Medical Literacy Group | MedAware

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Team

Joe Lanzone
Senior, Computer Science
Joe worked in collaboration with medical professionals to gain a better general understanding of how physicians interface with their patients in prescription-writing contexts. He did this through interviews with physicians and Yale computer scientists building products in the healthcare space.
Joe also re-drew the storyboards to increase their legibility.

Joe Connolly
Sophomore, Computer Science
Joe worked through all design stages, from first brainstorming and envisioning the problem space of medical literacy, to collecting user data through interviews, analyzing user trends, sketching potential designs and storyboards, and picking a design to continue working with for the rest of the semester.

Simon Mendelsohn
Junior, Computer Science
Simon worked throughout the design process to help make sure we chose a design that addresses the needs of our target users. He played a part in every step of the design evolution, from brainstorming, to running a contextual inquiry, to understanding the important tasks and creating a design that best fits those tasks.

Dalya Dickstein
Junior, Computer Science
Dalya worked on drawing up designs that would help us identify and address the problem space surrounding the issues of medical literacy. She collaborated with her teammates on each assignment, sketching potential designs, completing a textual inquiry, writing tasks to encapsulate the challenges that users face, and brainstorming ideas.

Problem and Solution Overview

Frequently, patients incorrectly take or fail to take their prescribed medications. This is not generally not because they make a conscious effort to ignore their doctors' instructions. Rather, the instructions for these medications can sometimes be involved or confusing, and it can be difficult to follow them every day, often multiple times a day. So we propose a way to alleviate this situation. Broadly, we hope our application will improve drug adherence for patients with chronic illnesses. We hope to do this by providing a mobile application that can aggregate all of a patient's healthcare materials (most simply, by allowing patients to photograph and upload images of these materials), and can send patients reminders when their medications must be taken.

Research Goals, Stakeholders, and Participants

Potential Users/Target Participants

Our design deals with the problem of lack of medical literacy and how that impacts the time and manner in which people use various medical devices. We propose a system that helps users both remember and know how to use their medical devices. There are a number of different populations that can benefit from such a product, including:

- One-time prescription users
- Users of medication for chronic illnesses
- Blind/Reading-Impaired/Foreign users
- Users of medical equipment (blood pressure cuffs, medical creams, etc.)

Other Stakeholders

In order to properly design a useful and in-demand product, we will consider speaking not only to our target participants, but also to additional stakeholders in the medical sphere. For example, doctors are not direct stakeholders in our solution, but their information and insights will go a long way in helping shape the design of our solution. Such stakeholders include:

- Doctors
- Pharmacists
- Hospitals
- Pharmaceutical companies
- Home healthcare workers

Research Results and Themes

Doctors/Medical Professionals

Interviewee Background and Interview Environment
We conducted a phone interview with Joe Lanzone's father, a Urologic Surgeon, to get his insight on problems in medical literacy. We conducted this interview after-hours, while Dr. Lanzone was relaxing at home. For context, we gave Dr. Lanzone a list of core questions around one hour before the interview. The conversation largely focused on patient education, the reasons why patients engage in contraindicated medical behavior, and the current structures that exist to educate patients about their illnesses and treatments.

What was learned from the research?
- There already exist many interfaces in which patients are given simple, "non-legal-document" medical information. People just don't use them!
- "Good practice" when taking medication can be classified into three levels:
  - **Primary importance:** Potentially extremely dangerous actions
  - **Secondary importance:** Potentially slightly dangerous actions
  - **Tertiary importance:** Positive, low-risk actions
- Generally, as long as you are not neglecting actions of primary importance while taking medication, you are not risking serious consequences
- Many risky contraindicated drug interactions are flagged by EMR (electronic medical record) systems to prevent physicians from prescribing dangerous-to-mix chemicals
- Generally, pharmacists don't have the necessary medical training to know when dangerous medications are being prescribed; however, they often do possess short informational sheets displaying proper usage and warnings
- There are common barriers to taking medications:
  - **Cost:** some medications cost upwards of $400 per month, and many patients are prescribed more than one medication per month.
  - **Scary potential side effects:** Due to liability, companies need to explain all potential consequences of taking a medication that have occurred or can occur, no matter how unlikely or scary; hearing this list can deter patients from wanting to take medications
  - **"Allergic reactions":** patients misattribute non-medical events to starting their medication (start taking an antibiotic -> stub your toe).
- Products have already been made in an effort to solve this problem. If they are reasonably priced, physicians often love them. For example, Bard Urology used to sell disks that would allow you to print out informational

sheets that would provide expository illustrations for patients using medication, but the product quickly became too expensive.

What tasks, problems, or opportunities were uncovered?
- **Tasks:** Patients want to take their medication without spending a lot of time studying the warnings associated with it.
- **Problems:** Patients do not read all the instructions given to them.
- **Opportunities:** As long as at least one good informational document is given out to the patient (likely by the pharmacist), doctors are safe to give out simplified, nuance-less instructions. Also, since existing solutions for generating informational sheets have become too expensive, there might be an opportunity in the market for a much cheaper alternative.

Any difficulties establishing rapport or getting the desired information?
The conversation went well. The interviewer had a personal relationship with the interviewee, and the interviewee was happy to discuss the topic domain.

Patients

General Research Overview and Participant Background
We also spoke with three individuals (two through contextual inquiry, one through an interview) who took medication daily, either for chronic illness or in recuperation from a serious medical event.

One of these contextual inquiries was with a male Yale student who had suffered serious health problems over the summer and was still taking a number of medications as a result. The contextual inquiry was done in the student's dorm, while the student took his morning medication.

The second contextual inquiry was done with a 21-year-old female Yale student who took a fixed set of pills and a powder that she dissolves in hot water daily (at night), for the same chronic condition that she has had for many years. She has been taking the pills for approximately 2.5 years, but just added the powder to her regimen post-winter break. Both are over-the-counter medications. She also uses a prescribed cream which she applies topically, also every night. The cream is meant to treat a skin condition she has had for a long time, and is the latest in a list of medications that she has tried. She has been using the cream since this past summer. The contextual inquiry was done in the student's dorm, while the student used these three nightly medications.

We also carried out a formal interview with someone outside of the Yale sphere: an adult relative of a team member who was diagnosed with a chronic disease

within the past year. The interviewee was given a prescription for the disease that they had to take multiple times daily.

Key Findings
- One of the most striking things that appeared in all of our conversations was how non-digital our subjects' approaches were to managing their medication. This may be a factor of the way that patients are generally instructed to take medication by a physician: "Before bedtime", "with dinner", etc. *People seem to link taking medicine with other habits,* and use technology only to supplement this.
- In taking medication, our participants generally didn't have significant fallback systems. Should one day's medication be forgotten, they just carry forward. This is the medically recommended approach, but the frequency of failure here isn't well documented.
- The individuals we spoke to all seemed keenly aware of the negative effects that *failing* to take their medication would generate. Two of the three individuals had bounced between many medications in pursuit of a positive outcome. Most agency was placed in the hands of the medical professional in choosing which medications to take.

High-Level Themes and Problems
- Forgetting to take medication even in the presence of sporadic electronic and/or physical reminders.
- Awareness of general procedure for taking medication, and associating that procedure with events in a daily routine.
- Various artifacts in-use to organize taking medication; Items are interacted with at habitual points; clear visual cues on devices (times/dates for pills, electric kettle in front of bedroom as reminder to boil water)

Task Analysis Questions

- *Who is going to use the design?*
  - Users range from patients who have chronic illnesses to patients who are using medical products for the first time. Target populations are individuals who have prescriptions or medical devices that they will use frequently for a span of at least a few weeks.
- *What tasks do they now perform?*
  - Read prescription labels
  - Read instructions from doctors/pharmacists
  - Set reminders either electronically and/or through daily routine
 - Keep landmarks as cues to take medication

- ○ Replenish medication through calling a pharmacy and/or traveling to a store in person
- *What tasks are desired?*
  - ○ Reliable, self-accountable reminders
  - ○ Completely clear instructions for use (i.e. no important details left out)
  - ○ Clear warnings for possible side-effects of taking medication
- *How are the tasks learned?*
  - ○ Routine through association with important daily events (waking up, going to bed, eating a meal, etc.)
  - ○ Various types of reminders
- *Where are the tasks performed?*
  - ○ Participants read their instructions at the doctor's office or at home
  - ○ Participants almost always take their medication at their place of residence (for medications that must be taken out of home, habitual locations still persist)
  - ○ They replenish their medication at pharmacies; some pharmacies do mail delivery
- *What other tools does the person have?*
  - ○ Physical and/or electronic reminders
  - ○ Medication organization tools
- *How do people communicate with each other?*
  - ○ Often the only communication between people for these tasks is when the patient receives instructions from the doctor and/or pharmacist before starting the medication
  - ○ Another round of communication might happen when the patient returns, but (as highlighted in last week's interview), many patients do not return for follow-up appointments, either per availability or economic constraints
- *How often are the tasks performed?*
  - ○ Taking medication can be as frequent as multiple times daily
  - ○ Reading prescription labels and medical instructions often happens one time at the start of medication *or not at all*
- *What are the time constraints on the tasks?*
  - ○ Usually medication needs to be taken within an interval less than a day for proper usage; for medications taken 3x daily, there's often a 2-3 hour optimal window
  - ○ Reading instructions on labels or learning about medications from doctors needs to happen before the user starts their medication in earnest.
- *What happens when things go wrong?*

○ Usually there were no drastic negative effects when the participants neglected to take their medication. They simply did not experience the benefits of their medication for the period in which they forgot to take the medicine.
○ However, in some cases, patients can suffer severe effects for failing to take their medication.

Proposed Design Sketches

Design 1: Mobile Application

This design is intended for any chronic user of medication who owns a mobile device. The main idea behind this app would be to give users information about their current medication in a centralized, understandable format and to simplify the processes of remembering to take and refill medication. This app would support features such as a list of current medication for the user, warnings and relevant information for each drug, automated drug refills and delivery, and a reminder system for taking drugs.
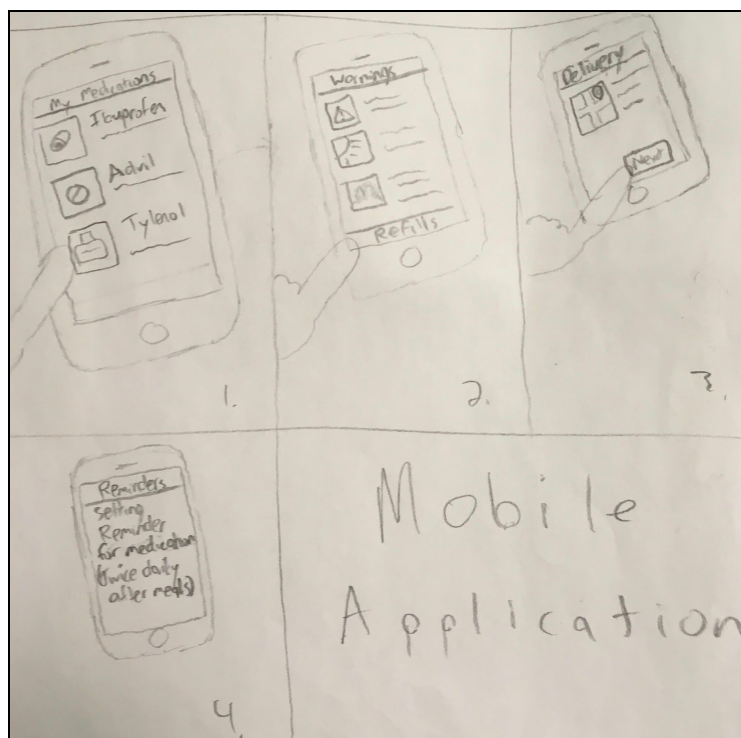
Figure 1: Mobile Application Sketch

Mobile Application Task Completion
The home page would be the current list of medications being taken by the user (1). The user could then tap on the icon of a certain medication and be taken to a page with relevant information and warnings about that medication (2). The user would then have the option to order or refill their medication by tapping on the relevant button and entering their home address (3). Finally, the user would have the option to set an electronic reminder in order to take their medications once the medication has been delivered successfully (4). To collect the necessary set of risks and warnings, the patient can take a photograph of the page of recommendations are drug interactions provided by their pharmacist.

Design 2: Smartwatch Application

The smartwatch design is also intended for people who take medications regularly (and who wear smartwatches) so that the app can be utilized to its full potential. The benefits of having the app on a smartwatch center around the idea of having immediate view and access to the app's features. Having a watch literally buzz around one's wrist is a great way to ensure that reminders about taking medications are not accidentally missed.
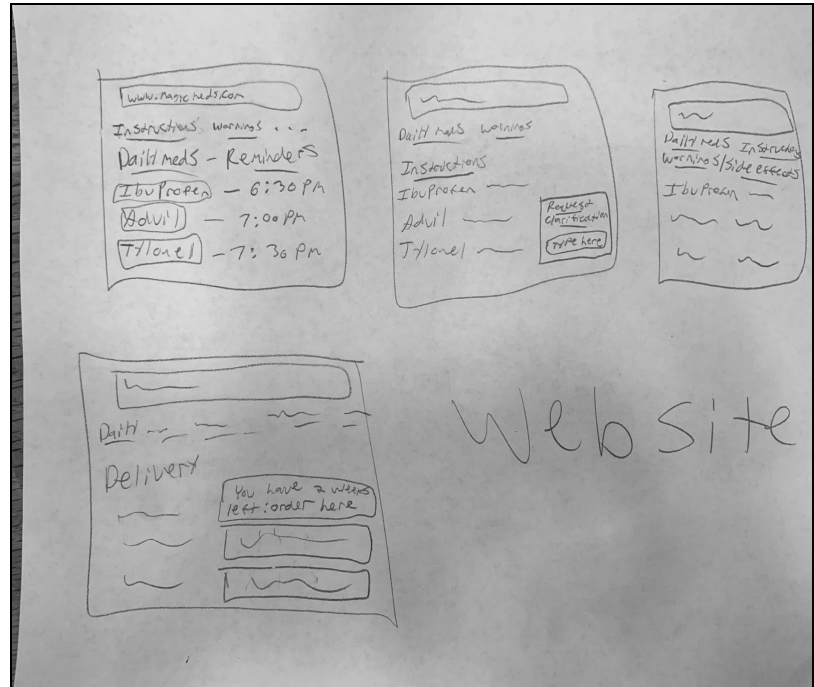

Figure 2: Smartwatch Application Sketch

Smartwatch Application Task Completion

A smartwatch provides a great interface for reminders, as its vibration capabilities ensure can pull the attention of users, even beyond visual or hearing disabilities (Top-left). At the required interval, the smart-watch screen will display instructions describing how to use the medication (dosage, area of application, time of day, etc.) (Bottom-left). Each of the user's medications could be viewed in a list, and each item selected to view further details, including warnings about potential side effects or other things to avoid taking in conjunction with the medication (3, Bottom-right). The application would also keep track of how many doses are left, with an easy button to send a refill request to a pre-designated pharmacy (Top-right). To help patients track how well they're maintaining their health, the app could also check to see if the medication was taken, enabling the patient to better understand their dosage accuracy over the course of days, months or years.

Design 3: Website

This design is intended for patients with chronic illnesses who interface with a computer with a daily, habitual cadence. This website would give users information about their current medication in a centralized, understandable format and to simplify the processes of remembering to take and refill medication. This website would support features such as medications for the user, warnings and potentially dangerous interactions for each drug, tracking on drug refills and delivery, and a reminder system for taking drugs. Should the patient build a habit of visiting this site daily, this would provide an interface where a patient can ensure that they have correctly taken their medication at the given critical points. For organizational purposes, it would also list the phone number of the prescribing doctor (likely input by the user), so that they can contact them with questions regarding drug interactions.

Figure 3: Website Application Sketch

Website Task Completion

The home page would be the current list of medications and their times (task 1). Reminders would also be configurable on this page (task 2). The user could click on the instructions page to see more detailed instructions on all the medications (task 3). The user could also click on the warnings tab to read the warnings or contact a doctor/medical professional (task 4). The user would also have the option to order or refill their medication by clicking on the relevant links (task 5).

Chosen Design & Tasks

Design Rationale

We chose the phone application design for its convenience and simplicity. People take their medication in a variety of settings, and it is useful for them to be able to have our application conveniently available on their phones wherever they are. The vast majority of our target users have smartphones that they interface with frequently, and we could leverage partnerships with physician to drive downloads. Our other designs (a website and an application for a smart watch), on the other hand, are not as readily available to the general populace. Most of our target users do not have smart watches, and whether or not they have laptops, bringing a user to a website is a much higher friction action than getting them to respond to a smartphone icon on their home screen, prompt, or push notification. Furthermore, contemporary mobile development is virtually at parity with what you can see on the web.

Task Rationale

We first chose the reminders task because the most important part of having medications is that people actually take them, and they can only take them if they have a reliable method of remembering when to take them. The rest of the app's functionality would be useless if people do not even remember to take their medications in the first place. We also believe that our design will be a good way to implement reminders, because most people carry their cellphones on their persons nearly all of the time. Having a centralized app with built-in ways to set regular reminders will make it easier for users to use electronic reminders. Some of our interviewees used some sort of Reminders app, but often accidentally marked them as "completed" or didn't have regular reminders set. Having an app dedicated to their medications and designed specifically with medical reminders in mind will make it more likely that people both set the reminders they need and also pay attention to them.

We also chose the side effects task because we felt that this was one of the areas in which medical literacy most fell short. People will usually make sure they know how to use their medications and will ask for help if they are unsure. Furthermore, they often know when they are confused, because their lack of complete knowledge will quickly manifest itself when it becomes time for them to start using their medication. However, when it comes to obtaining complete information about side effects, people might not even know what they should be asking, or even that they should be asking questions in the first place. With our design, doctors would be able to write in the warnings and side effect

information for their patient for prescription drugs, while pharmacists and drug labels would provide the information for over-the-counter medications. We believe that the app design can bridge this particular knowledge gap between medical professionals and patients by giving patients clear, concise, and readily available information about potential side effects of their medication.

Written Scenarios & Storyboards
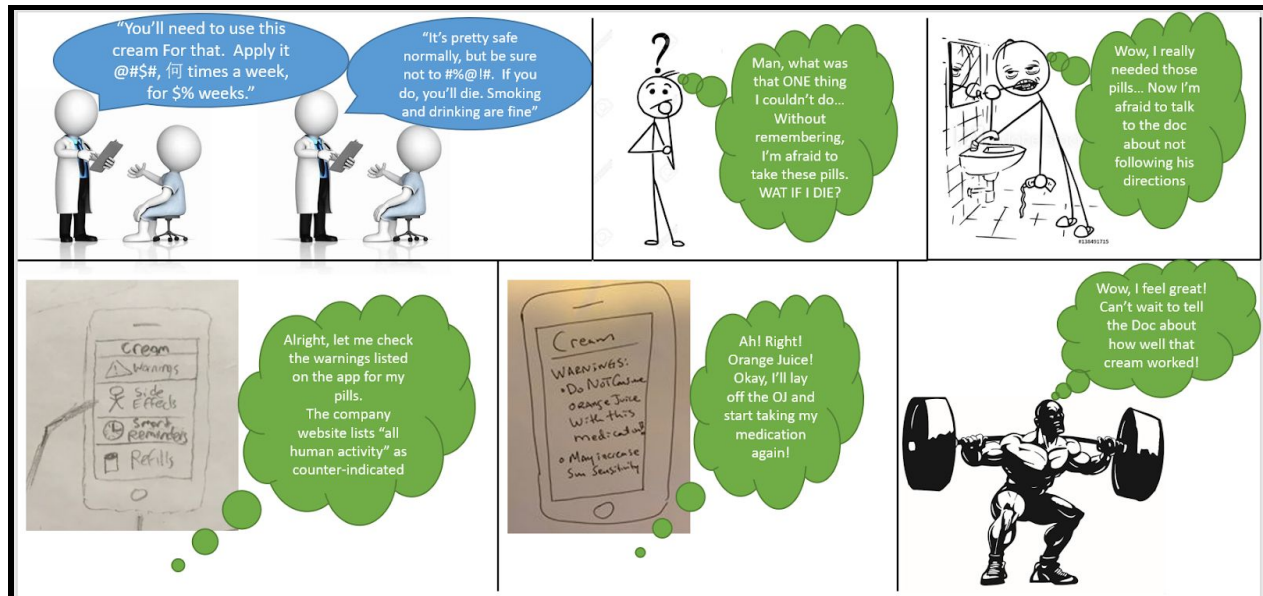
Figure 4: Storyboard detailing a patient trying to find clear information about side effects for their medication.

Our research has found that many patients will stop taking medication per lack of understanding, and will then become dissuaded from speaking with a physician by their deteriorating health. Online searches don't always yield the best information, so we hope for our app to aggregate materials and info provided by physicians directly.

When viewing the listed side-effects, it's important to note that we will not be listing all potential risks that medications carry. In accordance with direction given by medical professionals who we have interviewed, we hope to to only list the most important/high-risk contraindicated medications. This information should be provided by a pharmacist at the time of medication distribution.
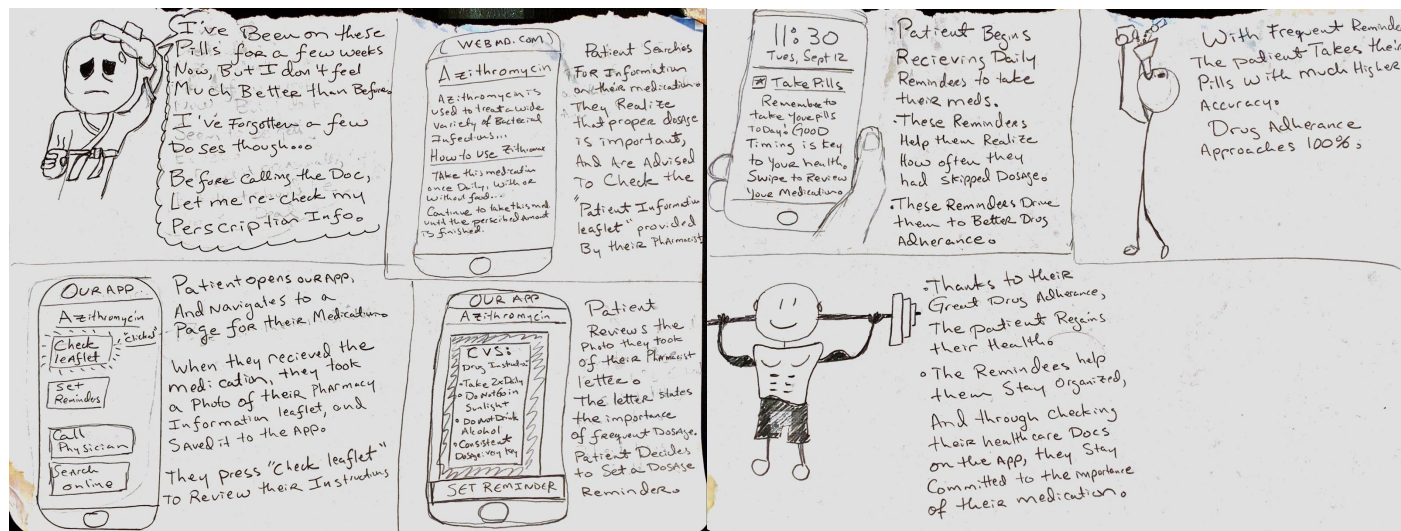
Figure 5: Storyboard for someone seeking reliable reminders for their medication.

Failure to take medication with proper frequency and on-time can lead to serious negative health effects. Unfortunately, many individuals (especially those with chronic illnesses), struggle to consistently take the medication they require. A key part of this is lack of insight to their own drug adherence: it's very easy to overestimate how often you take your medication.

Through providing a system to remind patients to take their medication, we can bring the matter of their drug adherence front-and-center on a consistent basis. We believe that this will have significant health benefits for those who fail to take their medications with high consistency.