

# Home Opioid Patient-Controlled Analgesia (PCA) Box

Team 11 Recovery Improvement Interactive Technologies (RIIT)  
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Sponsor Seattle Children's Hospital & The University of Washington  
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Milestone 1 **Design**

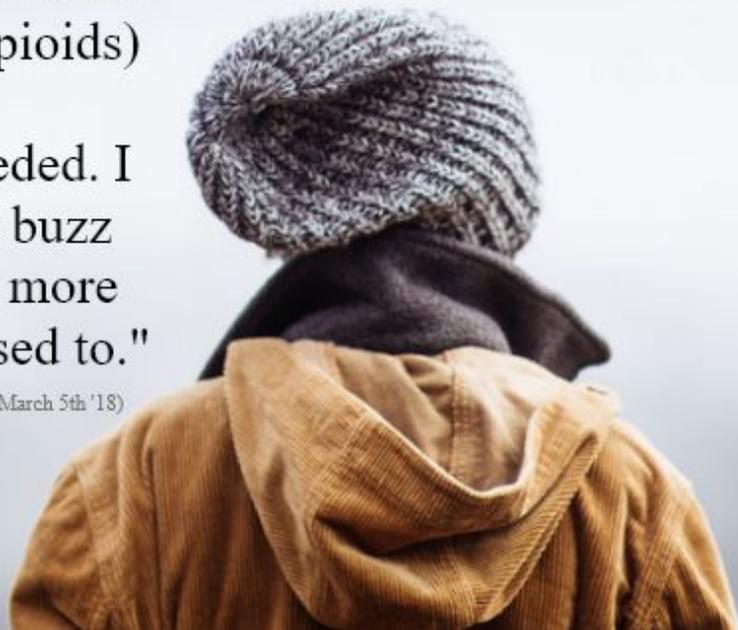
# Project Overview

Opioids provide necessary pain relief to postoperative patients. However, opioids can be addictive, dangerous, and are often subject to misuse. Our project, an in-home oral Patient-Controlled Analgesia (PCA) box, will address these issues by providing patients with the guidance they need to manage their pain effectively during their postoperative recovery.

Our team will be researching, designing, prototyping, evaluating, and iterating a Patient-Controlled Analgesia (PCA) device and companion app that monitors and manages opioid prescriptions while connecting patients to doctors throughout the postoperative recovery phase. Through design, we will explore various solutions to the problem as supported by our initial research.

"I got in a car accident and was in the hospital for three or four months. At first, I took (opioids) for the pain as prescribed, as needed. I started to like the buzz so I began taking more than I was supposed to."

- Cassandra Blasingame (Time Magazine March 5th '18)



# Design Process

Milestone 1  
**Design**



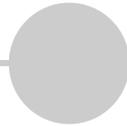
Pill Box  
Companion App

Milestone 2  
**Prototype**



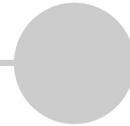
Physical Computing  
Interactive Demo

Milestone 3  
**Evaluation**



Usability Testing  
Data Analysis

Milestone 4  
**Iteration**



Pill Box 2.0  
Updated Companion App

# Milestone 1 **Design**

Project Manager: Michael Beach

# Milestone 1 Overview

The design phase is an essential part of the process where conceptual ideas become concrete artifacts and systems can be built and tested.

In this phase, we utilize the contextual understanding we gained from the preliminary research we conducted to design concepts for the PCA device, the device interface, and the companion app. We identify viable solutions through sketches, user flow diagrams, and other design sprint methodologies.

- Design Questions
- Pre-Design Research
  - Competitive Analysis
  - Personas
- Design Sessions
  - Session 1: Mapping Exercise
  - Session 2: Lightning Decision Jam
  - Session 3: Design Concepts and Sponsor Feedback
  - Session 4: Sketches and User Flow Part 1
  - Session 5: Sketches and User Flow Part 2
- Moving Forward



Necessary



Over-prescribed



Addictive



Dangerous

# Design Questions

How do we provide patients with the guidance they need to manage their pain effectively during their postoperative recovery?

How can we design for every user and their capabilities?

How can we account for existing research on appropriate medication routines for avoiding prescription abuse and addiction?

# Pre-Design Research

# Competitive Analysis

## **Question**

How do existing products address problems in this design space?

## **Purpose**

Identify the viable market opportunity, challenges, and successes faced by currently available products.

## **Result**

We did not identify a product that guides users through their opioid prescription as they wean through the use of OTC medications. Our product will highlight this need.

# Competitive Analysis

Product	Notification	Connectivity	Lockable	Form	Portable	Adherence data collection	Adherence data access	Doctors have data access	PRN Support	Target audience	Power	Cost
<b>SMRxT / Nomi</b>	Text messages	LTE	Unknown	Pill bottle	Yes	Yes	Web portal	Yes	Unknown	Anyone, families, caregivers	Unknown	Unknown
<b>tricella</b>	Bluetooth LE	No	Pill box / drawer	Yes	Yes	Yes	App with pill history	No	Yes	Anyone, families, caregivers	Coin battery	\$55 - 75
<b>ProsperSafe</b>	Alarm, lights	None	Yes	Wheel / hopper	Yes, but needs power	No	No	No	No	Addiction recovery / clinics	Wall + backup battery	\$400 - 850
<b>Livi</b>	Light, sound, text alerts	LTE	Yes	Hopper	Yes, portable travel packs	Yes	Web portal	No	Yes	Seniors / senior caregivers	Wall	Buy - \$1999 Rent - \$79/month
<b>AdhereTech</b>	Text, phone calls, lights, chimes	LTE	No	Pill bottle	Yes	Yes	Web portal	Yes	Yes	Anyone	Rechargeable battery	Unknown

# Personas

## **Question**

Who are we designing for?

## **Purpose**

Create personalities that will guide design decisions and help our team maintain scope.

## **Result**

Sharper focus on what components will and will not serve these users best. Addition purpose and direction for our design suggestions.

# Eleanor



Age: 64

User Status: Caregiver

Identifier: Grandmother

Occupation: Librarian

Location: Bremerton, WA

Eleanor just had her 64th birthday, which was a guided her to thoughts of mortality. She lost her son and daughter in law in a car accident six years ago and has been raising her grandson Tom ever since, Tom has started to make rebellious decisions in his teen years. Eleanor wants the best for her grandson, but worries about him and the friends he has started to keep. Recently Tom was out past curfew with his friends and got into a bad bicycle accident, shattering his lower arm. He just returned home from surgery and Eleanor has to help him manage his pain during post operative recovery. Eleanor is concerned about introducing Tom to such powerful drugs at this impressionable time in his life.

## Goals / Desires

- Wants to ensure Tom is taking enough medication to manage his pain successfully
- Wants to ensure Tom is not taking more opioids than he should be
- Wants to help Tom wean off of his opioid prescription

## Pain points

- Worries about Tom since his accident
- Doesn't know if Tom is following his opioid prescription correctly as she leaves for work before he wakes up
- Feels like she is becoming disconnected from Tom as he becomes more independent

## Triggers

- Learning that Tom has been in pain
- Finding that Tom has fewer opioid pills remaining than he should

“My grandson has lived with hardships all his life, I don't want his pain management to be another one.”



Age: 31

User Status: Patient

Identifier: mother

Occupation: Illustrator

Location: Sammamish, WA

Liz is a full time mother of 2 working part time at home. She has two boys 4 and 7. She is an illustrator and does commission work for children's books and magazines. Liz prides herself on being a great mother, homeschool teacher, homemaker and enjoying her weekends with the family. On the weekend her and her husband of 9 years teach the boys to ski. Liz is a faithful church goer which has helped her stay away from drugs and alcohol all her life. Her father and extended family have had severe addiction issues in the past. When she isn't skiing with the family she is spending time at her mother's helping take care of her elderly, struggling father. Liz recently had some major pains emanating from her stomach, which she ignored for days before finally going to the doctor. She was then immediately taken to the hospital to have her gallbladder removed. She was given high doses of pain relief before, during and after the surgery to cope with the immense pain. This is her first experience with this caliber of pain relief, and she still has a lot of responsibilities to keep up with at home.

#### Goals / Desires

- Do at least the minimum to stay on top of work and family responsibilities
- Recover quickly
- Get away from opioids as quickly as possible

#### Pain points

- Causing family issues while she is recovering
- Losing her work relationship with her top clients
- Craving pills beyond pain relief

#### Triggers

- Feeling she is putting her pain relief ahead of work and family

“I don’t have any substitutes, I can’t pause family and work while I recover, I need help.”

# Bill



Age: 52  
User Status: Patient  
Identifier: Father  
Occupation: University  
Professor  
Location: Lynnwood, WA

Bill and his wife both work full time. They each make five-figure incomes that allow them to travel during the holidays with his wife and their two kids. Bill uses the web from work and home. He checks his email and administers online classes. He also looks for events and places that the whole family could visit. He is impatient with the internet because his back gets sore if he sits at the computer too long. Bill manages his high blood pressure with diet. He eats healthy and tries to exercise at least two or three times a week. He uses glasses when he reads and surfs the web. He hates sites with small print because they make him feel old. Bill recently had surgery after a car accident where he suffered a back injury. His wife is often at work, one son is in college, and other son is either at home or with a caregiver, Bill is responsible for his own pain management and opioid prescription

## Goals / Desires

- Wants to ensure he is taking enough medication to manage his pain successfully
- Wants to ensure he is not taking more opioids than he should be
- Wants to wean off of his opioid prescription successfully

## Pain points

- Worries about getting back to work and helping his family since his accident
- Worries about becoming addicted to pain meds due to his family history (father suffered from alcoholism).
- Worries that his kids may have inherited the family's "addictive gene"

## Triggers

- Being reminded that he is not spending quality time with his family
- Being reminded that he is not working to help support the family

“I’m a big baby when it comes to pain tolerance, I want relief without enslavement.”

# Design Sessions

# Design Session 2: Mapping Exercise

## **Question**

What is the current state of postoperative prescription opioid use?

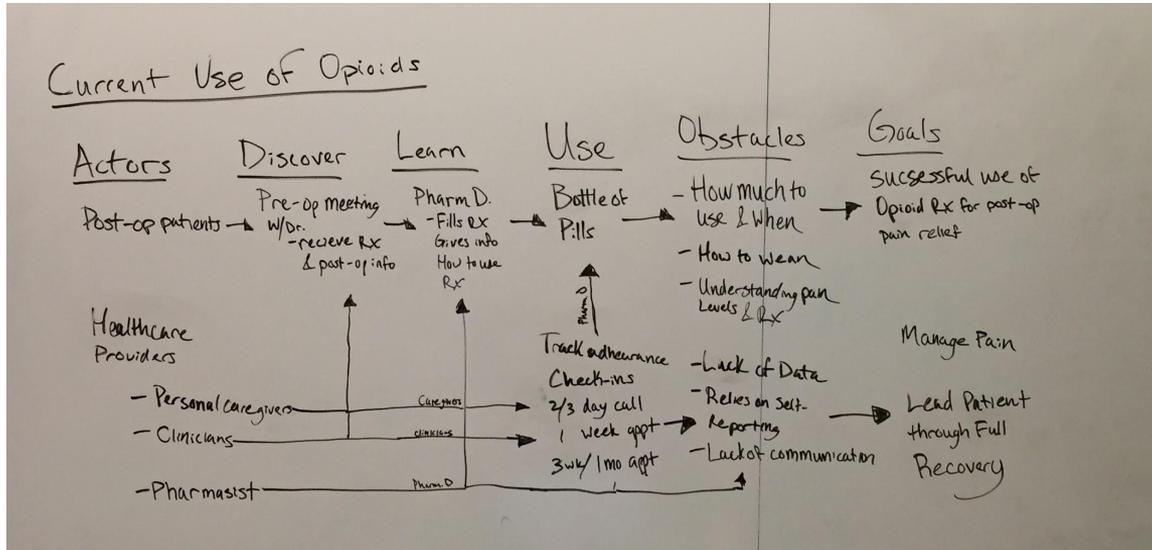
## **Purpose**

To give scope and foundation to design sessions and understand our problem space.

## **Result**

A framework for understanding the problem space.

# Actor Mapping Exercise



Decoding the image from left to right:

In this exercise, we mapped out the "actors" in the postoperative system as it is now to identify pain points. Specifically, we looked at how patients discover, learn about, and use prescription opioids in the current system, their goals, and potential blocks to achieving these goals.

Our primary focus is the postoperative patient's use of opioids, starting with a pre-op meeting where a doctor prescribes opioid medication and explains to the patient how to use opioids. Currently, patients are then given a prescription for a bottle of pills without any further contact with their doctor for several days.

As it stands, there are many obstacles for patients to overcome when trying to understand their opioid prescriptions while recovering from surgery. Through this mapping exercise we identified what obstacles we need to design for and where we have options to intervene and inject support for all relevant actors.

# Design Session 2: Lightning Decision Jam

## **Question**

How do we design a device that matches our project goals?

## **Purpose**

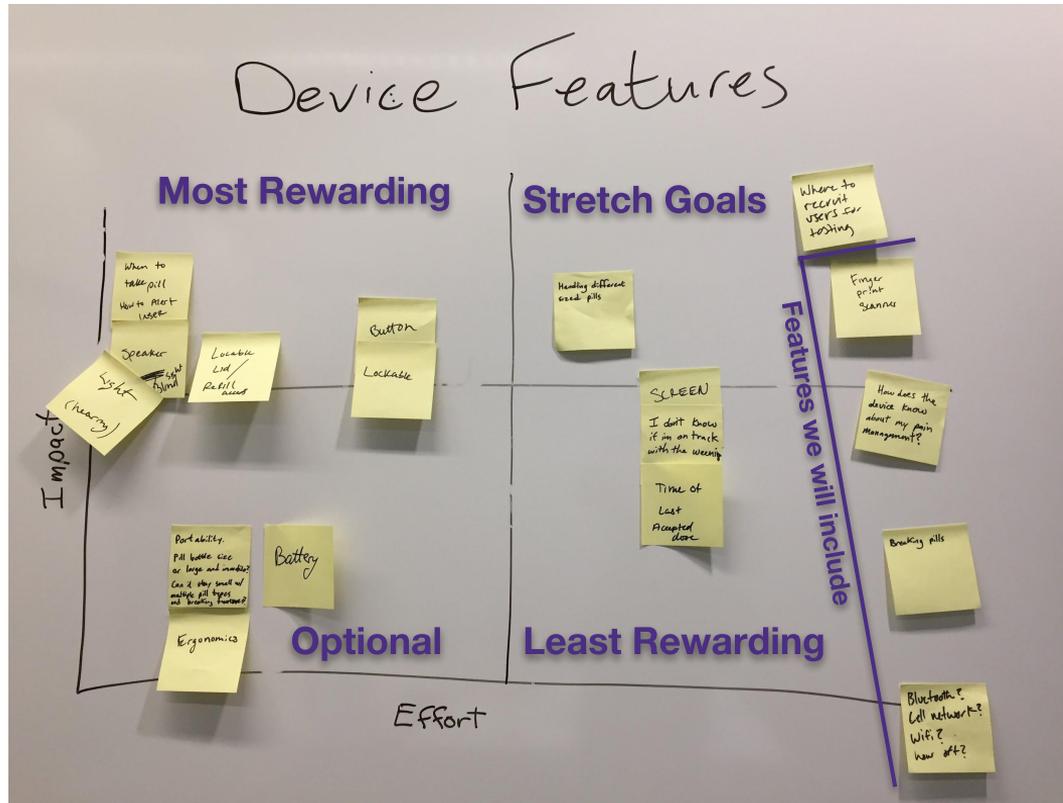
Define the scope of our project and its features.

## **Result**

Identified features that will have the highest impact for our users.



# Lightning Decision Jam: Effort-Impact Scale



As a group, we placed the features and opportunities from our brainstorm onto an impact-effort scale. From this exercise, we determined which features we wanted to include in our dedicated design sessions. Together we identified how much effort each would require and the resulting impact.

The top-left quadrant contains the most rewarding topics, bottom-right the least rewarding. We decided that the top-right box contained valuable components that would require forethought and early preparation to execute.

We drew a line near the right side of the graph to indicate, on its left, which features we deem reasonable to include, while on its right are features we would implement if we had more time.

# Design Session 3: Design Concepts and Sponsor Feedback

## **Question**

How should the device function?

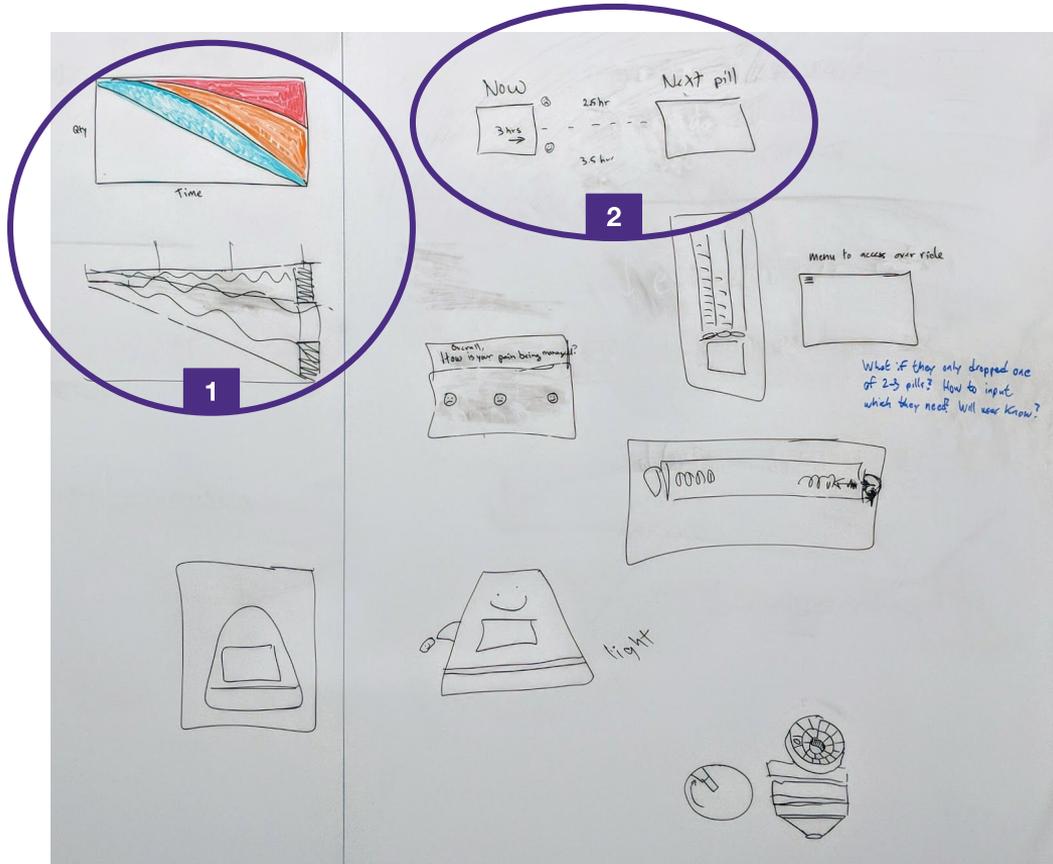
## **Purpose**

Define functional features for the device and the companion app.

## **Result**

Potential paths for future design sessions.

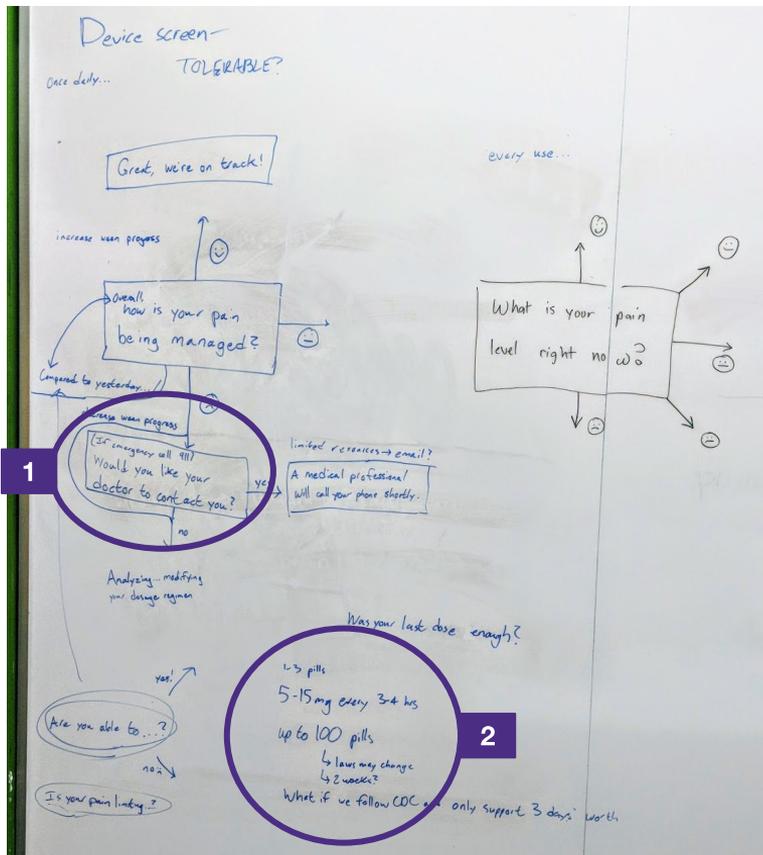
# Design Concepts and Sponsor Feedback



In these sketches, we explored different pill dispensing mechanisms and discussed how the device applies the user's pain feedback to its dose timing algorithm.

1. This graph sketch shows use of opioids over time, where patients ideally would reduce their usage over time. Green would be an ideal trajectory while patients following paths in orange or red would be contacted by their medical care team for check-in. We want our device to help users stay in the green, and allow their responses on pain to determine how the device tracks dose timing.
2. This sketch shows how a user who responds with a happy face will be given their dose after a longer duration than a user who responds with an unhappy face.

# Design Concepts and Sponsor Feedback



In these sketches, we explored the device interaction flow. We discussed how the device would enable users to contact their medical care team when in pain.

During this interaction flow exercise, we met with a member of our sponsor team who prompted us to consider how busy doctors are and their lack of time to connect with their postoperative patients in this manner. We removed this feature in the next iteration of our interaction flow sketches, instead moving it to a menu.

1. Our initial concept for the device's response to a user feeling that their pain is not being managed. After discussion with our sponsor, we removed interaction flow based on the user's pain response and instead we track that data for dosage timing.
2. We asked our sponsor about typical prescription values that would inform our design parameters.

# Design Session 4: Sketches and User Flow Part 1

## **Question**

How do we iterate our current design paths?

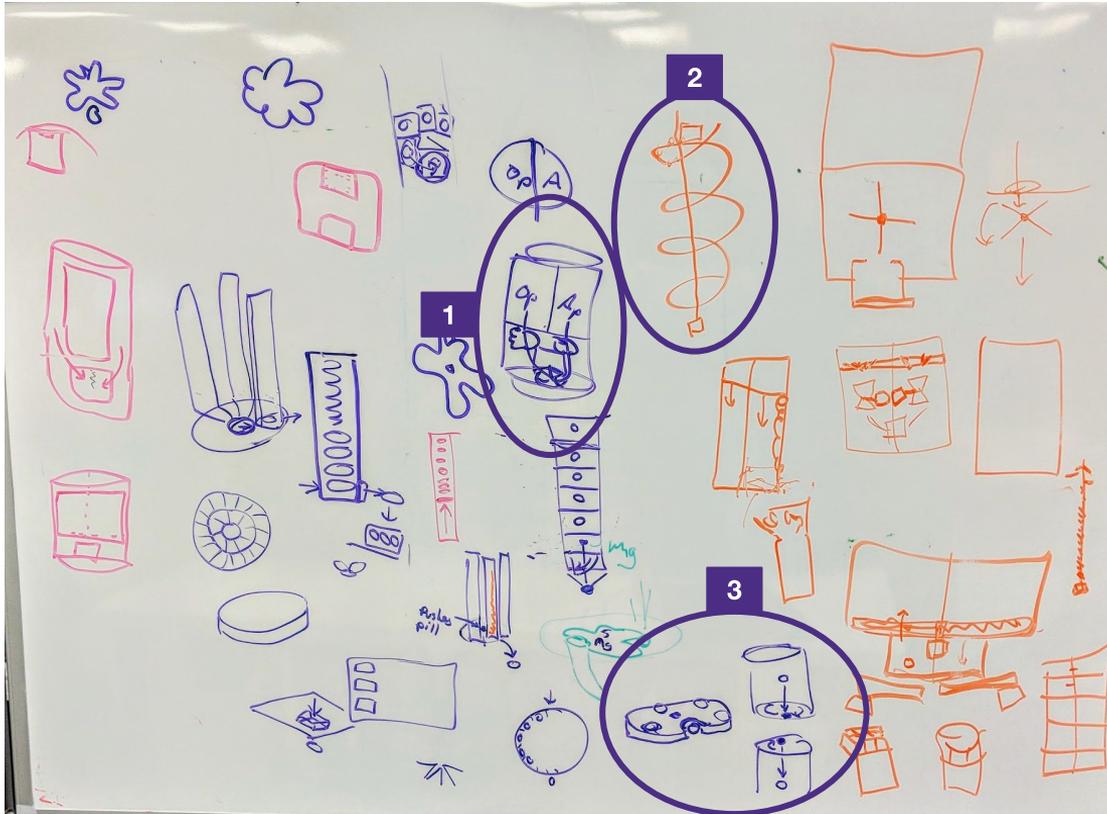
## **Purpose**

Improve designs to serve user flow and goal acquisition.

## **Result**

Improved designs and user flow paths.

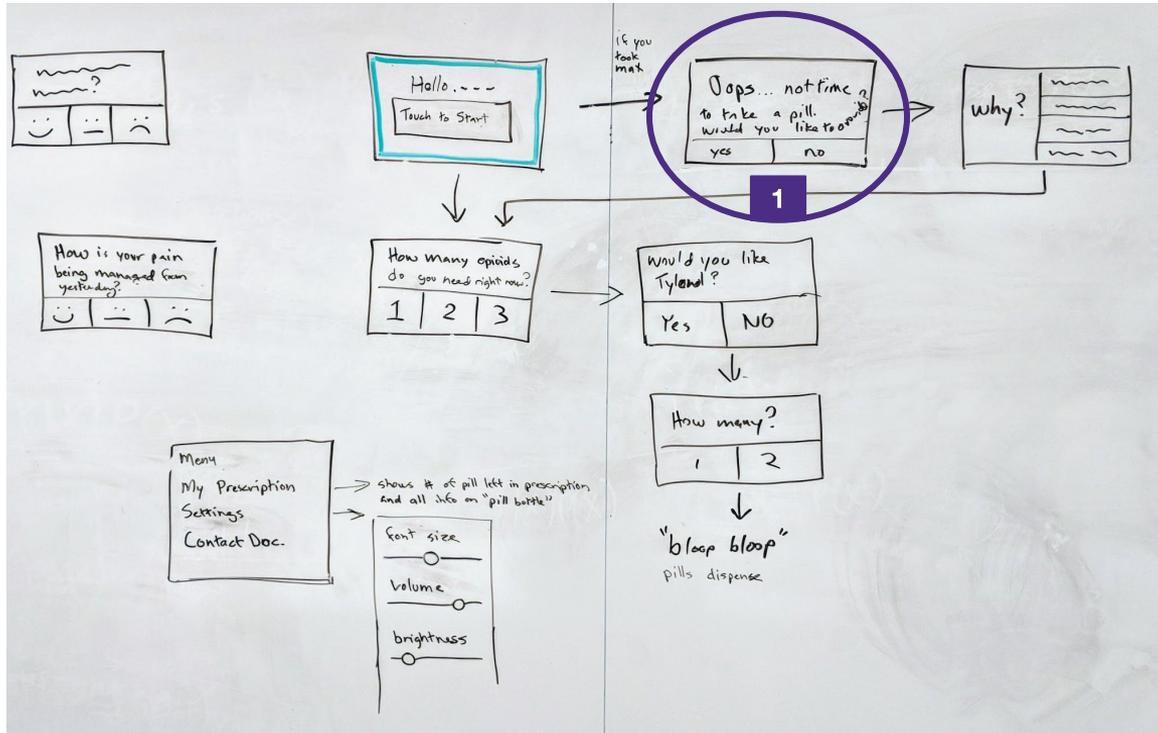
# Sketches and User Flow



In these sketches, we explored and considered the feasibility of different pill dispensing mechanisms and how we could fit two compartments into one device with a screen and computer.

1. The overall form factor of our device, with two compartments above a housing for the microcontroller that also allows pill to dispense out of one place.
2. A spiral mechanism that would allow our device to accurately work without gravity, yet would be more difficult to 3D print and implement.
3. A rotating gear mechanism that would be easy to implement but may fail to dispense a pill every time the user requests one.

# Sketches and User Flow



In this iteration of our device interaction flow, we considered what screens and interactions should a user face if they request more opioids than their prescription suggests. We discussed how a user may need to request extra medication if they lost or dropped their pills, if they were in excessive pain, or if they would be unable to take the device with them somewhere. The device would record the user's response here in order to appropriately track whether the user is sticking to their prescription (such as when they dropped a pill) or exceeding it.

1. The "override" screen presented to users when they request more opioids than their prescription allows in a number of hours.

# Design Session 5: Sketches and User Flow Part 2

## **Question**

How do we finalize our design paths?

## **Purpose**

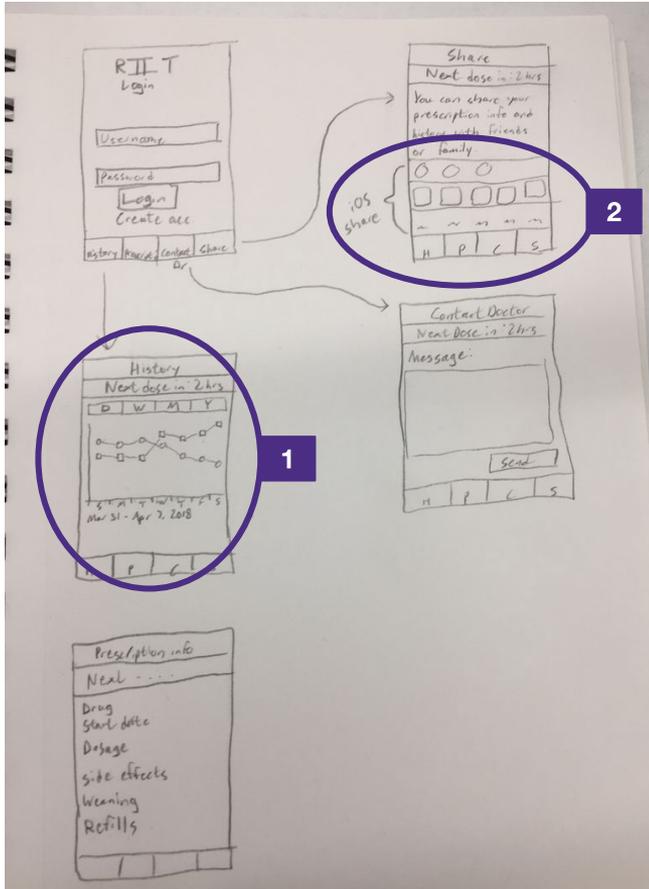
Build clear, complete paths to follow when implementing our prototypes.

## **Result**

The framework for Phase II: Prototyping.



# Sketches and User Flow



In these sketches, we explored how the app screens and interaction flow would look. We considered how the app would fit within iOS design guidelines. We planned out a login screen with the idea that patients would receive or create login info when they learn about the device at the hospital. They could then share their profile with family members to allow them access to their data and prescription information. Caregivers would receive their own login information at the hospital.

1. The history screen, where we were in part inspired by the iOS health app's historical data view. Users could view how many opioid or OTC pills (such as Tylenol) they took either over day, week, month, or year time resolution.
2. The iOS share content interface, allowing a user to share their prescription info and historical data.

These sketches will guide our 2D screen design as we transition to the Prototyping phase.

# Moving Forward

In this Design phase we turned conceptual ideas into concrete artifacts so systems can be built and tested.

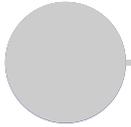
In Phase 2, we will create a 3D and 2D Prototype for the PCA device, the device interface, and the companion app using 3D printing, physical computing, and digital interactive wireframes.

In Phase 3, we will Evaluate and Analyze our PCA device through usability evaluations with users.

In Phase 4, we will Iterate on our design by utilizing what we have learned from all previous steps in this process.

# Moving Forward

Milestone 1  
**Design**



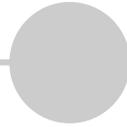
Pill Box  
Companion App

Milestone 2  
**Prototype**



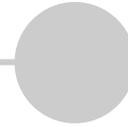
Physical Computing  
Interactive Demo

Milestone 3  
**Evaluation**



Usability Testing  
Data Analysis

Milestone 4  
**Iteration**



Pill Box 2.0  
Updated Companion App