Ola worry free diabetes care

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Project Home Page
http://stanford.edu/class/cs147/projects/information/ola/index.html

App installation
http://install.diawi.com/XrFBA3

I.   Problem and Solution Overview

Currently, type one diabetics must manage their condition by continuously monitoring their blood sugar levels, insulin dosages and food intake using a variety of isolated devices. They also have to worry about what would happen in an emergency. Worse, our research found that a large portion of diabetics only consult their doctors for medical advice during appointments once every six months, even though a patient's needs may vary in a matter of weeks.

Ola addresses these issues by consolidating each component of diabetes care and by facilitating communication with healthcare providers. It consists of a smartphone application and wearable pod that provides real time context-aware care for diabetic patients through advanced data analytics and the pod's continuous blood glucose monitor or insulin pump. With approximately 8% of the world population suffering from diabetes, we have developed Ola with the vision of enabling every diabetic person to live a normal life without having to worry about his or her condition.
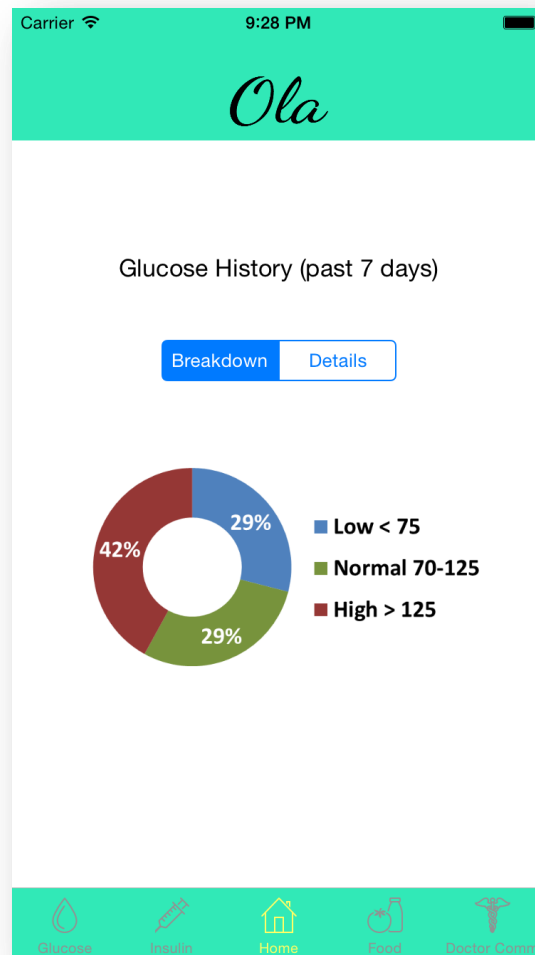
Figure 1 Ola overview

Figure 2 Ola Home Screen

II. Tasks & Final Interface Scenarios

The three representative tasks we chose in order of increasing complexity are:

1. Eating a meal [Simple]
    Counting carb intake is one of the most important things that people with diabetes would do every day. Whenever they want to eat something, they have to estimate the carbs in the food in order to inject proper amount of insulin. Much of this learning occurs by rote memorization from print or web guides or by trial and error. The hypo- and hyperglycemia associated with the latter can be especially dangerous for a young person unfamiliar with counting carbs. Therefore, we implemented a food camera, as well as a dictionary of foods and carbohydrate values, in order to offer more precise treatment for the user. This task is

chosen because the impact of inaccurate estimation of carbs could be huge. If the estimation is higher than reality, too much insulin would be injected and may result in low blood sugar. If the estimation is lower, the amount of injected insulin would not be enough to cover the carbs and would lead to a high blood sugar level. Thus diabetics need a convenient and accurate way to count the carbs and determine the appropriate amount of insulin to inject.
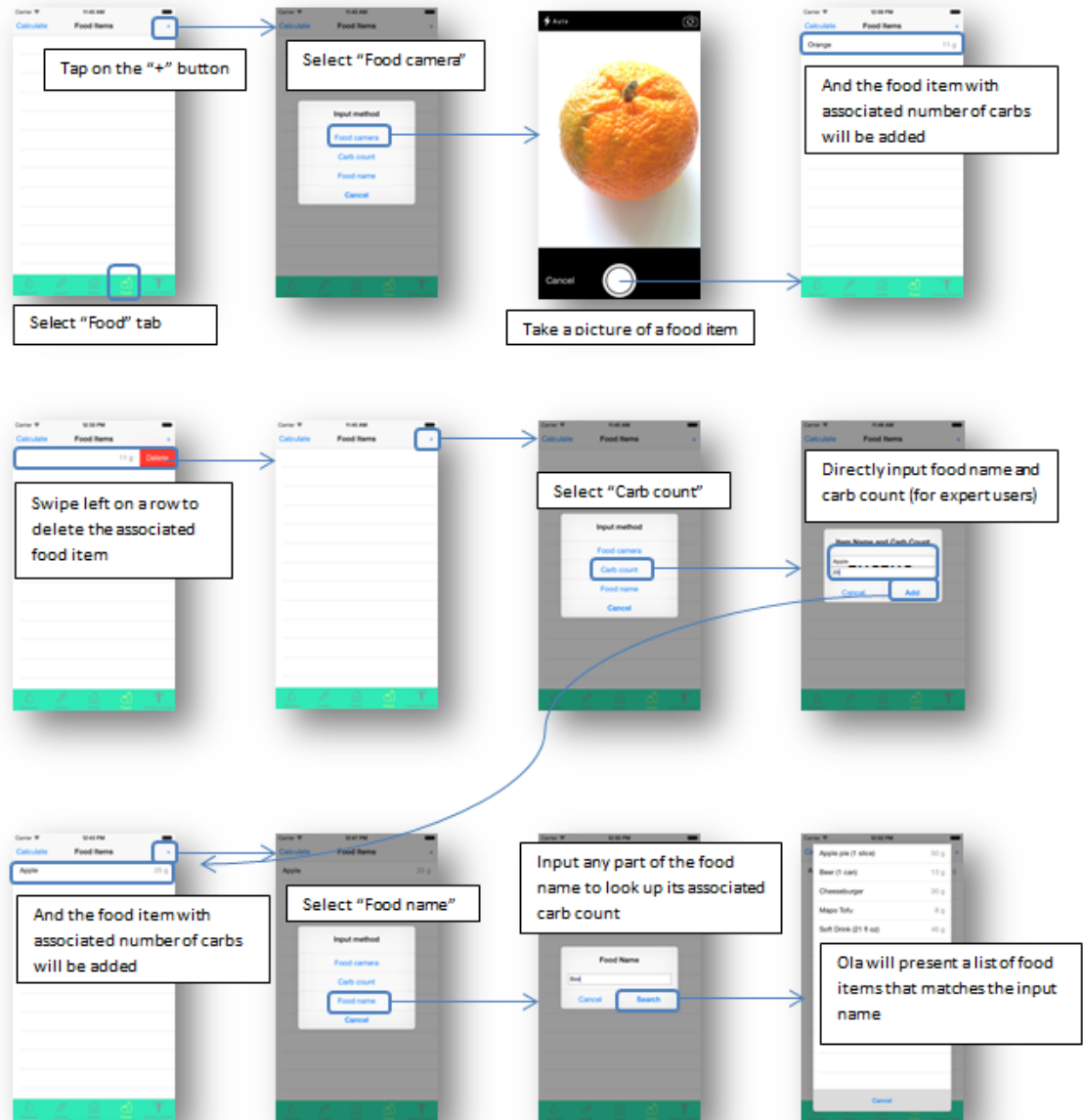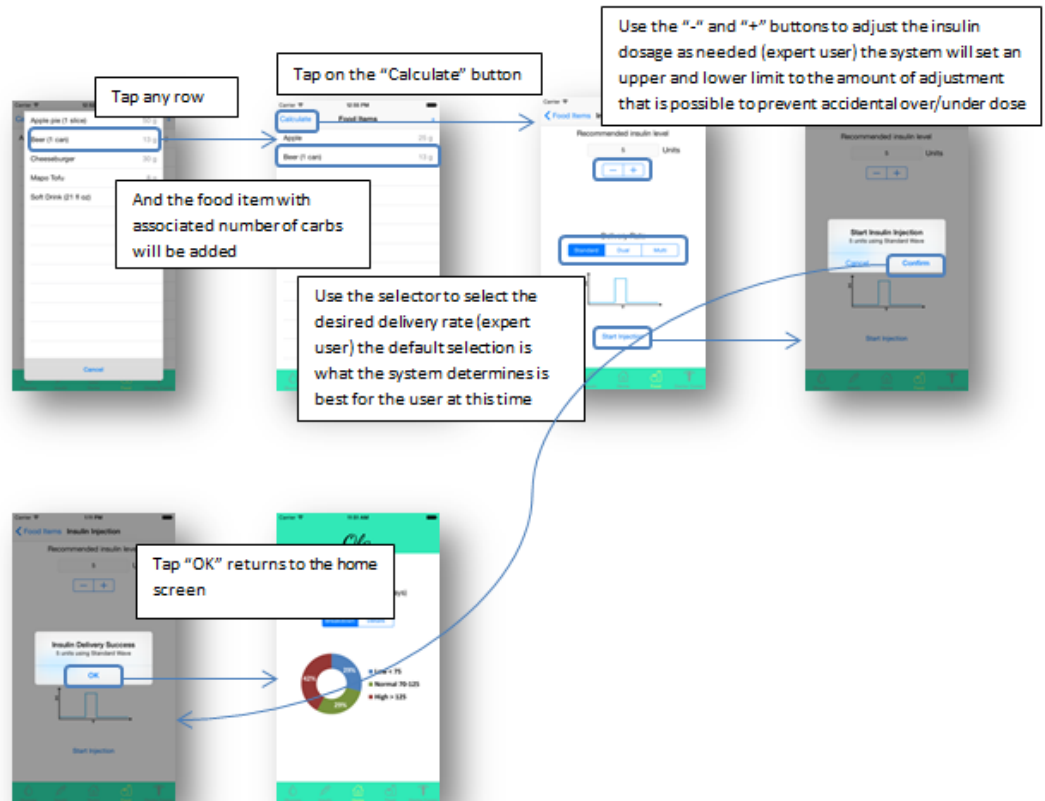

Tap on the "+" button

Select "Food camera"

And the food item with associated number of carbs will be added

Select "Food" tab

Take a picture of a food item

Swipe left on a row to delete the associated food item

Select "Carb count"

Directly input food name and carb count (for expert users)

And the food item with associated number of carbs will be added

Select "Food name"

Input any part of the food name to look up its associated carb count

Ola will present a list of food items that matches the input name

Figure 3 Eating a meal storyboard (1/2)

Tap any row

Tap on the "Calculate" button

Use the "-" and "+" buttons to adjust the insulin dosage as needed (expert user) the system will set an upper and lower limit to the amount of adjustment that is possible to prevent accidental over/under dose

And the food item with associated number of carbs will be added

Use the selector to select the desired delivery rate (expert user) the default selection is what the system determines is best for the user at this time

Tap "OK" returns to the home screen

Figure 4 Eating a meal storyboard (2/2)

2. Emergency severe low blood sugar care (moderate)

We chose this as a task because, currently, if a diabetic person loses consciousness as the result of severe low blood sugar, he or she is at the mercy of bystanders, and may not receive the care he or she needs. This can result in serious injury, or in many cases, death. Ola is designed to recognize an emergency severe low blood sugar event based off of data from the wearable pod. It will alert paramedics and emergency contacts, as well as provide useful instruction for any bystanders.
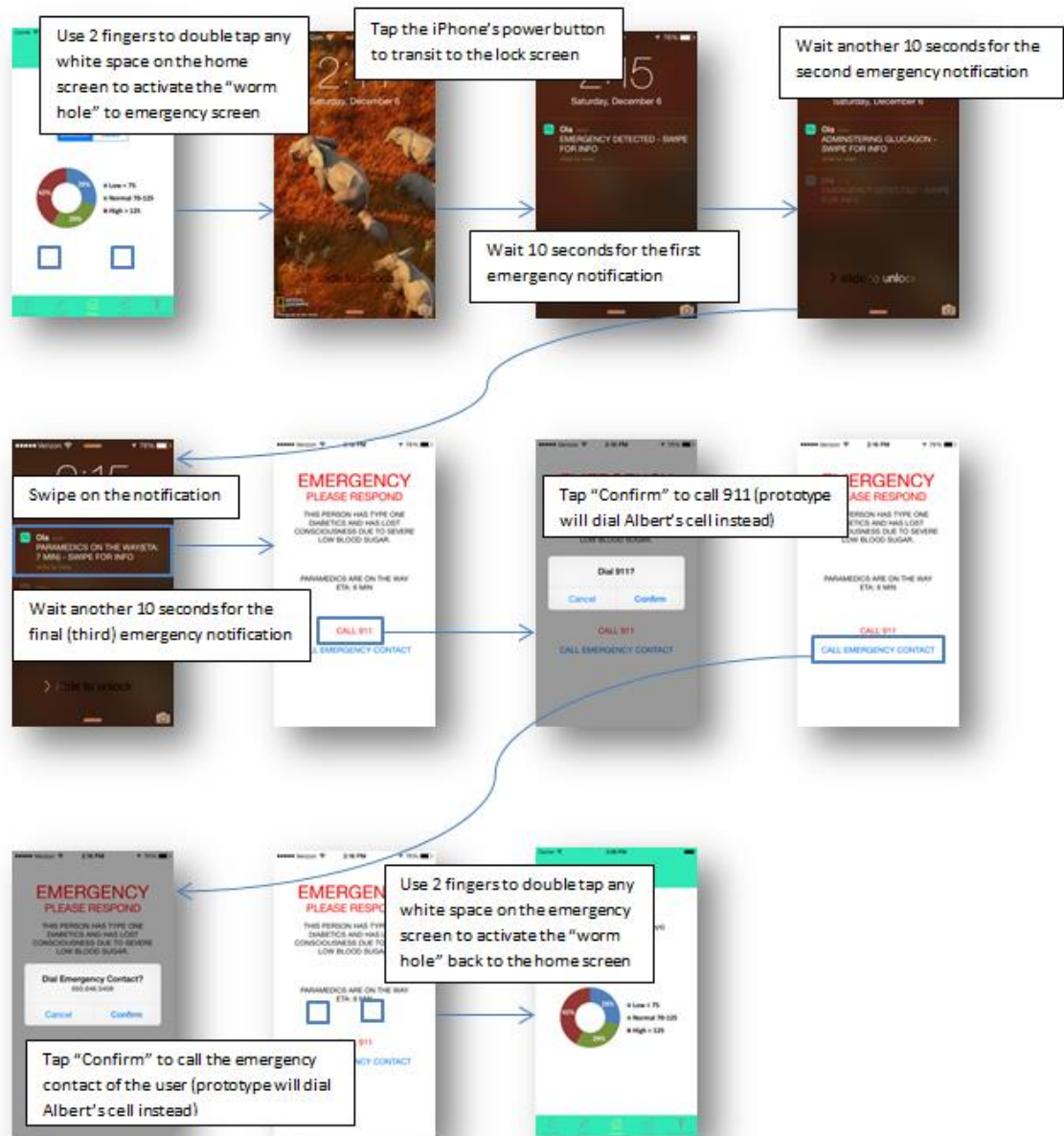
Figure 5 Emergency severe low blood sugar care storyboard

3. Determine and implement optimal insulin dosage (Complex)

Communication between the user and his or her doctors and nurses is at the center of the Ola app. Currently it is likely that a user may only receive instruction on a dosage change when in the doctor's office. Such changes may be outdated in as little as one or two weeks, when most diabetic patients visit their doctors at most once every three months. Therefore, we have chosen to make communication with the user's health care providers central to the Ola app, and allow users to implement doctor's recommendations directly from a message.

Tap the "New" button to compose a new email to doctor

Select the "Doctor Comm" tab

Use the search box to locate a specific doctor message

Tap any row to view the associated doctor message

Tap the "Reply" button to send a reply message

Tap on the first row to view the unread message (indicated by the blue dot)

Tap "Confirm" to implement the dosage change

Tap "Confirm" to undo the dosage change

Figure 6 Dosage change storyboard

III.   Major Usability Problems Addressed

1.   [H2-8: Minimalist Design] [Severity 3] [Found by B+ D]

Evaluators' Comments

I feel that both of these pieces of information are highly relevant to users, but do both (Charts and Doctor Communications) need to coexist on the same page? They didn't feel intrinsically relevant to each other. I feel both pieces of information would be better served if they had their own dedicated pages that users could devote their attention to without having to decide their focus. By doing this, each page could also build up a more detailed page with relevant data to the pie chart and/or email communications. (Figure 7)

Response

We agreed that the ability to communicate with health care providers was being obscured, even though it is supposed to be one of the most important features. We solved this by replacing the "Profile" tab with "Doctor Communications," thus uncluttering the home tab and centering the communications in one more easily accessible location as showed in Figure 8.
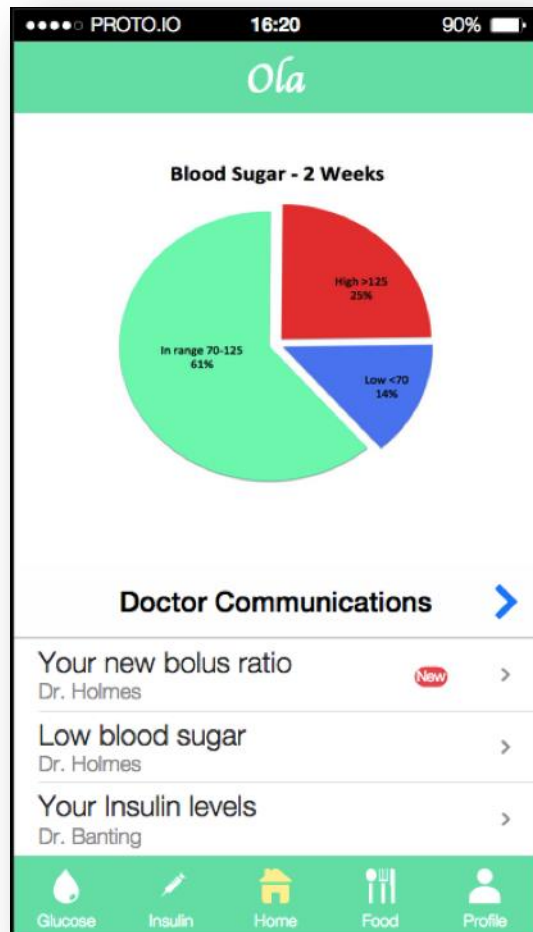
Figure 7 Mid-fi home screen
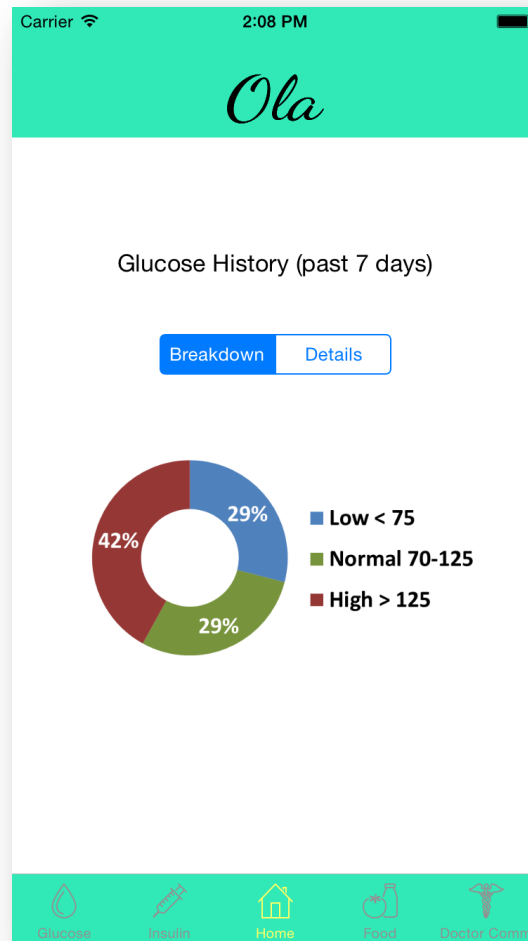
Figure 8 Hi-fi home screen

2.   [H2-7. Flexibility and efficiency of use][Severity 4][Found by A + B+ D]

Evaluators' Comments

Replying to doctors takes you off the App and into your email. To make this app very useful, it would be convenient to get all the information under one room. Having your incoming messages go to the app and your replying messages go somewhere else is inefficient and lacks consistency. Having the ability to reply to a doctor's note on the app will make things much easier.

Response

This was a function of the tool we used for building our medium-fidelity prototype. We made all communications with healthcare providers possible from within the app to avoid confusion and needless complexity, as showing Figure 9.
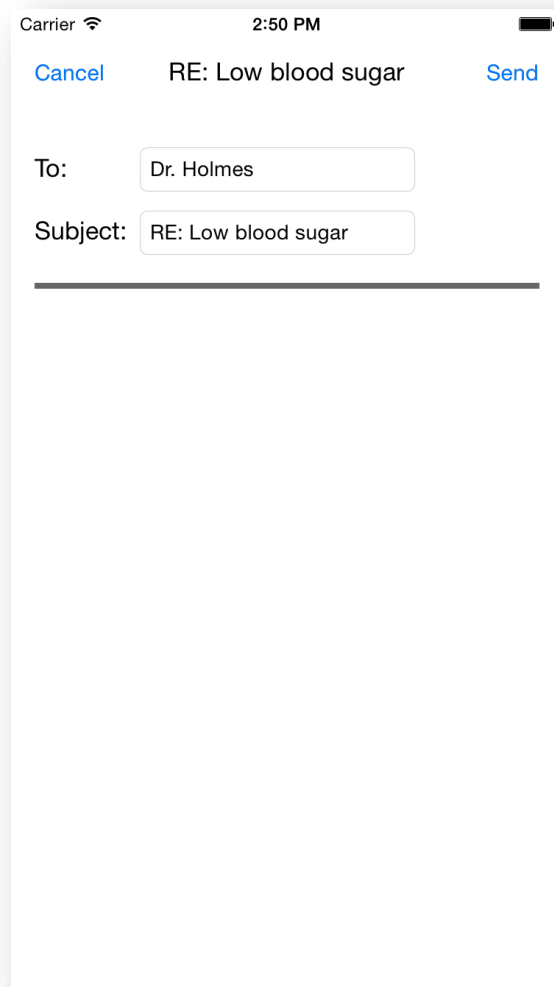
3.   [H2-7. Flexibility and efficiency of use][Severity 4][Found by A]

Evaluators' Comments

No way to add a note to your doctor. This is a function that many users will want to use. This also comes back to the idea of having everything under one roof; being able to fully communicate with your doctor through this app will bring a lot of value to it. Having a system that splits your communication into two different platforms defeats the purpose of this app.

Response

As part of our overhaul for the doctor communications component of the app, we added in-app email capabilities to send a new message to a doctor (Figure 10).
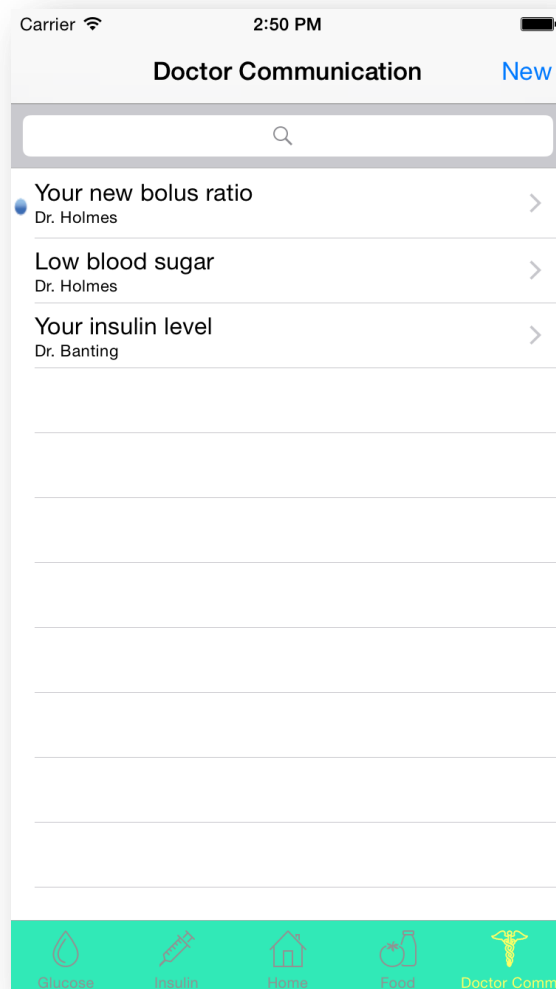
Figure 10 Hi-fi doctor communications screen

4. [H2-7. Flexibility and efficiency of use][Severity 3][Found by A]

Evaluators' Comments

Can't search under "Doctor Communications". It is very frustrating to manually filter through many messages. Adding search functionality would make things much easier for the user.

Response

We added a search bar to doctor communications to allow easier organization of the user's messages (Figure 11).
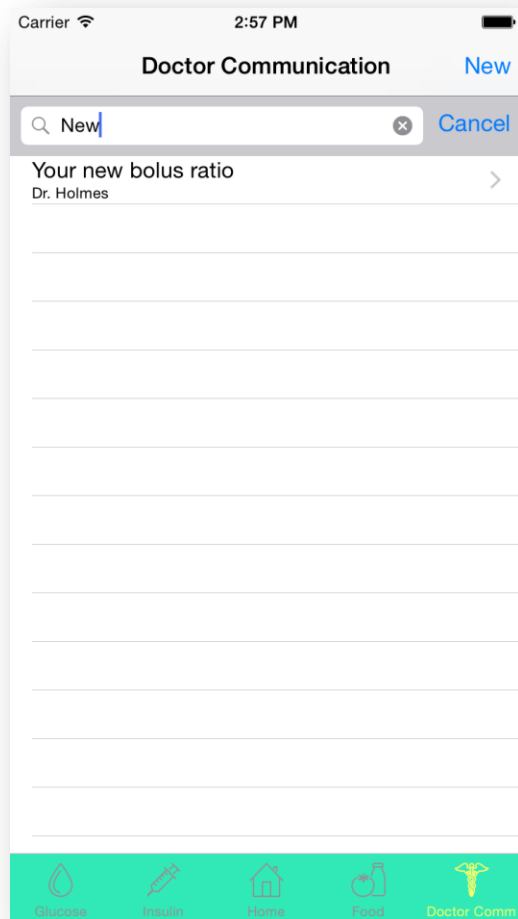
5.   [H2-5: Error prevention] [Severity 3] [Found by B]

Evaluators' Comments

When looking at an individual note from a doctor (a "Doctor Communication"), the user has two options: to either Reply to the note or to Implement the recommendation. However, the placement of the "Implement" button is placed where the most intuitive next step button would be. Further, if that button is clicked, there is no way to undo that action. (Figure 12)

Response

The next logical step should be to approve the change (i.e. there is no other "next step" possible, showed in Figure 13). We added the ability to undo the change from within the message in Figure 14.
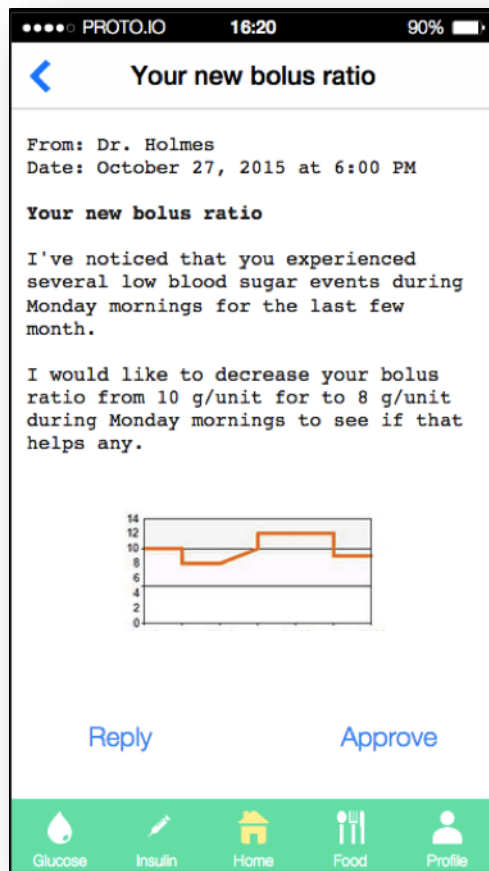
Figure 12 Mid-fi dosage change notification
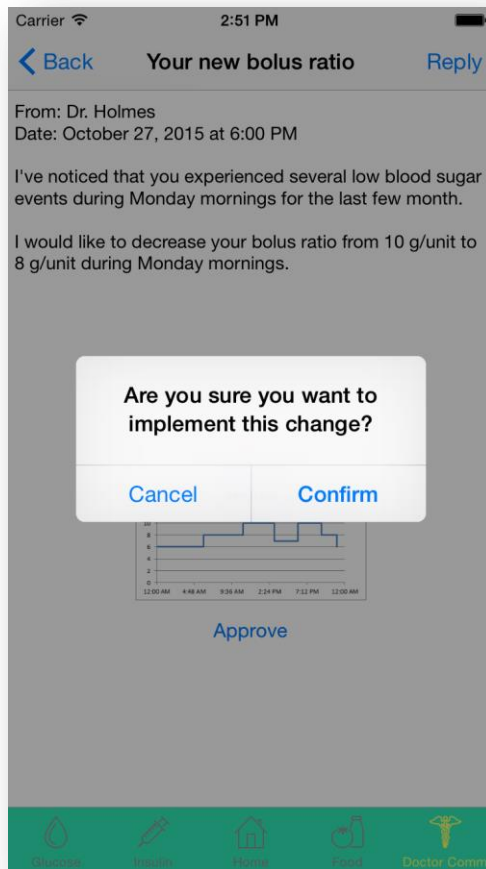
Figure 13 Hi-fi dosage change notification
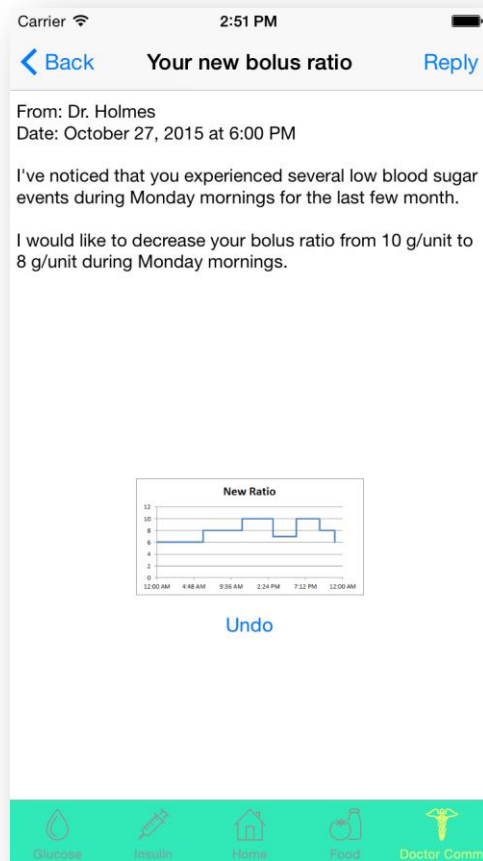
Figure 14 Hi-fi dosage change undo

6.   [H2-7:Flexibility and efficiency of use] [Severity 3] [Found by B+ D]

Evaluators' Comments

Again, on the foods page, I realize that there are TWO options of how to enter your carb intake. However, I don't think the way the page is laid out makes it obvious that the user can choose ONE of the TWO methods. Instead, it seems a little like the user has to use both features on the page to get to the next step. (Figure 15)

Response

We modified the food tab(in Figure 16) to be a list screen and each push of the "add" button gives the option to 1) take a food picture, 2) search for a food by name, or 3) input a carbohydrate count manually.
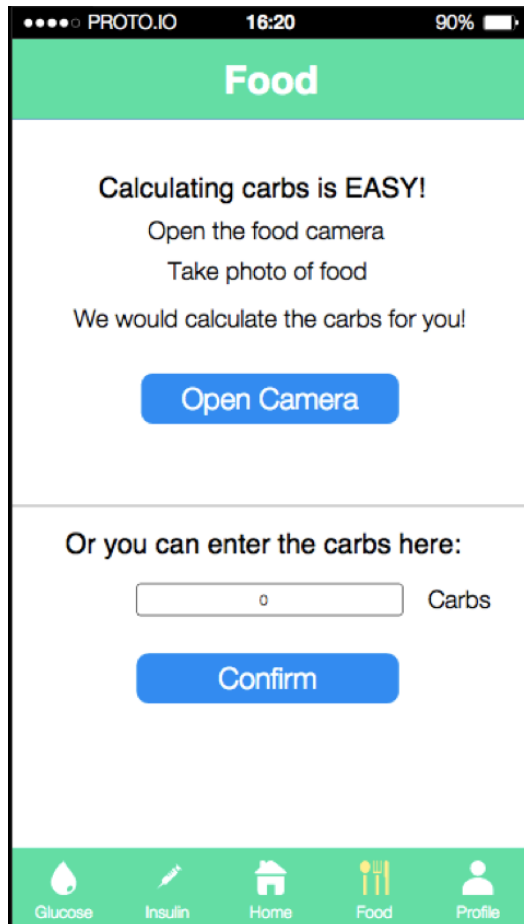
Figure 15 Mid-fi new food item input
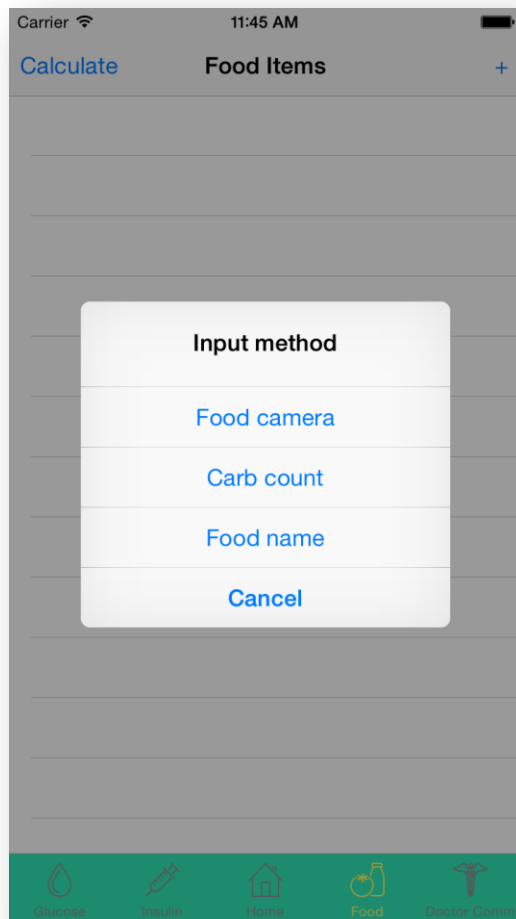
Figure 16 Hi-fi new food item input

7. [H2-1. Visibility of system status][Severity 3][Found by A+C+ D]

Evaluators' Comments

I was unaware that I could click the pie chart on the main page to see a different chart. This is something that can easily be overlooked because the app has no indication that clicking the pie chart will bring you a different chart. (Figure 17)

Response

We modified the home screen to use a selector to choose which chart to display, as showed in Figure 18 and Figure 19.
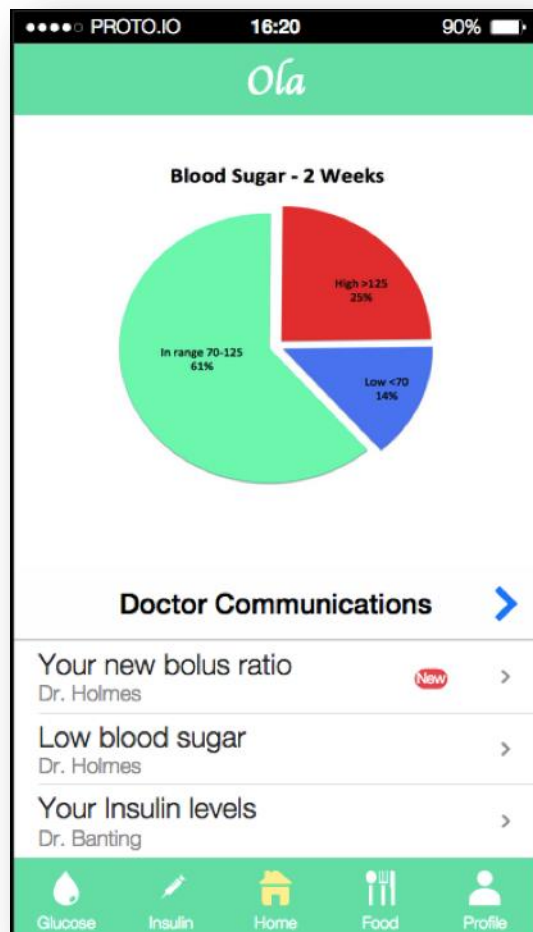
Figure 17 Mid-fi home screen chart
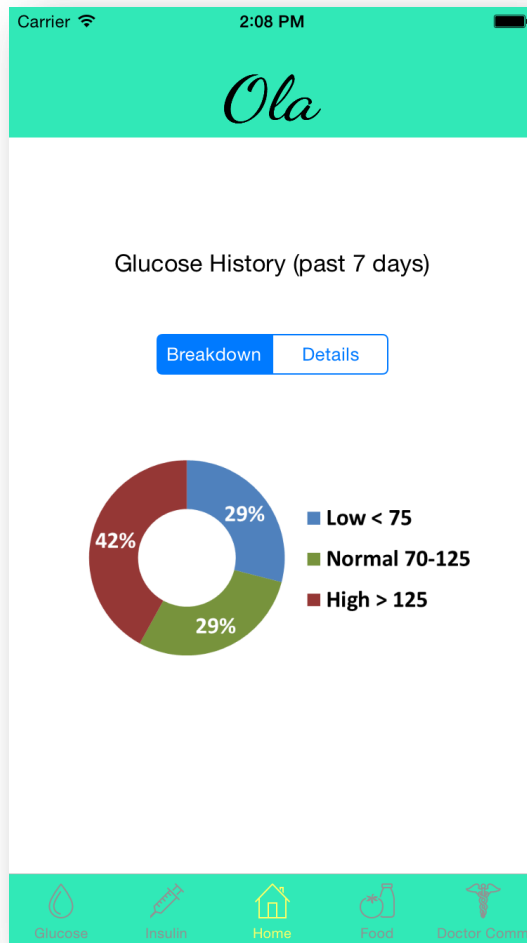
Figure 18 Hi-fi home screen chart 1

Figure 19 Hi-fi home screen chart 2

8.   [H2-5. Error prevention][Severity 3][Found by A]

Evaluators' Comments

Under the "Food" section, after confirming the amount of carbs I am currently consuming, it says "Based on your history data, your recommended insulin level is…" not sure what kind of time frame this is working with. This ambiguity may cause problems for someone who interprets it the wrong way. There is also no documentation to help with this issue. (Figure 20)

Response

We reworded label to "Recommend insulin level", as shown in Figure 21.
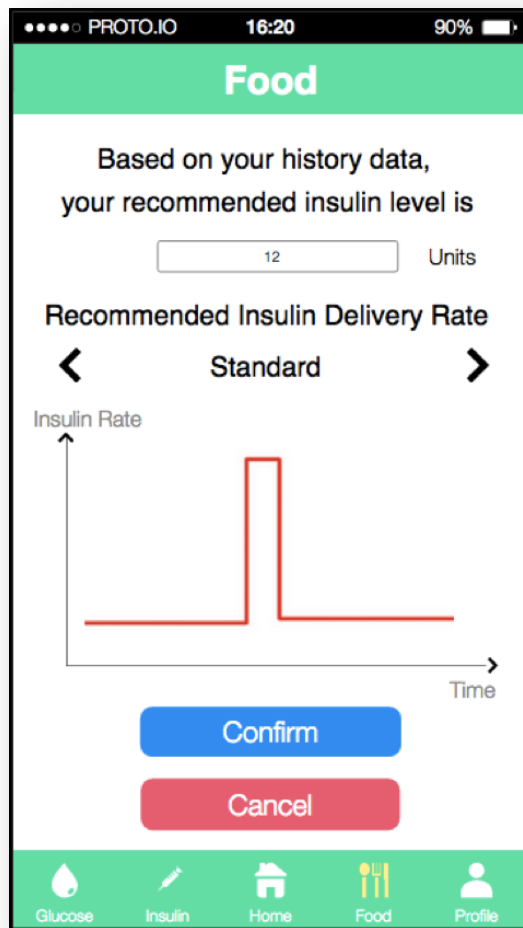
Figure 20 Mid-fi insulin injection screen
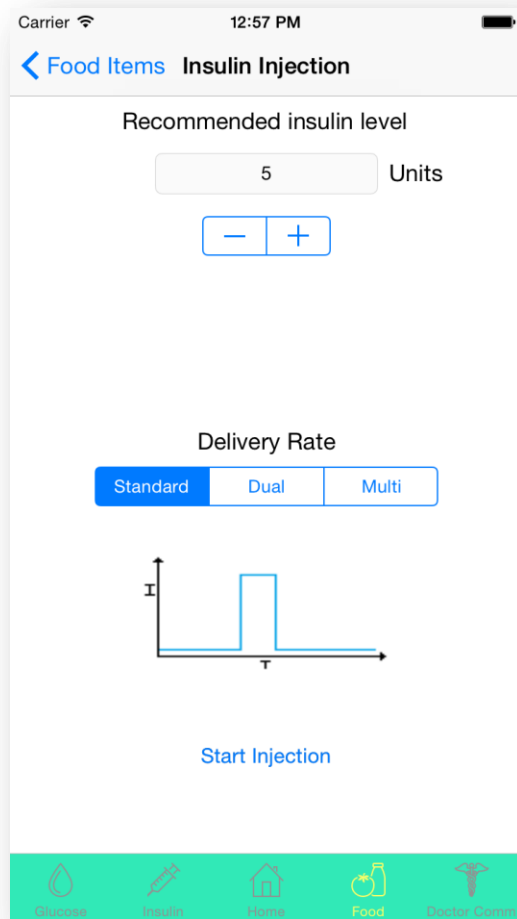
Figure 21 Hi-fi insulin injection screen

9. [H2-10 Help and Documentation] [Severity 3][Found by A+C]

Evaluators' Comments

Under the food section I have the option of choosing "Standard", "Short Extended", and "Dual". This is probably something a diabetic would know, but if they don't, for some reason, there is nowhere to check what that is or what the best delivery method is.

Response

Our target users are diabetics.

10. [H2-7. Flexibility and efficiency of use][Severity 4][Found by A + B+ D]

Evaluators' Comments

The calculation of carbs via picture seems very inaccurate. Being able to manually enter carbs is a good thing, but taking a picture of your meal probably won't give you the best results (this would take quite a bit of machine learning and would most likely end up being the main focus within development). I suggest having some sort of search functionality where a user can enter what they are eating and the portion size. The returned output will be the carbs associated with that piece of food.

Response

We modified the food tab to be a list screen and each push of the "add" button gives the option to 1) take a food picture, 2) search for a food by name, or 3) input a carbohydrate count manually. As shown in figure below, the user could now search a food by name and Ola will return a list of matching food items.
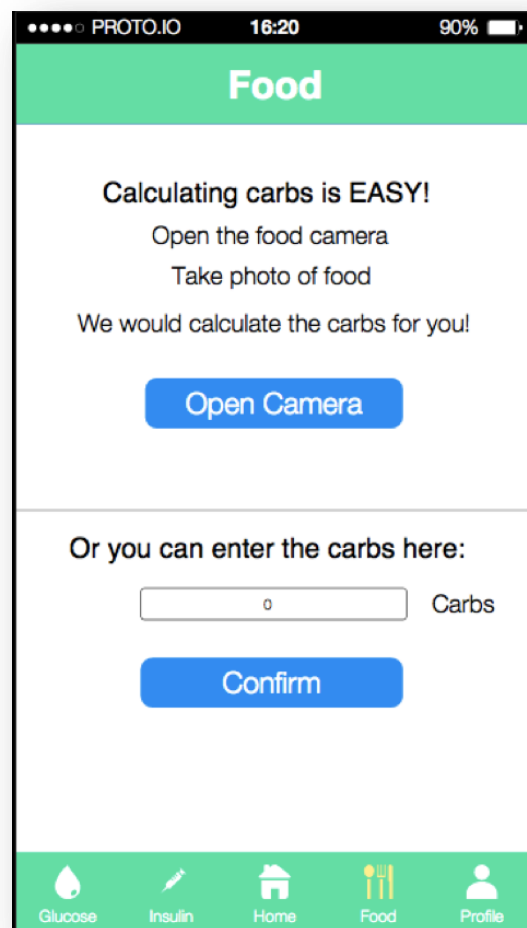
Figure 22 Mid-fi food tab
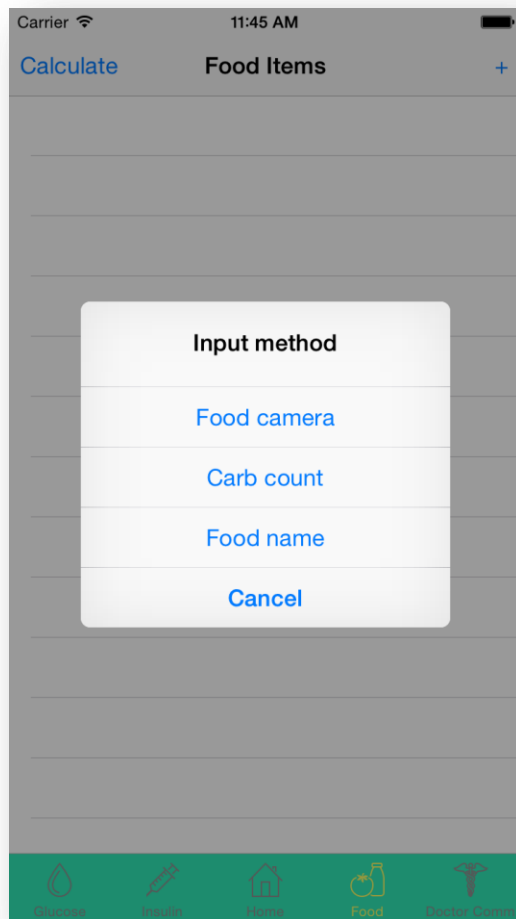
Figure 23 Hi-fi search by food name 1/2
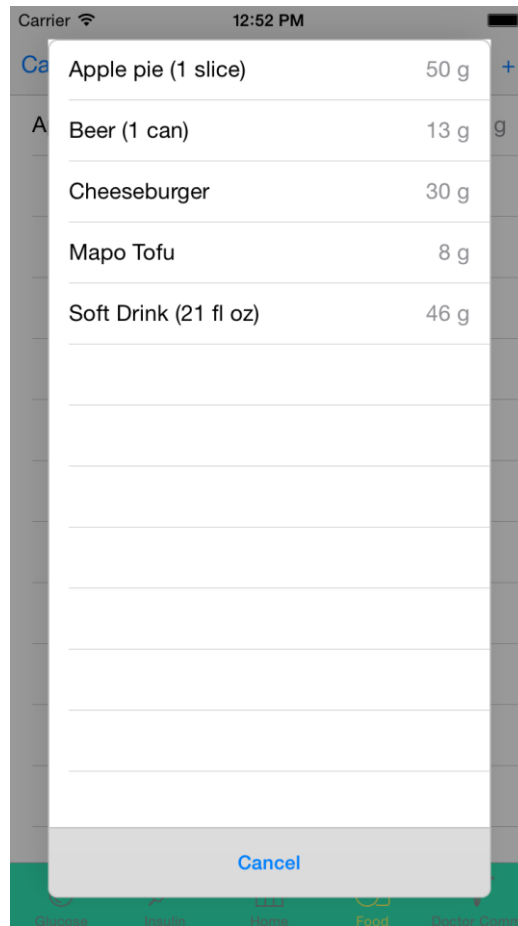
Figure 24 Hi-fi search by food name 2/2

11.   [H2-7. Flexibility and efficiency of use][Severity 3][Found by A+D]

Evaluators' Comments

The only way to add multiple pieces of food (i.e. Banana and Milk mentioned in the report) is by taking separate pictures. You cannot input multiple amounts of carbs. This is a simple fix that would make the carb counting functionality a bit easier to use and more consistent.

Response

We do support multiple food items in a single shot. This might not be self-evident in the Mid-fi prototype.

12.   [H2-1: Visibility of Status] [Severity 3][Found by D]

Evaluators' Comments

There is no responsive indication of where the user is in the app. Ola works to segment the app into logical sections (insulin, home, food, etc.) but does not give the user either a pipeline or highlighted tab to help them get a sense of where they are within the application. I found this most disorienting

when in the 'Dr. Communications' section, when the forward/backward buttons take you to an inbox rather than home. I immediately searched to figure out where I was but was left confused.

Response

We modified the color scheme to make the highlighted/selected tab more visible. As seen in the figures below, we have dimmed the unselected tabs to make the current tab more visible.
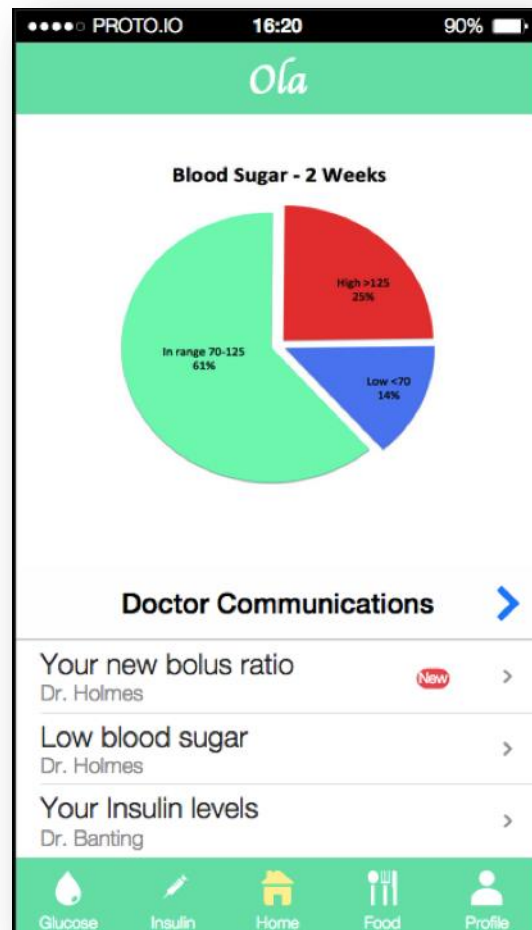
Figure 25 Low-fi home screen
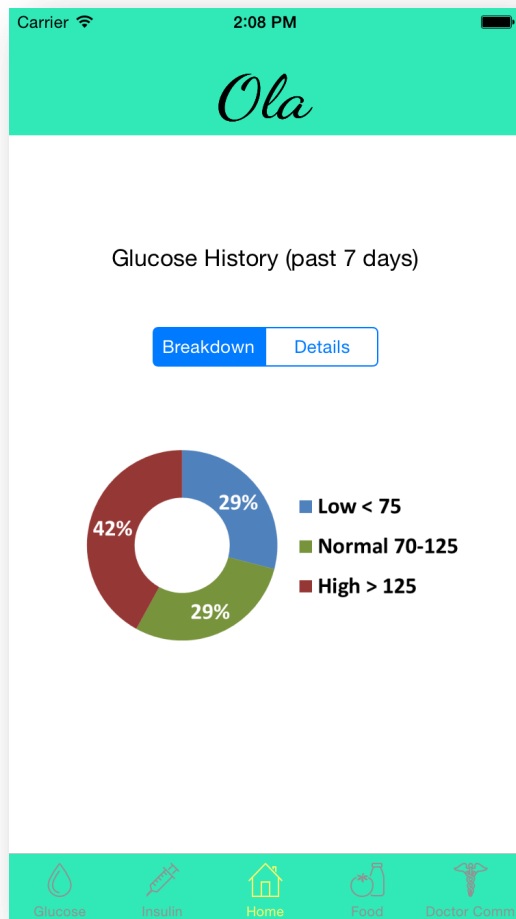
Figure 26 Hi-fi home screen

IV. Design Evolution

We firstly did contextual inquiries and gathered the feedback for our initial sketches:
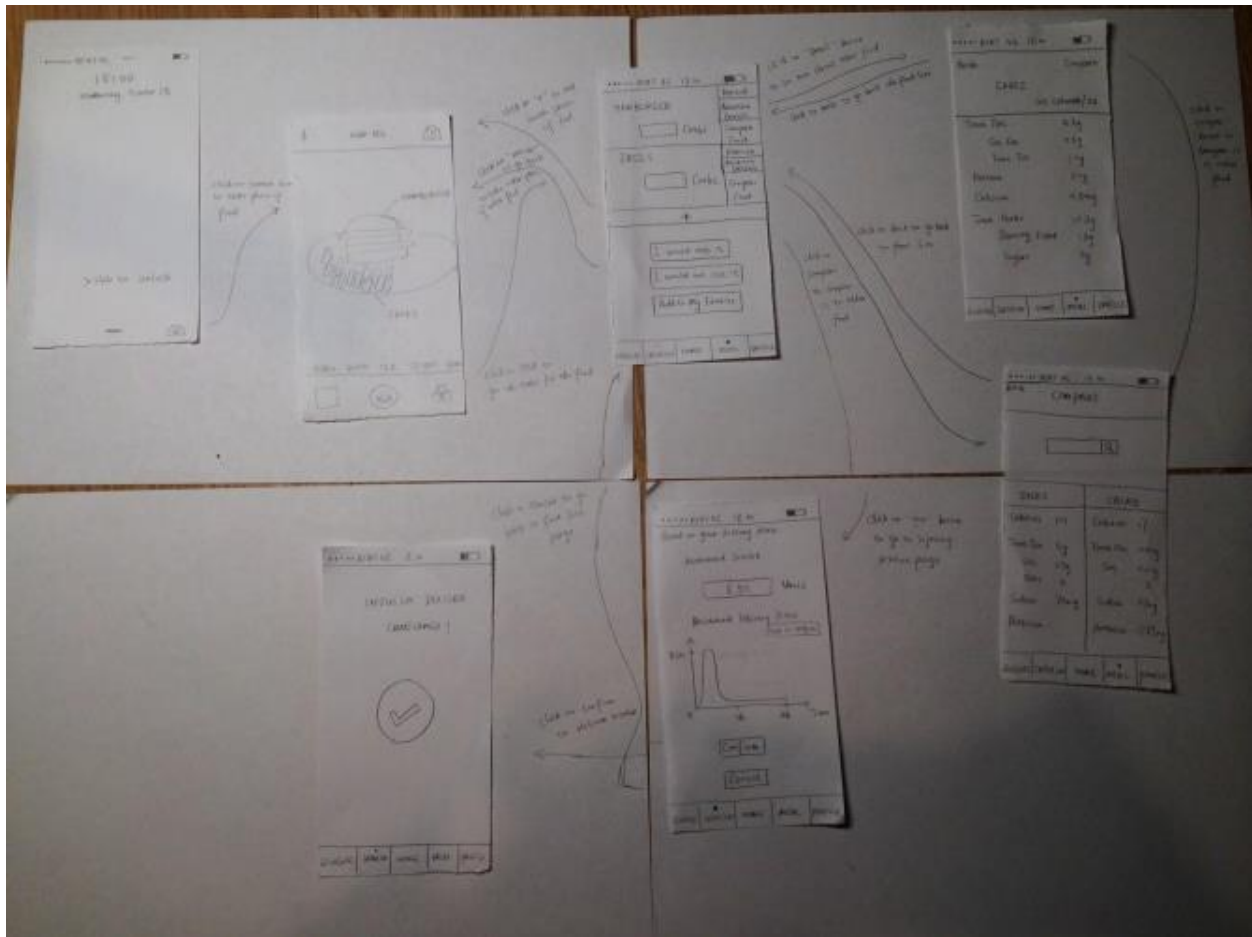
Figure 27 Initial storyboard sketch for carb counting and insulin delivery task.
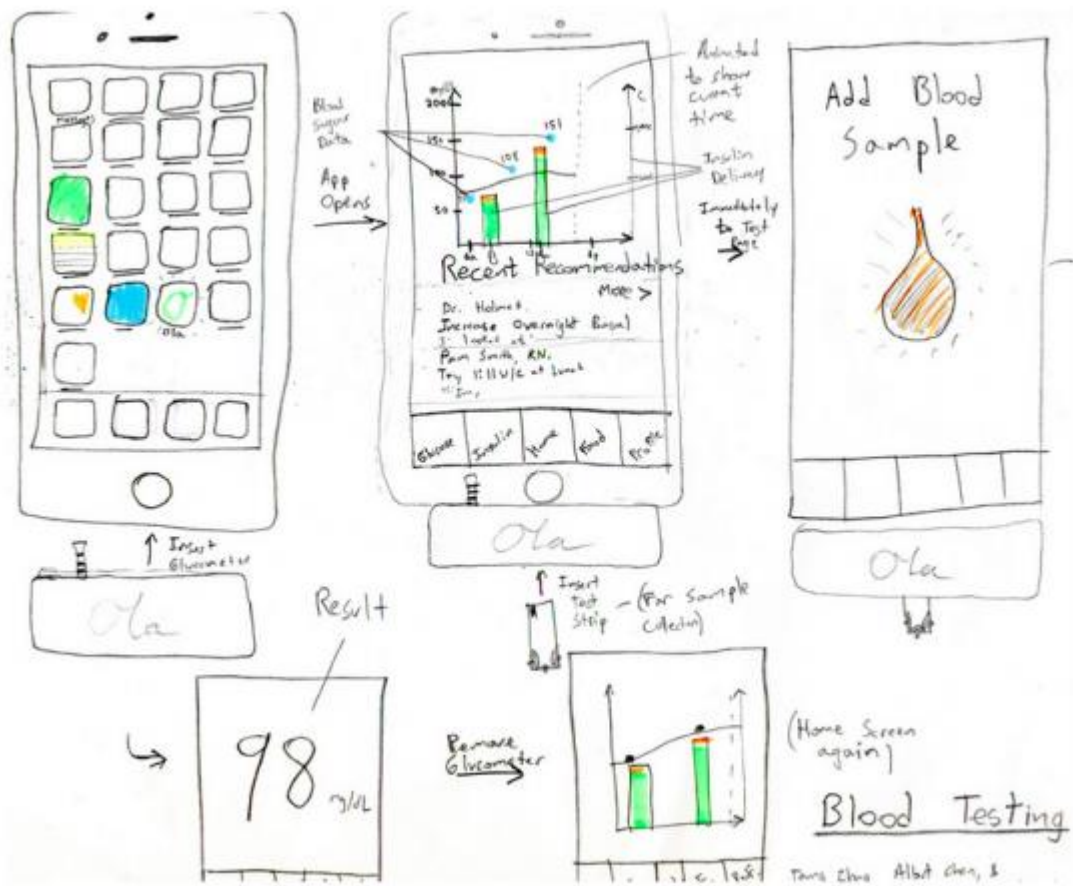
Figure 28 Initial sketch for blood sugar testing (a task we chose not to pursue).
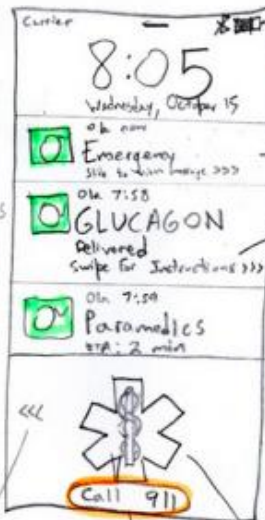
Figure 29 Initial storyboard sketch for Emergency Response.
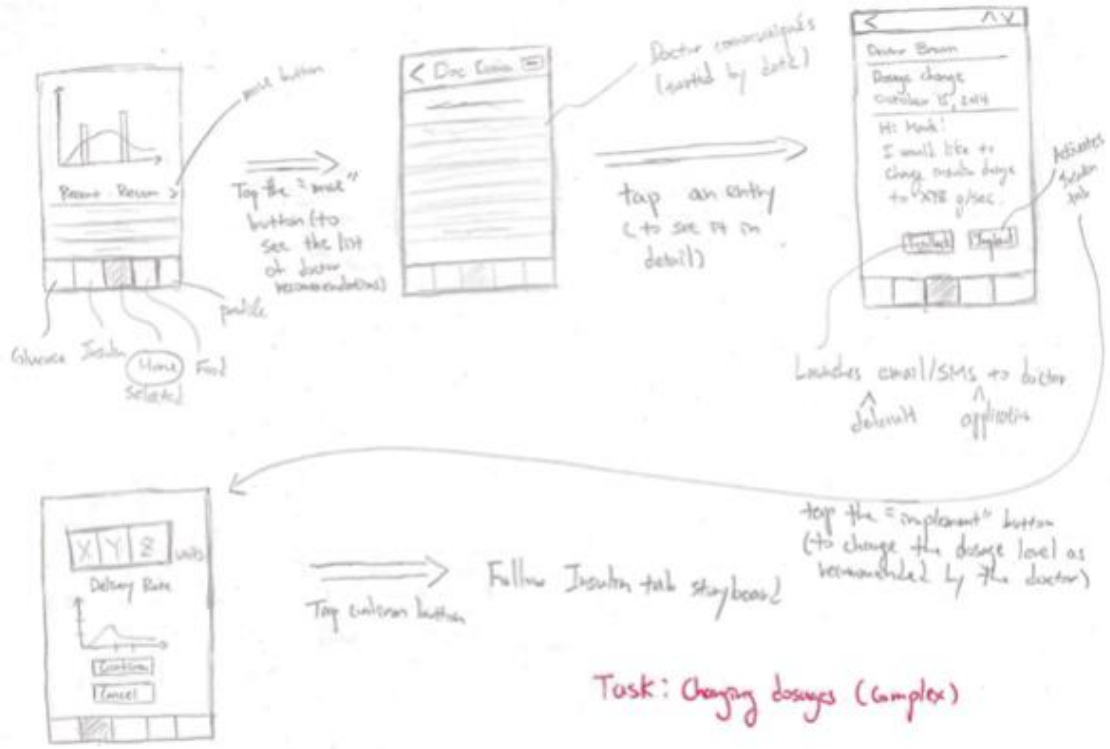
Figure 30 Initial storyboard sketch for Changing Insulin Dosages (later integrated into Doctor Communications task)
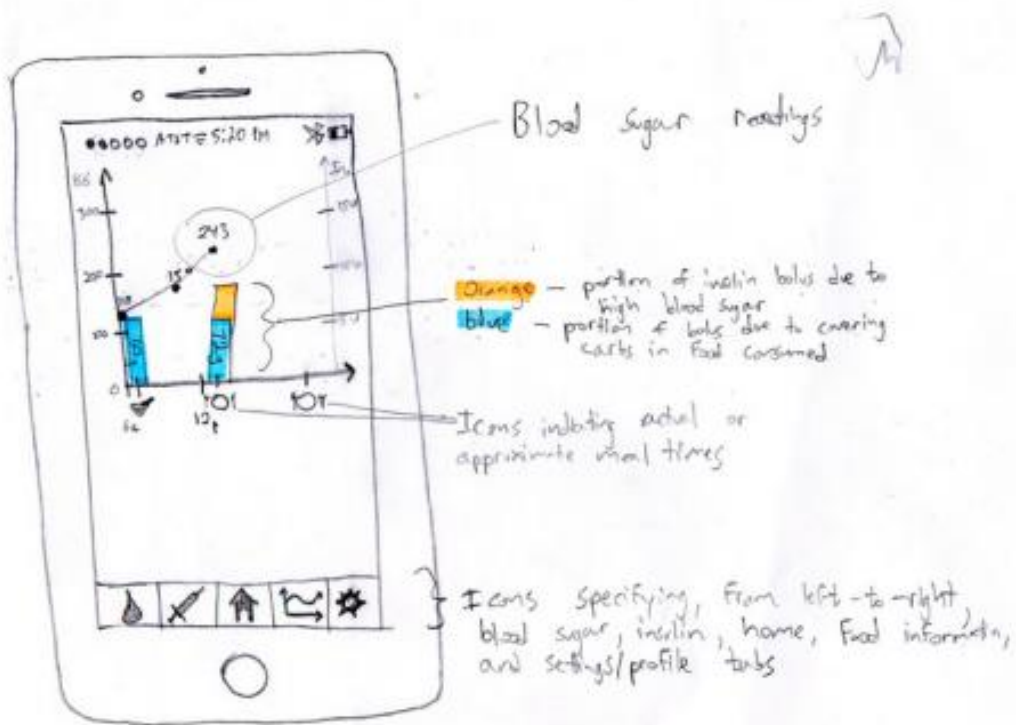
Figure 31 Early sketch of the home tab

Based on the initial sketches, we built our low-fi prototype:
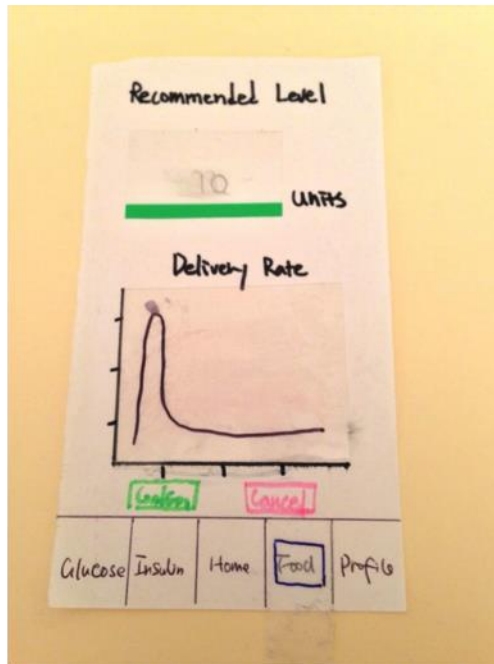
Figure 27 Paper prototype page from Insulin Delivery task
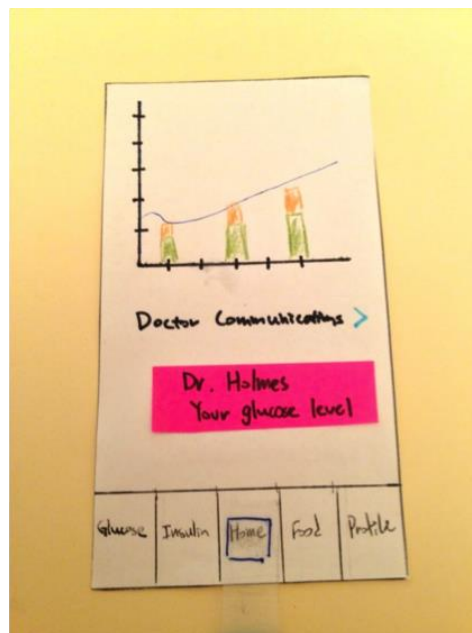
Figure 32 Paper prototype page from Doctor Communications task

Figure 33 Paper prototype for Carb Counting
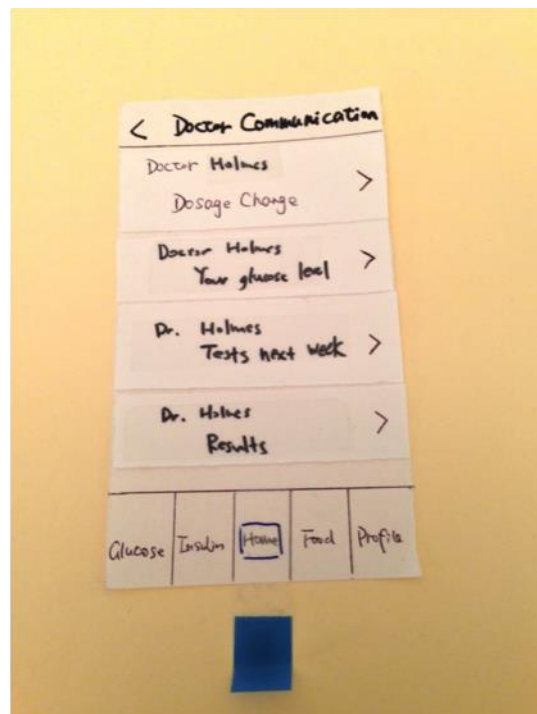
Figure 34 Paper prototype page for Doctor Communications
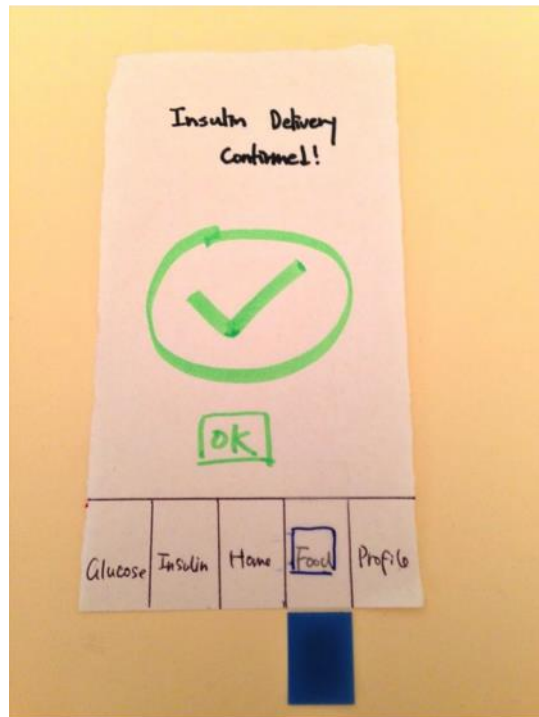
Figure 35 Confirmation Page
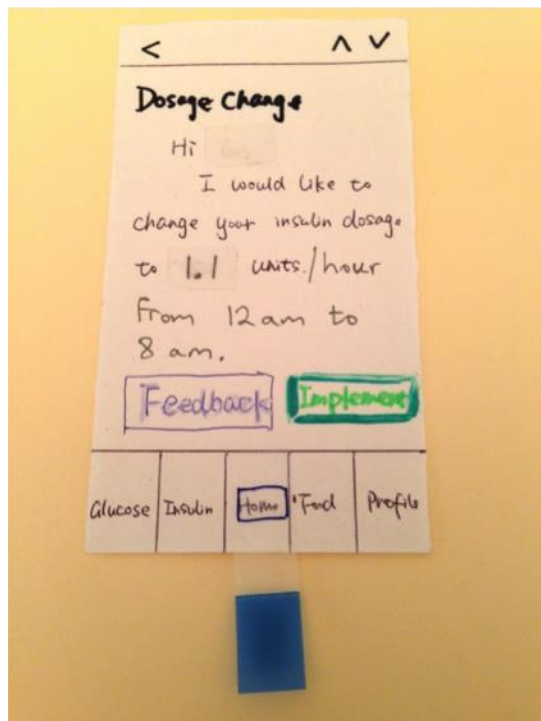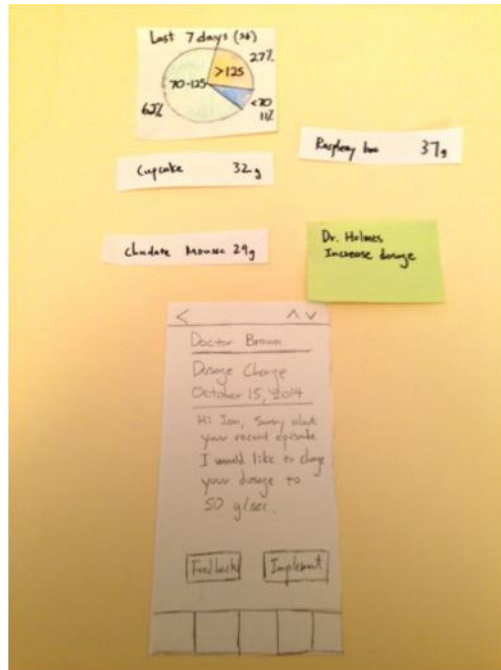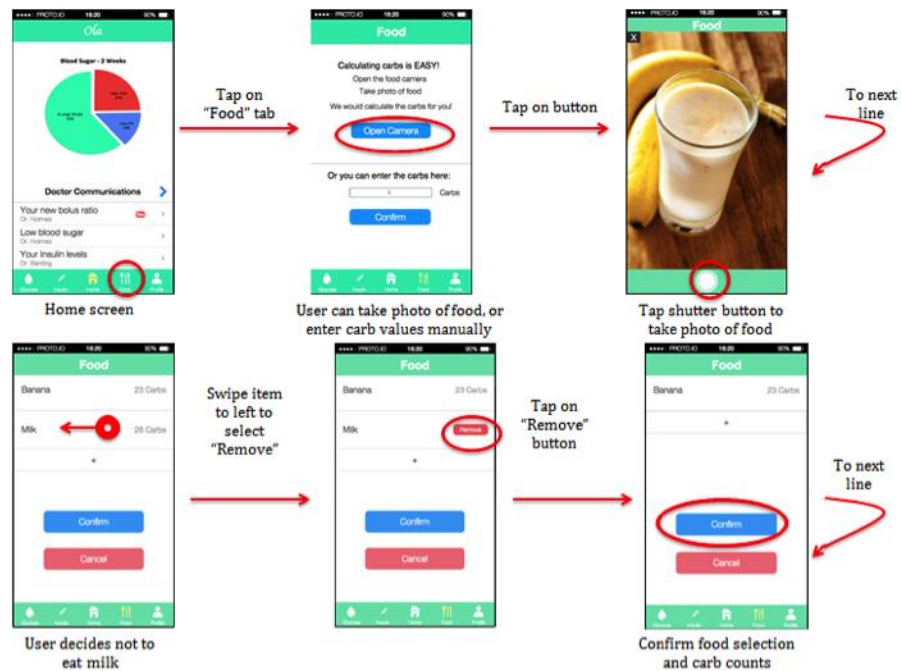

Figure 36 Paper Prototype Message from Doctor

Figure 37 Misc. components from paper prototype

From the initial sketches, we built the low-fi prototype and used it for three usability testing. By analyzing the result from user testing, we improved some user interfaces that we had and built the mid-fi prototype using proto.io:
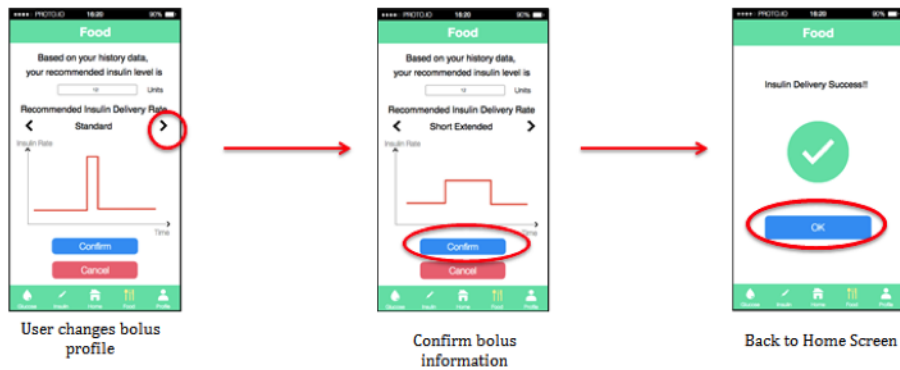
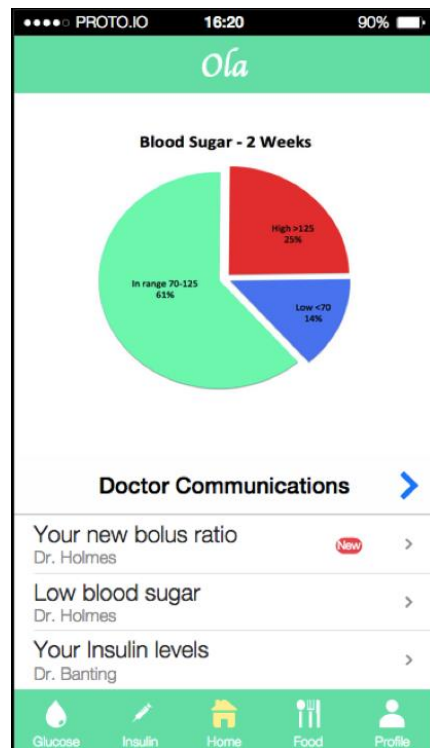**Figure 38 Med-fi storyboard for carb counting/insulin delivery task**
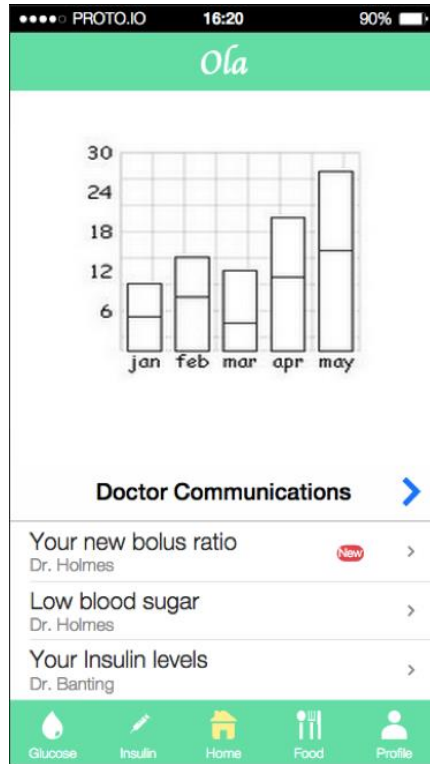

Figure 39 Med-fi Home Screen
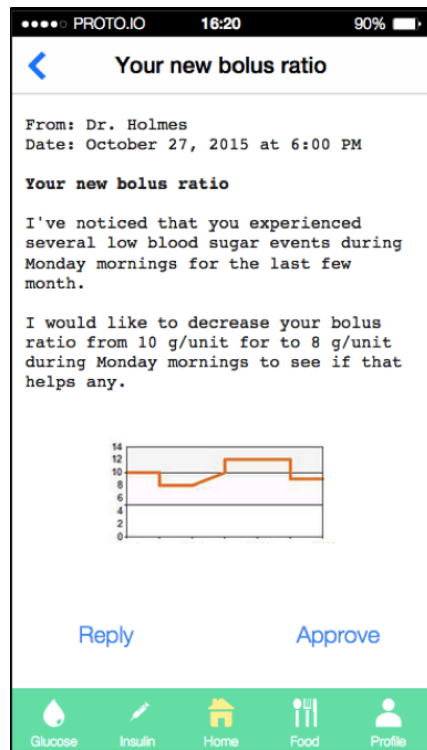
Figure 40 Med-fi Home Screen with Alternate Content
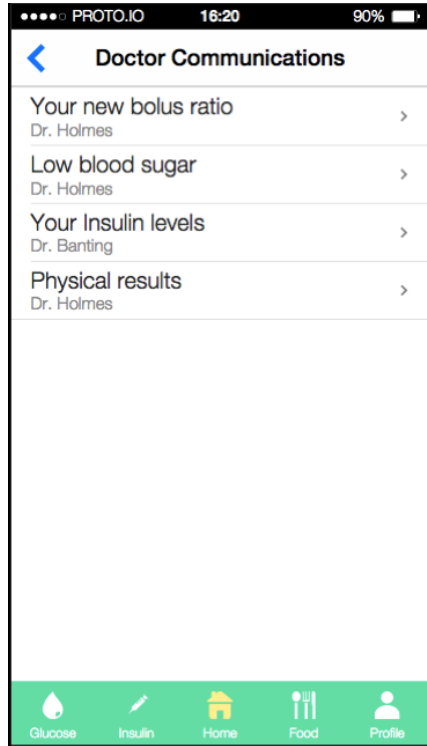

Figure 41 Med-fi Doctor Message

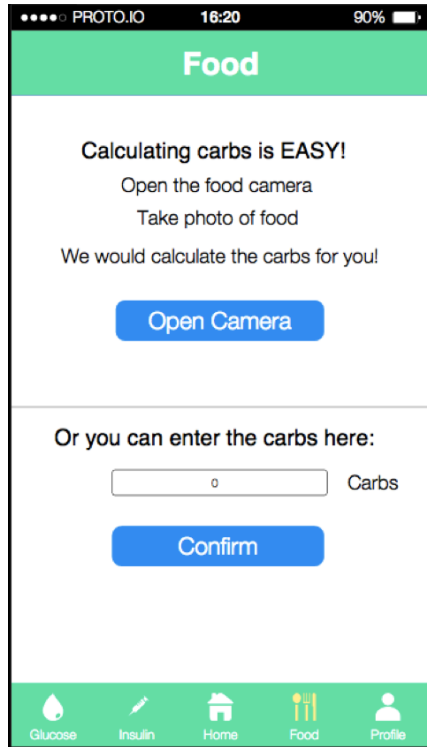**Figure 42 Med-fi Doctor Communications Menu**

Figure 43 Med-fi Carb Counting Initial Screen

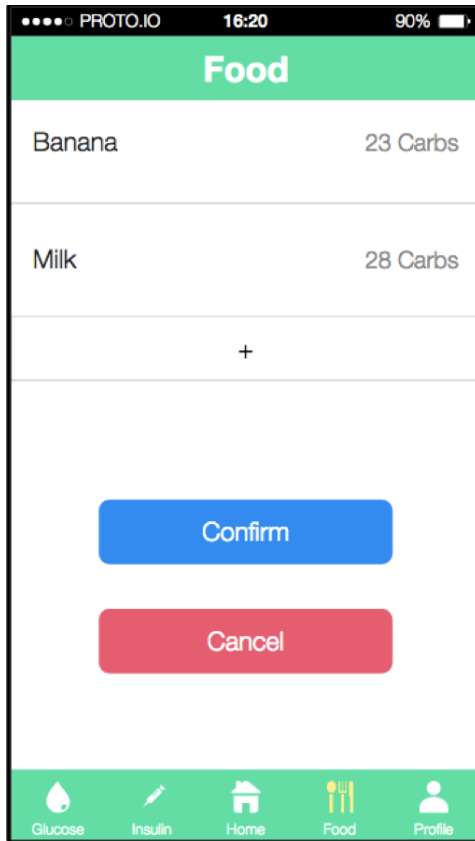**Figure 44 Med-fi Food Camera view**

Figure 45 Med-fi Carb Counting/Insulin Delivery Task
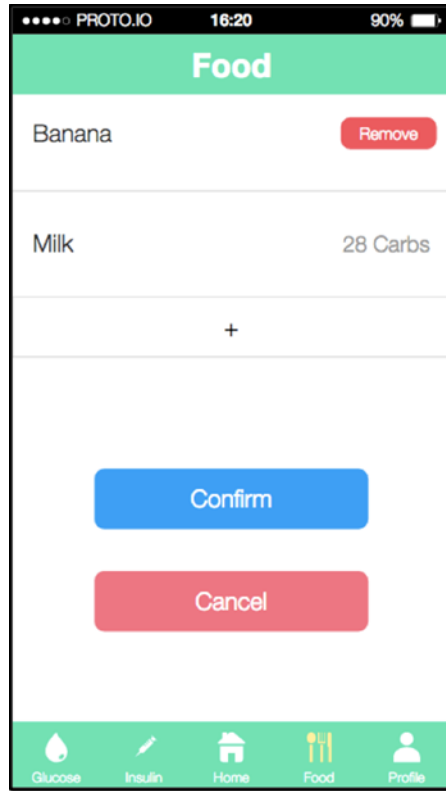
Figure 46 Med-fi screen displaying ability to manipulate food list.
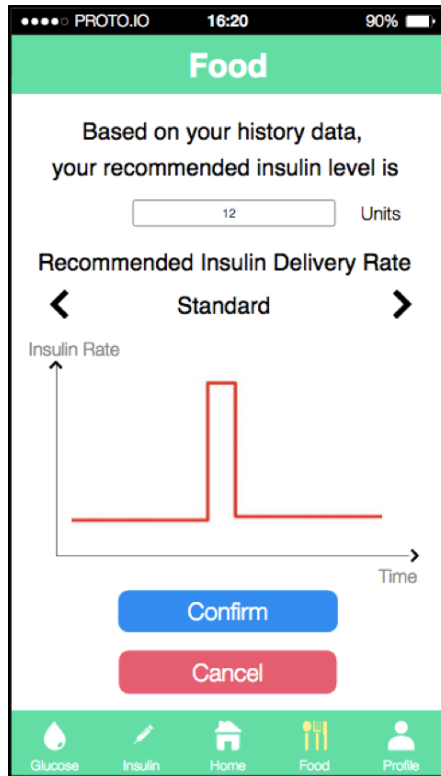
Figure 47 Med-fi Insulin Dosage Recommendation Screen

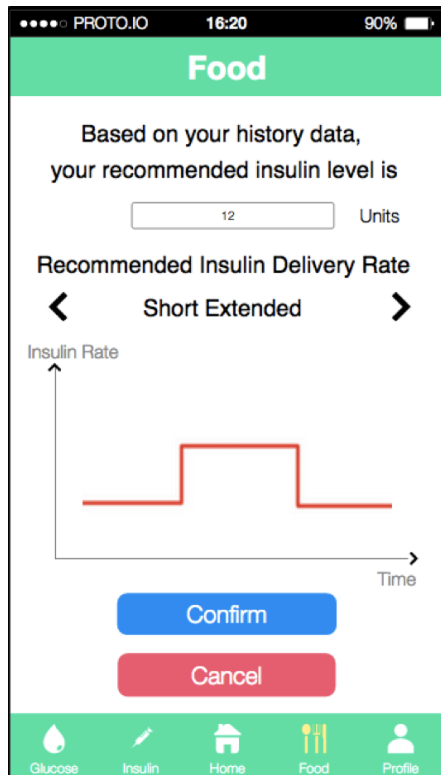**Figure 48 Med-fi Insulin Dosage Screen with alternate bolus profile selected**
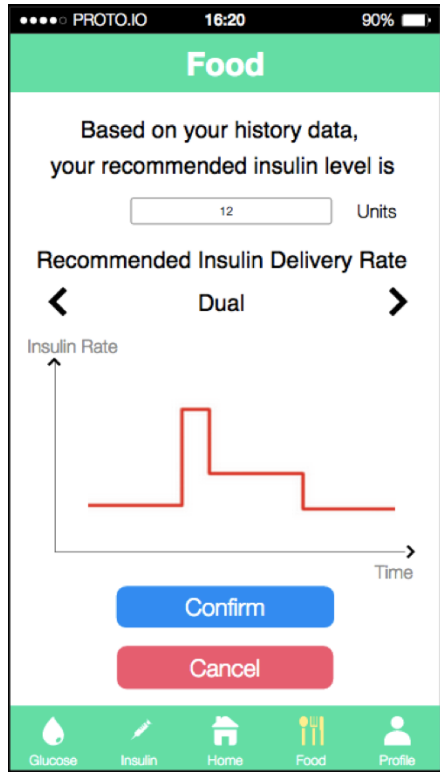
Figure 49 Med-Fi screen displaying alternate bolus profile
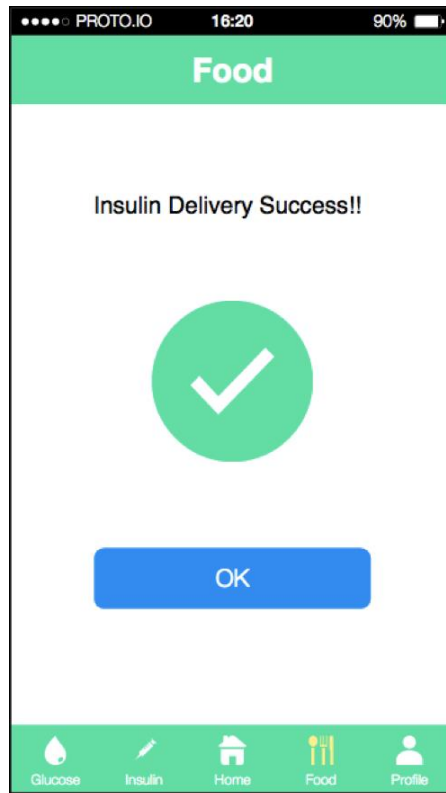
Figure 50 Med-fi Confirmation Screen for Carb Counting/Insulin Delivery task
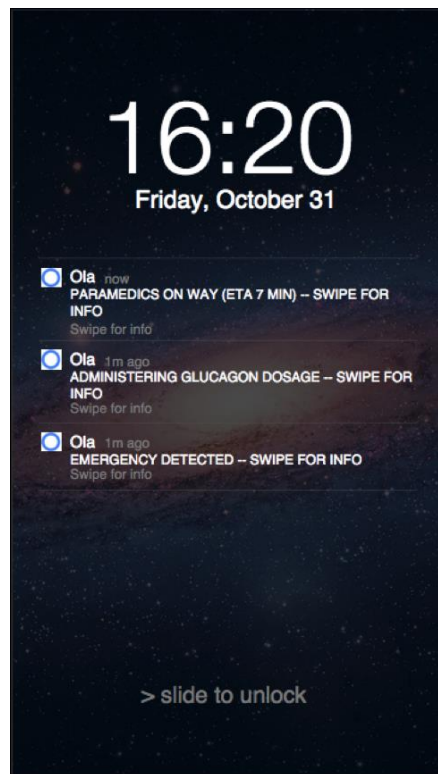
Figure 51 Med-fi Lock Screen showing push notifications for Emergency Response task
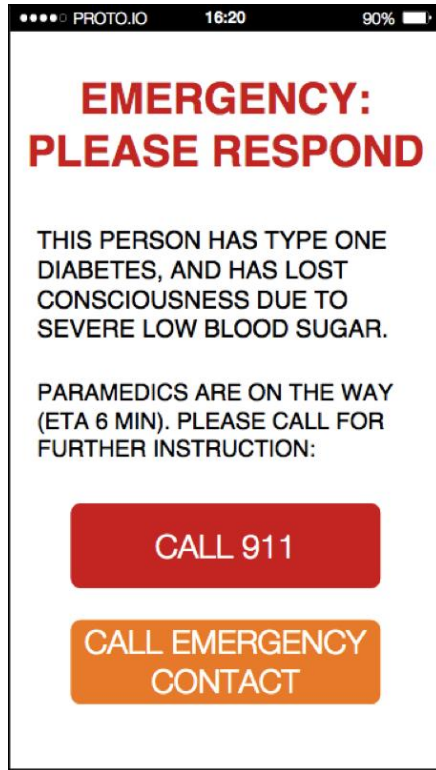
Figure 52 Med-fi Emergency Response screen

Figure 53 Med-fi "Coming soon" screen

Based on the med-fi prototype, we have feedbacks from other classmates doing Heuristic Evaluation and refined the user interfaces to work on the final hi-fi prototype.
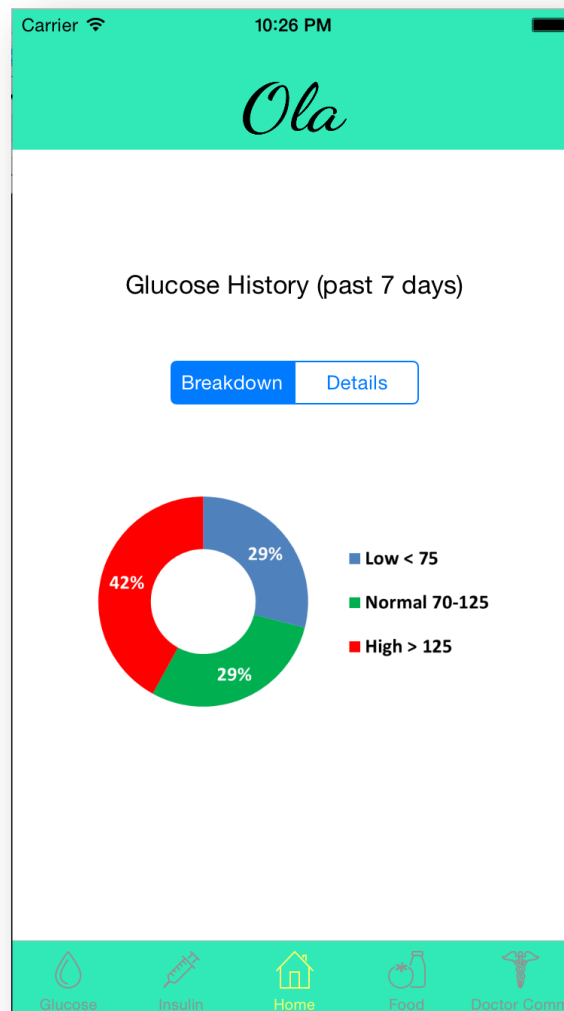
Figure 54 Hi-fi prototype Home Screen. Note that the Doctor Communications have been moved from the home tab into the tab bar. The personal profile tab would then be moved to a menu in the top-left of the header bar.

1. We used usability testing to test our low-fi prototype, and the results suggested several changes:

(1) Add buttons to call emergency contact and medical help in emergency care information screen.

Reason: Our low-fi interviewee thought it would help the bystander (caregiver) to have the ability to contact experts.
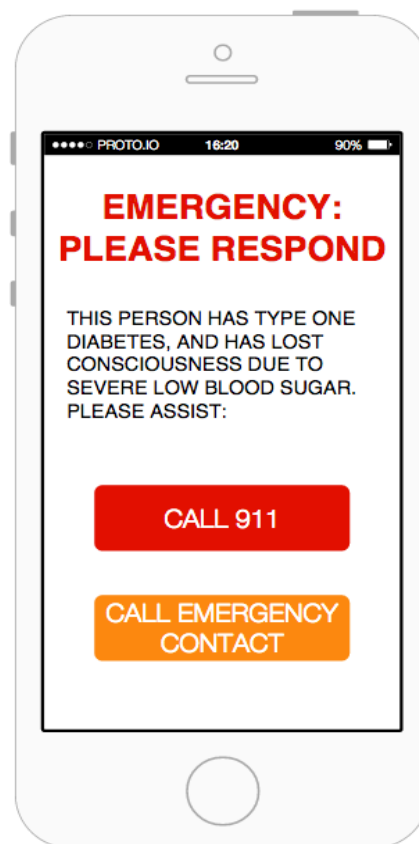
(2) Add instructions on the usage of food camera.
Reason: Our low-fi interviewee thought she should take a selfie with it.
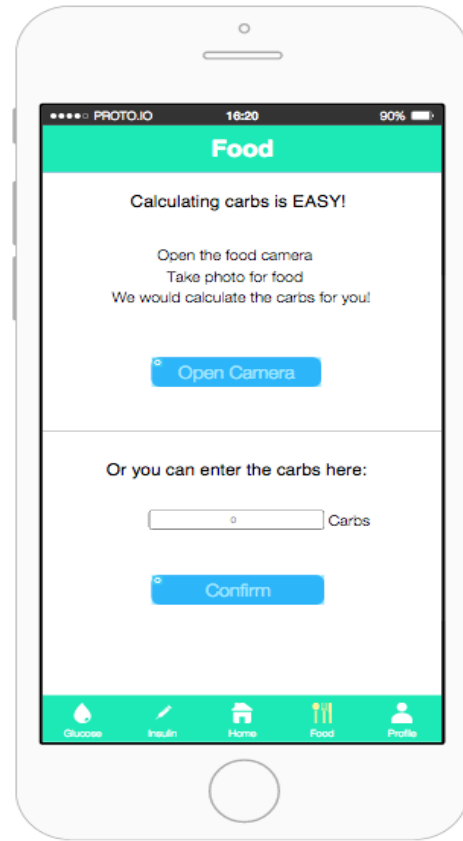
(3) Provide built-in options for insulin delivery rate.
Reason: Our low-fi interviewee thought free-form input can lead to errors.
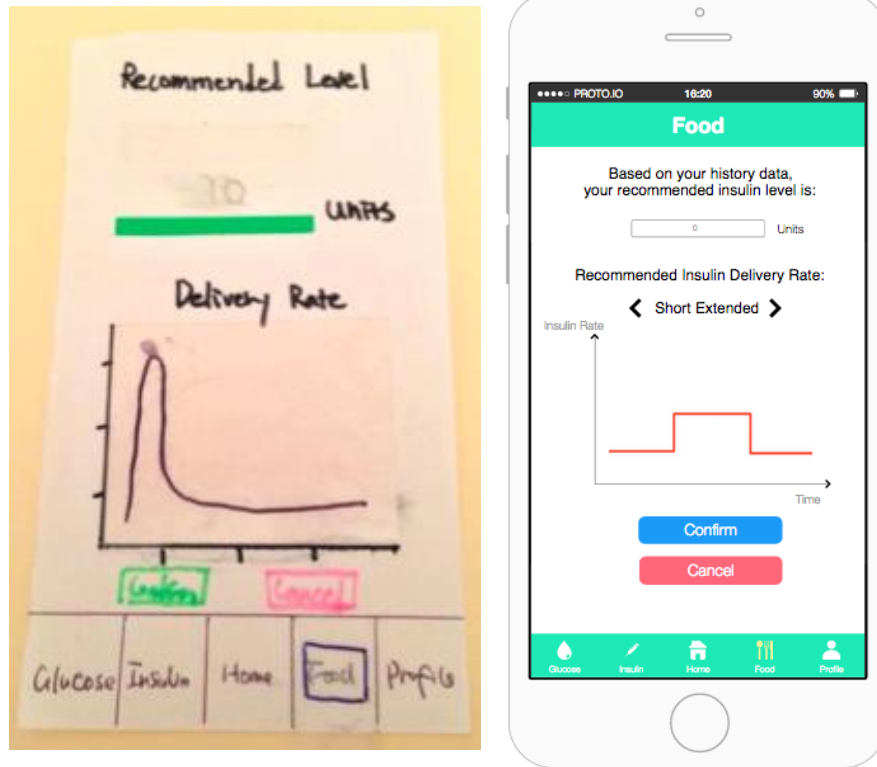
2. We used Heuristic Evaluation to test our med-fi prototype. And the result leads to several improvements. For the improvements and how we addressed the HE violations, please refer to "III Major Usability Problems Addressed".

V.   Prototype Implementation

Comments on our development tools

We built the hi-fi prototype as an iOS app for iPhone 6 using Xcode 6.1. We felt comfortable using Xcode because two of us (Ian and Albert) had taken the iOS class at Stanford (CS193P) and so had prior experience. Furthermore, we wanted to use Xcode because we wanted to use the native API in order to get the right look and feel for our app, and also to have access to other features such as push notifications (which are integral to our Emergency Response task). Finally, we wanted to build a native app using Xcode in order to gain experience in writing native iOS apps, which we are likely to do many times in the future.

That said, Xcode did sometimes prove extremely challenging for us. Part of this was due to our lack of recent experience with iOS development, which led to several mistakes and wasted time. Xcode was also a hassle to use as a development tool because of the convoluted process required for deployment. That said, after having had the experience of developing with Xcode, we would be willing to use it again for another similar assignment.

Wizard of Oz Techniques

1. Food Camera

The food camera is a tool the user can use to find out how many carbohydrates are in a given food. The high level idea is that a user should be able to take a picture of the food, and then have the food item appear alongside its carb count in the "Food Items" list. As of yet, we have not implemented object recognition, nor a crowd sourced or human intelligence task (HIT)-driven solution for this problem. Currently, a specific food item (either "Apple," "Banana," "Orange," "Tomato," or "Pear") appears in the "Food Items" list based on the MD5 hash of the image.

2. Search by Food

The user will eventually be able to search for a food in order to find a carb count for it, but currently, there is a short list of hard-coded foods and carb values which the user is limited to.

3. Search Function in Doctor Communications

Our current search algorithm simply returns one of the three included messages by modding the length of the search input by three.

4. Approve and Undo Functions from Messages

Our final product will enable the user to alter their insulin delivery based on recommendations from his or her doctor. We have not integrated our app with real diabetic hardware such as insulin pumps, glucometers, or continuous glucose monitors, so these buttons are currently nonfunctional.

5. Messaging System

We have not implemented a mail system for "Doctor Communications," so the "New" and "Reply" messages the user can compose do not actually send anywhere.

6. Emergency Response

Our Emergency Response mechanism will alert paramedics to come to the scene and enable a bystander to call either 911 or the user's emergency contact. Currently, push notifications appear to inform the user that an emergency is detected, and that paramedics are en route, but these notifications are, naturally, not tied to real events. Furthermore, for obvious reasons, the "CALL 911" and "CALL EMERGENCY CONTACT" options are both linked to one of our phone numbers.

Hard-coded Data
1. Glucose History
The blood glucose history data presented on the home tab does not represent real blood sugar data because we do not yet integrate with real hardware devices.

2. Doctor Messages
As mentioned above, we do not yet implement a messaging system, so the messages from doctors are all hard-coded.

3. Insulin Dosage Amounts
Our insulin dosage recommendations (for the food task) are based upon a simple formula unlike that which a patient would actually use, although it does use the carbohydrate count from the "Food Items" list in order to calculate the recommended amount.

Still to Come
Before our app is ready for the App Store, we will need to integrate it with the user's hardware, as well as produce our own hardware (i.e. the insulin/glucagon pod). We will need to build a functional and secure mail system for both customers and their healthcare providers, as well as decide how to best provide the emergency data from Ola to paramedics and other emergency responders.

One of the biggest developmental challenges will be how to implement our food camera. Our long-term vision is to enable this by true object-recognition, but realistically, such performance and accuracy is not likely to be made in less than several decades. Two remaining options, then, are to either crowd source carbohydrate count estimates from photos, or to use human intelligence task results to provide carbohydrate counts. Either of these latter options would have their own related challenges, but we have ideas about how to implement them in an effective manner.

Finally, once we have accurate user data due to a robust carbohydrate counter and hardware integration, we will also be able to offer the user true data analytics and alerts about how their blood glucose numbers have been over various periods of time. With this additional data will also come the ability to use machine learning to automatically recommend dosage changes to the customer or healthcare provider, instead of placing the onus for recommending changes on the provider alone.