I: So have options for that separated?
M: Yes.
I: What images or objects would help you to remember to take you pills?
P: Yes, I’ll forget it sometime. Eating will help me realize it.
I: If something you own could alert you to take pills, what would it be?
P: Apps on the phone.
M: Your mom, a buzzer.
I: What pill bottle information is most useful? When is it most useful? How often do you refer to it?
P: The name, time, means.
3. Detailed feature concept map
4. Detailed feature concept
5. Portable pillbox design
6. Pill types and sizes

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<th>Pill</th>
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<th>Short side (cm)</th>
<th>Shape</th>
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<td>Badge</td>
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<td>1.4</td>
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7. Pill size and configuration of the pillbox
Hand sizes

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(mm)