UNIVERSITY OF CALIFORNIA,
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Collection, Interpretation, and Delivery of Information in Mobile Health Informatics

THESIS

submitted in partial satisfaction of the requirements
for the degree of

MASTER OF SCIENCE

in Electrical Engineering

by

Ryan Matthew Smith

Thesis Committee:
Professor Mark Bachman, Chair
Professor Guann-Pyng Li
Professor Magda El Zarki

2014

DEDICATION

To

my wife Rebecca,

and daughter Penelope;

in recognition of their love,

support, and enthusiasm.

Thank You,

I Love You.

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ACKNOWLEDGMENTS

I consider myself fortunate and lucky to have ended up at UC Irvine researching in the Resonance Lab (formerly MIDAS Lab) in the Integrated Nano-Research Facility (INRF) and the California Institute for Telecommunications and Information Technology (CalIt2). And, a variety of people should be thanked for supporting me throughout this thesis.

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ABSTRACT OF THE THESIS

Collection, Interpretation, and Delivery of Information in Mobile Health Informatics

By

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Master of Science in Electrical Engineering

University of California, Irvine, 2014

Professor Mark Bachman, Chair

Health informatics is the multidisciplinary field of study that uses computing and information technology (IT) to collect, store, interpret, and deliver health information to doctors, patients, and consumers. Health informatics applications have historically been limited by the computing and IT capabilities of the time, whether it be equipment cost, size, processing abilities or general availability. However, in the past two decades, personal computers and peripheral equipment overcame these hurdles enabling an abundant amount of Electronic Healthcare (eHealth) applications, such as patient/doctor communication via telecommunication, electronic health record management, emergency information delivery, and medical data transmission. Furthermore, mobile devices such as smartphones and tablets are becoming a dominant computing source in the consumer market with over 1 billion smartphone and tablet sales in 2013 alone. Because of their prevalence, inexpensive costs, processing power, and small form factor, mobile devices are also becoming primary computing devices in Health Informatics, satisfying Mobile Healthcare (mHealth) applications. This thesis discusses 4 mHealth applications and the corresponding tablet-apps developed to handle the health information. Specifically, each tablet-app has a particular focus in either the collection, interpretation, or delivery of health information. The applications of the 4 mHealth apps are: surveying youth in Swaziland, Africa to research the connections between relationship-oriented, psychological development and impoverished environments, pain classification for pain treatment of veterans with spinal cord injuries and disorders (SCI/D), pressure ulcer prevention training for occupational therapists working with veterans with SCI/D, and self-health reporting and information delivery for senior citizens prescribed to anticoagulant medications. These apps aim to yield more extensive surveys and research studies, more standard diagnosis suggestions, less prevalence of pressure ulcers, and healthier senior citizens.

CHAPTER 1 INTRODUCTION

This introduction will discuss the history of health informatics, applications of electronic healthcare, and describe the potential of mobile healthcare systems. The thesis will discuss motivations and approaches of mHealth applications and the content, devices, and methods used to build the corresponding systems. This thesis will refer to ‘apps’ as mobile-based software and to ‘applications’ as the real world, purpose-driven situations motivating the software development.

1.1 Brief History of Health Informatics

Health informatics is a multidisciplinary field that handles the content, devices and methods in the collection, storage, interpretation and delivery of information in healthcare and biomedicine [1]. Health informatics has its roots in computing, information technology and medicine, in which their histories describe the limitations and possibilities of previous and future health informatics systems [2]. From the ideas of Gottfried Wilhelm Leibniz in the 17th century suggesting human behavior could be represented in a codified form, to Charles Babbage in the 19th century attempting to build the first mechanical and programmable computer for solving mathematical problems, to Herman Hollerith in the 1890’s developing a punch card system first used to effectively collect United States census data, all these events demonstrate the underlying principles for today’s informatics systems have been considered and executed for over a hundred years [3]–[5]. During WWII in the 1940s, the need for information management was met by the first electronic and digital computer, ENIAC, capable of being reprogrammed, occupying an entire room, weighing close to 30 tons [6]. From then to the late 1960’s electronic computers would marginally decrease in size and use a ‘mainframe’ approach where a large central computer would handle information processing and a ‘dumb’ terminal, consisting of a keyboard and monitor, would allowing multiple users to input and view information at a separate location [7].

In 1959, Robert Ledley saw the potential of high-speed, digital, electronic computers in biomedical sciences for handling large masses of data with many interrelated factors [8], [9]. In particular, Ledley saw the workflow analogy between manual computing and electronic computing, as seen in Figure 1.1, enabling biomedical applications such as numerical solutions to differential equations, data processing and reduction, information retrieval, and simulation of biological systems.

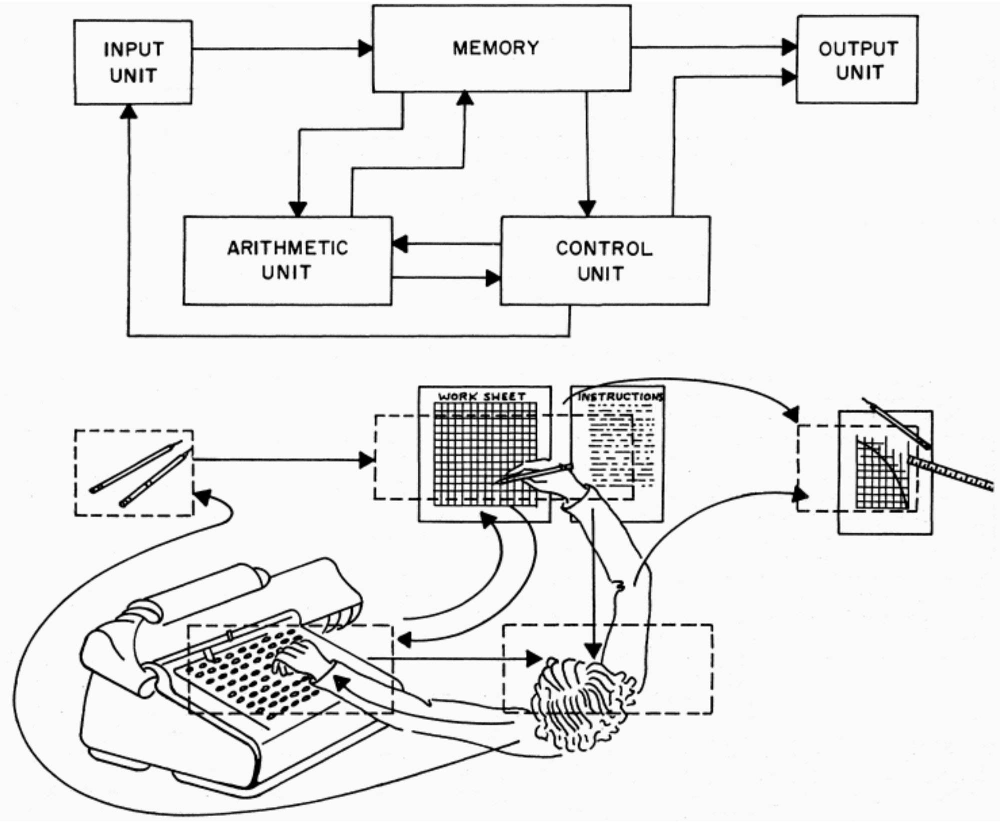


Figure 1.1 Analogy Between Manual and Electronic Computing. Robert Ledley also described the value of electronic computers in the biomedical sciences [8].

However, the problems with using mainframe computer systems in 1959 were monetary expenses, costing on average $250 per hour for use, and obtaining computer time, which priority was given to physical and engineering applications [8].

Within the next decades, these issues would be resolved with the release of minicomputers in the late 1960's, a lower cost solution to mainframe computers with high performance using state-of-the-art technology [10]. In the 1970's the microprocessor, or a single integrated circuit containing the main central processing unit (CPU), was used desktop computers and in medical device systems, exponentially decreasing the cost of 'million instructions per second' [11], [12]. At the end of the decade, microprocessors were becoming successful in their use inside Personal Computers (PCs) such as the Apple II and IBM PC [13]. Along with the hardware advances, PCs later introduced graphical user interfaces (GUIs) as the user-to-machine interface with mouse input using WIMP (windows, icons, menus, and pointing device) graphical components [14]. Since the 1980's to current day, microprocessors have developed more sophistication and continue to double in processing power approximately every two years, as a result of miniaturization manufacturing techniques in the semiconductor industry [15].

With an understanding of the limitations and potential of computing and information technology, and previous efforts integrating them with medicine, Health Informatics can be approached.

1.2 Health Informatics

Again, Health Informatics is an interdisciplinary field concerned with the devices, content, and methods of collecting, storing, interpreting and delivering health and biomedical information [1]. Health informatics has its origins in and encompasses medical, dental, and nursing informatics, with similar applications in data entry, handling electronic medical records, information retrieval, and decision support systems [16], [17]. Health informatics applications can be classified into two categories: computing-based (information and communication technologies) or health-based (healthy living, population health, health service delivery, and health policy) [18]. One major application within computing-based health informatics is use of telecommunications for transferring health information, once known as telehealth, now commonly referred to as eHealth (electronic-health).

1.2.1 eHealth: Electronic Healthcare

eHealth, or electronic-health, applications refer to healthcare related applications that provide tools, processes, and communication means to support electronic healthcare practices [19], [20]. eHealth applications have been widely used in professional healthcare venues are gaining increasing acceptance in homecare [21]–[24]. In healthcare management, eHealth is used for electronic records, recruitment, ‘going paperless’, healthcare score cards, audits, and information systems; in European sparsely populated areas, eHealth is used in ECG transmission, tele-cardiology outpatient clinic, pediatric tele-health, managed clinical networks, diabetes medical screening, picture archiving system, and emergency care summaries; in the US, eHealth could bring a national health information network [25]–[27]. Traditionally, eHealth systems use desktop or laptop PCs as a main device for handling information; however, mobile devices now have the computing power and functionalities allowing complete health informatics system solutions.

1.2.2 mHealth: Mobile Healthcare and Applications

Mobile health, referred to as mHealth, is a component of eHealth and can be defined as medical and public health practice supported by mobile devices, such as mobile phones, tablets, personal digital assistants, and other wireless devices beyond the laptop computer [28]. Mobile devices are currently built with functionalities that can be useful in mHealth applications such audio/video recording, image capturing, wireless connectivity via Bluetooth/Wi-Fi, telecommunication abilities, and Internet connectivity. Also, software is developed for mobile devices allowing direct development and use of programming languages such as Java, C, Python, etc. Although these are all functionalities of PCs, the main advantages of mobile devices are low cost to consumers (sometimes free to users when subsidized by cellular carrier companies with purchase of a cellular plan), their small size (usually able to fit in the user's pocket), their light weight (2 lbs. or less), and their optimized battery life (generally allowing device usage upwards of 8 hours or more on a single charge). Furthermore, the prevalence of mobile devices worldwide continues to grow each year indicated by the annual sales—smartphone sales increased 42% from 2012 to 960 million sales in 2013, and tablet sales increased 68% from 2012 to 195 million sales in 2013 [29], [30]. These reasons make mobile devices the ideal candidate for some mHealth applications such as rural applications where common infrastructure is lacking, or for personal-assistance applications where patients can have health information at their fingertips wherever they travel.

Since most people already have a mobile device or access to a mobile device, mHealth developers usually only need to develop a single app that can be installed on the consumer's or patient's mobile device, utilizing the device's functionalities as needed. Apps are a popular method of delivering software to mobile devices; the US Apple App Store had over $10 billion in sales in 2013, with over $1 billon in sales in December 2013 alone [31]. The amount of health, fitness and medical apps in the US Apple iTunes app store reaches over 40,000—though more than 50% of the apps have less than 500 downloads, and 5 apps account for 15% of all downloads in the healthcare category [32]. And in the US, health information could effectively be delivered to people via text message, internet, and email regardless of socioeconomic levels or English speaking abilities [33]. So, the development of apps for mHealth applications can be effective solutions in Mobile Health Informatics.

This thesis will discuss the motivations and solutions for 4 mHealth applications each with a particular focus in the collection, interpretation or delivery of health information. The solutions for the mHealth applications are 4 separate tablet-based app systems.[1] The next chapter will discuss the development framework of the tablet-based apps and advanced app functionalities.

[1] With the amount of health apps on the market, the US Food and Drug Administration (FDA) is interested regulating the contents of health apps as needed. If mHealth apps collect the user's health information and recommends specific treatment, then FDA approval is needed. However, if mHealth apps assist in self-logging and providing general health information, then no regulation and FDA approval is needed [77]. The apps developed for this thesis do not require any FDA regulations.

CHAPTER 2 TABLET-BASED APPS

The tablet-based apps developed for this thesis are all built with the same frameworks and similar functionalities. These functionalities were intended to be robust for health informatics purposes and can be deployed for various applications. Each application has software needs in one or more of the following areas: collection, interpretation and delivery of health information. This chapter will discuss the frameworks and functionalities used in the apps and how they are used to meet the software needs of the applications.

2.1 Functionality and Layout

The apps were developed using Starling, a 2D gaming framework built on top of Adobe's Actionscript 3.0 (AS3) programming language [34], [35]. The starling framework uses restructured functions and objects from the native flash library, rendering all images and textures to geometric triangles that are sent to the graphics processor of the tablet. This allows for graphic intensive processes such as elaborate particle animations with thousands of individual moving images to render at near native speeds—potentially displaying a constant frame rate of 60 [fps] for most tasks. The Starling framework has been used in successful web and tablet-based games such as Angry Birds: Facebook, Angry Birds: Star Wars, and over 100 other games since 2011 [36]. So, Starling was an ideal candidate for the mobile apps because of the fast GPU powered graphics, previous success, and support from Adobe.

Feathers is a graphical user interface (GUI) controls library for the Starling framework, allowing for form and navigation functionality within the app [37]. Form functionality includes data input such as selectable buttons and lists, and editable text boxes. Navigation functionality includes page-to-page displaying with sliding or fading transitions, and similar GUI controls to initiate navigation. Examples of Feathers functionalities can be seen on the Feathers website [37].

The conceptual app structure is shown in figure 2.1. In general, the app contains N number of modules and M number of pages within each module. Accessing the modules and pages are handled by the GUI using lists and navigation buttons, such as ‘previous’ and ‘next’ page buttons allowing the user to sequentially travel through the pages.

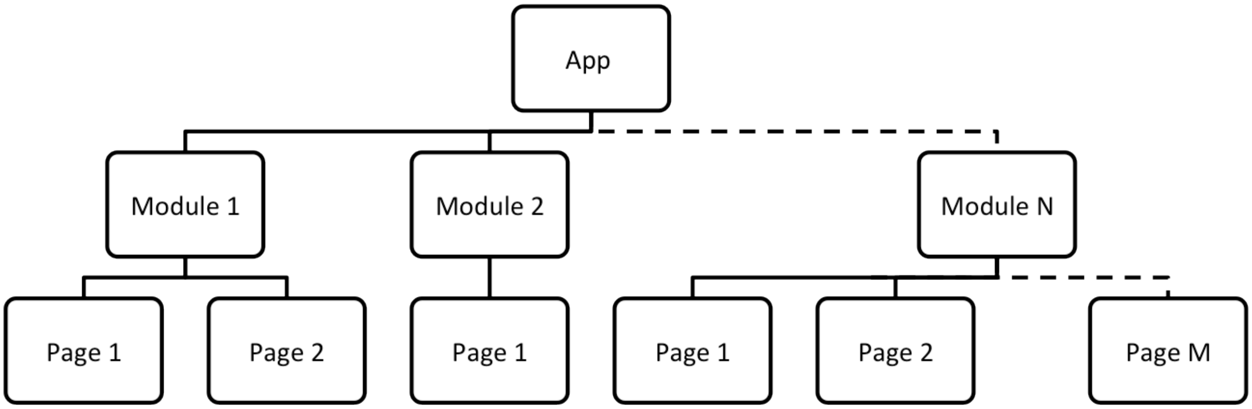


Figure 2.1 Typical App Structure Diagram. Hierarchy of contents within the app starting with the app, then modules, then pages. This structure is displayed with, but not limited to, 2 pages in module 1 and 1 page in module 2.

The general app layout is shown in Figure 2.2 within a tablet simulator provided by Adobe’s Flash Builder software—the interactive development environment (IDE) for creating, debugging, and exporting AS3, tablet-app code [38]. The layout has 3 main components: header, navigation bar and page contents. The header describes the page content below its position; the navigation bar allows the user to select a module; the page contents displays all GUI objects for that page. Also, the header contains buttons for navigating through pages within the module. (The previous page button is disabled since the first page of the module is displayed.)

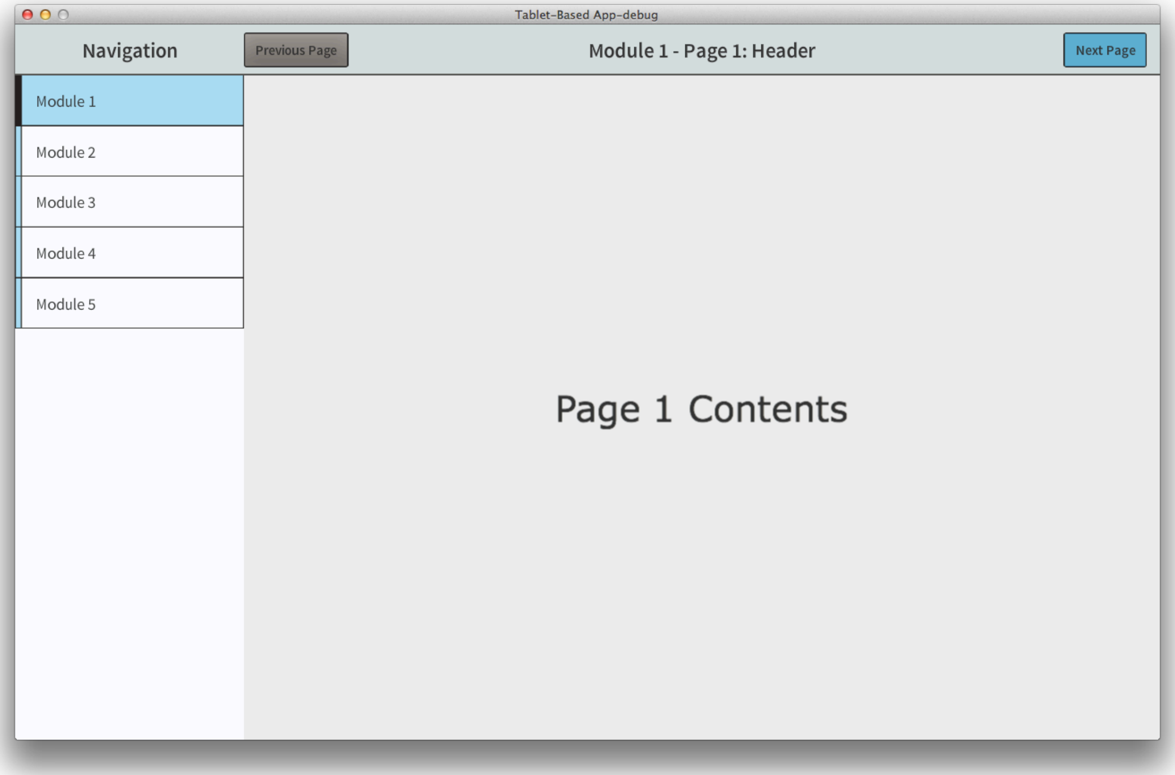


Figure 2.2 General App Layout. Three main sections: header, navigation, and page contents.

Page contents are arranged using layouts within containers, shown in Figure 2.3. The container is added to the page region and defines a boundary for display content to be shown. Multiple containers can be added to the page region and multiple containers can be nested within themselves, each with their own layout. The layout defines how the display contents will be positioned and ordered within the container. Commonly used layouts for these apps include horizontal and vertical layouts[2]. For instance, as contents are added to the container with a vertical layout, the first item will be at the top, the second item will be below the first, the third below the second, and so on, which can be seen in Figure 2.4.

[2] Other mHealth apps, especially phone-based apps, could benefit from the use of tiled columns and tiled rows layouts.

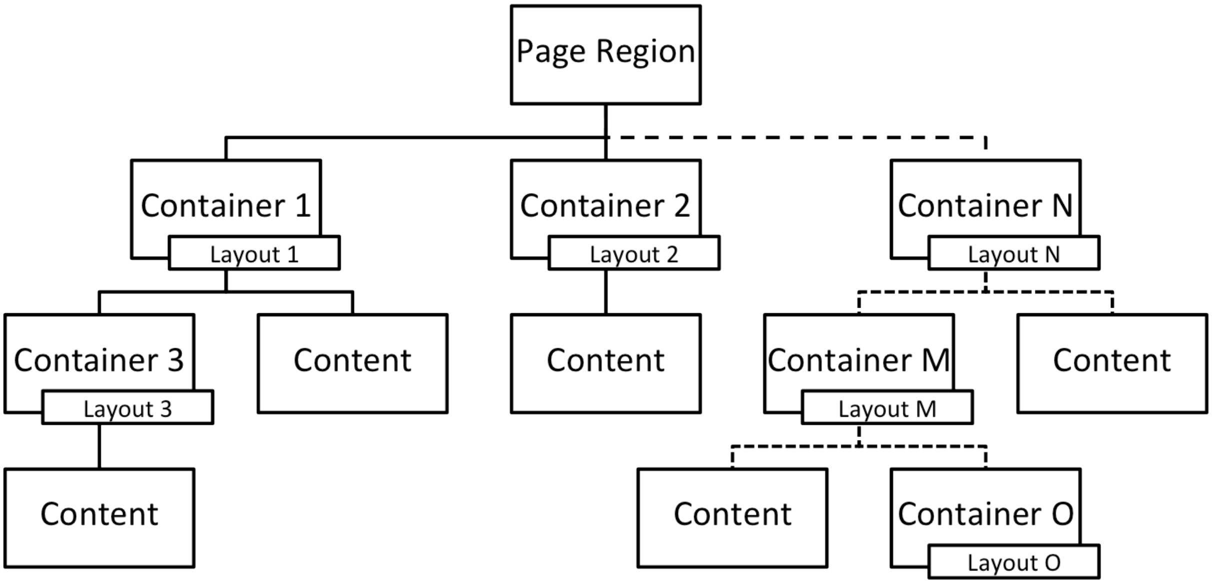
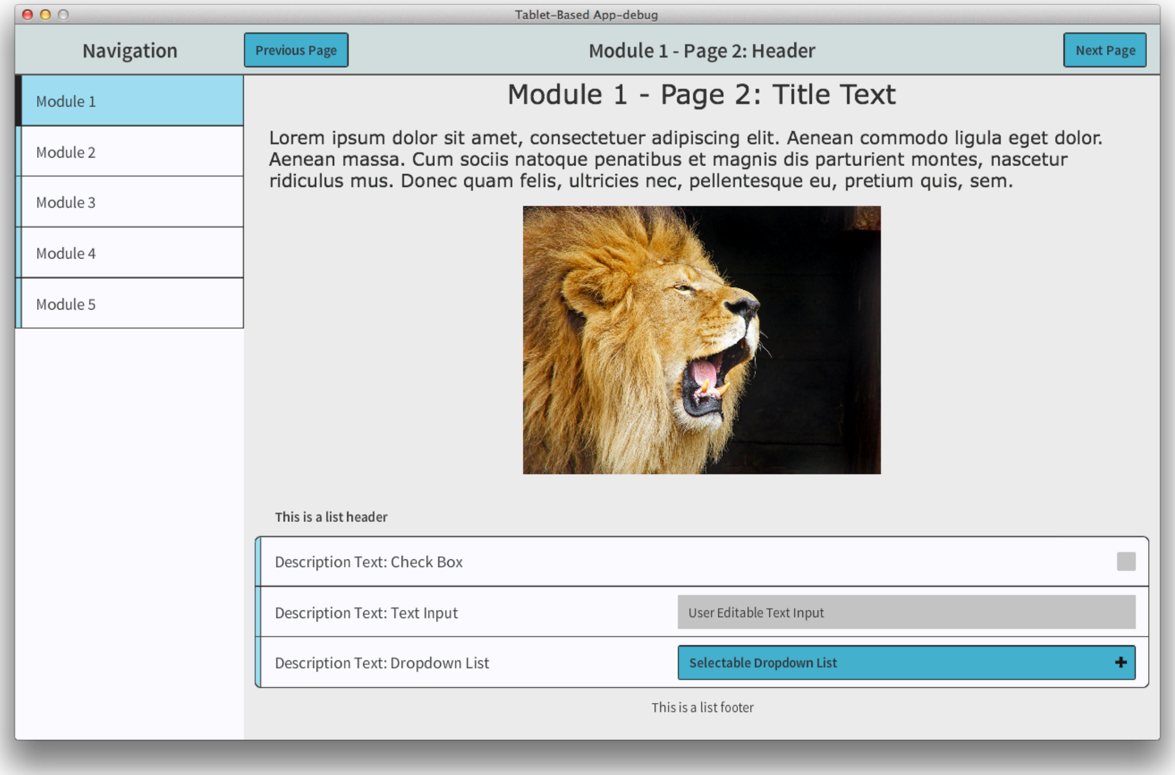


Figure 2.3 Page Content Arrangement. Hierarchy of arranging page contents with layouts in containers. Multiple containers can be added to the page region, and multiple containers can be added in containers. Contents are then added to the container.

Page contents typically include text, images, and form-list components and are shown in Figure 2.4. Specifically, the text has a common format among apps and has two text styles: title text and body text. The image is loaded at runtime and can be displayed with a variable size. The form-list is a list of items with description text on the left and form accessories on the right. The displayed form-list items include, but are not limited to, a check box, a user editable text box, and a dropdown list. The page in Figure 2.4 has a single container with a vertical layout.



Module 1 - Page 2: Title Text

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec quam felis, ultricies nec, pellentesque eu, pretium quis, sem.

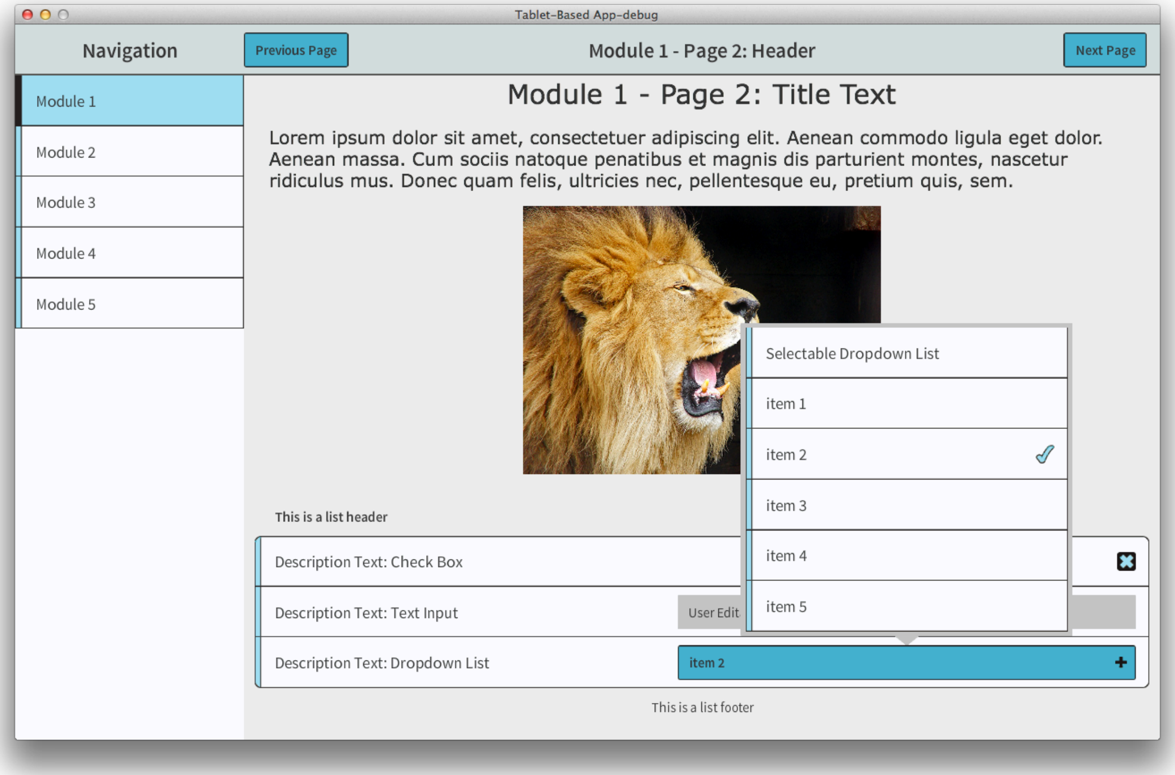
This is a list header

Description Text: Check Box	□
Description Text: Text Input	User Editable Text Input
Description Text: Dropdown List	Selectable Dropdown List +

This is a list footer

Figure 2.4 Typical Page Contents. Page content with title/body text, image, and form-list with check box, text input and dropdown list.

The form components allow for user input and can be seen activated in Figure 2.5. When the check box is toggled, an X graphic is skinned on the object and its Boolean flag is set true. When the text is added to the text input, the text string can be accessed within the app. And, when the dropdown list is initiated, a scrollable list is displayed allowing the user to make a selection. After a selection is made, the app can then access and handle the selection.



Module 1 - Page 2: Title Text

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec quam felis, ultricies nec, pellentesque eu, pretium quis, sem.

This is a list header

Description Text: Check Box ☒

Description Text: Text Input

Description Text: Dropdown List

This is a list footer

Figure 2.5 Typical Page Contents Activated. Dropdown list contents displayed and check box selected.

With the layout and functionalities from Figures 2.4 and 2.5, quizzes can be created within the app. Each module can be a general topic, and each page can display text and images delivering information about the topic. Quiz pages can appear throughout the module displaying multiple grouped lists, corresponding to multiple questions. The question text can be displayed in the list's header, and each answer is the description text of each entry in the list. Making a selection of the appropriate answer will be handled by check boxes, text inputs, dropdown lists or button components. This allows the app to collect information regarding the user's understanding of the content throughout the module and respond appropriately.

Lastly, native tablet functionalities are integrated within the health-apps, like audio recording and image capturing[3]. Both of these functionalities are used to collect additional health information in the apps.

There are additional features and functionality within each of the apps that will be discussed in the next sections. These features include HTML page display, HTML table display, HTML image map interaction, sending emails and text messages, displaying videos and booklets all used for different applications of collection, interpretation and delivery of information.

2.2 Advanced Collection Methods

Collecting health information is required for many applications from conducting new research studies to reporting health-events. Collecting health information can be done in multiple ways from collecting text-based information with input-forms, audio-based information using microphones, and image- and video-based information using cameras. Collecting audio-, image- and video-based information are inherently robust collection methods since the microphone and camera are not limited to only a specific type of information (e.g. the camera does not only capture images of humans, the camera can collect images of the environment, food, etc.), so unique information can be collected without previous design. However, text-based collection in mobile-based apps is typically limited by the input components (check boxes, dropdown lists, toggle buttons, etc.). Even when text input boxes are used, the user still has to type their response, which can be especially inconvenient in a mobile-based app for users with minimal mobile experience. A more robust solution for text-based collection in mobile-based apps is to

[3] To access native tablet functionalities, the configuration file within the tablet-app must first define the permissions to the corresponding functionalities that will be used.

have a PC based workflow allowing custom input-forms, using simple input methods such as check boxes and dropdown lists, to be created and added to the app.

The PC based workflow for creating custom mobile-app input-forms is outlined below. The input-form has a few components: text-based directions and questions, input components, and hidden formatting values. The components for the input-form are first described in a Microsoft Excel spreadsheet, referred to as a codebook. Column headers for the codebook include: direction text, question text, question type, question value, section name, and formatting values. The codebook is then exported as a Tab-Delimited text file and converted into HTML form pages using custom JavaScript (JS) code. The HTML form pages are saved on a Secure Digital (SD) memory card, placed in the tablet, and are then accessible by the mobile-apps. Then a web browser in-app is used to view the HTML form pages and collect information. Finally, the information is sent back through the HTML/JS to the AS3 and saved in the app. This workflow is shown in Figure 2.6.

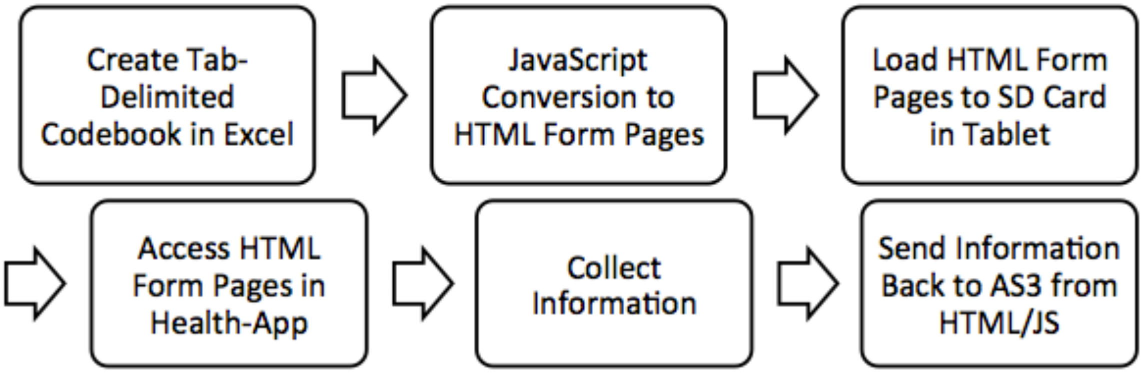
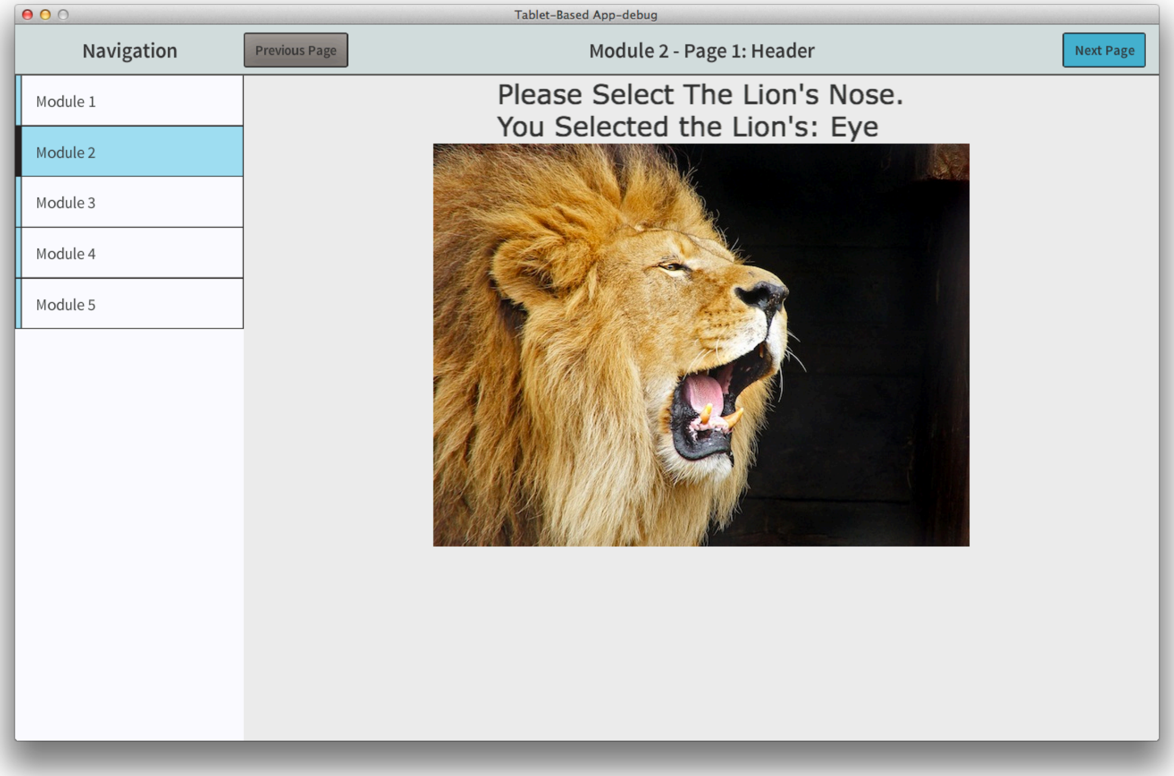

Create Tab-Delimited Codebook in Excel
JavaScript Conversion to HTML Form Pages
Load HTML Form Pages to SD Card in Tablet
Access HTML Form Pages in Health-App
Collect Information
Send Information Back to AS3 from HTML/JS

Figure 2.6 HTML Input Form Workflow. This workflow allows non-tech savvy content providers to develop customizable form pages for robust text-based information collection purposes.

This workflow and advanced collection method is not commonly used within tablet-based apps. Typically, input-forms are hardcoded into the app using native form components

(Starling/Feathers in this case), or require the user to use an in-app question editor, both of which are either expensive or inconvenient methods for content providers. This workflow is used in one of the collection-based apps and allows for a more comprehensive research study.

Another advanced data collection method that will be use in the apps is based on the functionality of HTML image maps. These image maps essentially display an image and have invisible buttons overlaid on sections of the image. When the buttons are pressed, the app responds as defined by the HTML script. Using these image maps require the use of the in-app, AS3 web browser, that load the local HTML image map file. This functionality allows for health applications such as body pain reporting by displaying an image of the body and asking the user to click on the body at the location of pain. Figure 2.7 shows an example of the integration of an HTML image map into an app.



Please Select The Lion's Nose.
You Selected the Lion's: Eye

Figure 2.7 HTML Image Map Example. Image maps enable interactive information collection by responding to touch events at specific locations on the image. This example prompts the user to touch the lion's nose and shows the response when the user touches the lion's eye.

These information collection methods enable more applications within the health-apps. Once the information is collected, the app decides how to handle the information. Usually, the information is stored within the app and can be accessed at a later time. Sometimes, the information may require interpretation and will be discussed in the next section.

2.3 Advanced Interpretation Methods

Interpreting information within the app may be required for some health applications. In some cases, the tablet is used only as the front-end client software that sends data to a server to be processed. The data on the server is then sent back to the client software on the tablet and displayed, leaving the computational heavy processes to the server. However, current consumer level tablets have powerful enough hardware to handle the processing and interpretation within the app itself. An interpretation method that will be used within the tablet-based apps is Classification using Artificial Neural Networks using an AS3 library [39].

An Artificial Neural Network (ANN) is a non-linear, statistical, data-modeling tool based on the functionality of a biological neural network. An ANN is capable of machine learning, pattern recognition and classification. Using an ANN as a classifier with a supervised learning algorithm requires the ANN to first 'learn' how to classify data before it can begin classifying. (This is similar to how we, as humans, must first see examples of cats and note their features before we can determine if an animal is likely a cat based on an animal's features.) Classifier ANNs first learn from learning sets, or predefined sets of data with known a classification for each set. Then, as new sets of data are provided to the ANN, the ANN can provide a likelihood that a particular set falls under a certain classification [40].

More specifically, the ANN algorithm used in these apps only accepts binary inputs and outputs, where each binary output corresponds to a particular classification. The binary input is first separated into individual integers[4] then used in the ANN classification algorithm—the back-propagation algorithm for supervised learning. The ANN first learns from the learning set by attempting to define a single function that maps each set of input values to the correct set output values of the learning set. This is done by repeatedly passing the input values through the network, calculating the error of the output in relation to the expected output, and incrementally adjusting the statistical weights at each artificial neuron in the network. The learning is completed when the output from the iterations is approximately equal to the expected output

[4] A binary value of 1001 is separated into four integers (1,0,0,1) then used in the ANN algorithm.

value, or when the output error is approximately zero. The structure of the ANN can be seen in Figure 2.8.

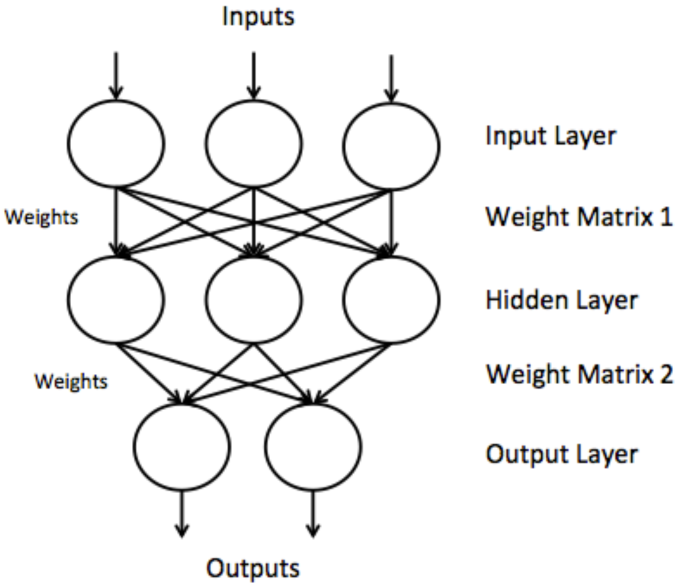


Figure 2.8 Artificial Neural Network Structure. As the ANN learns, input values from the learning set are repeatedly passed through the network, the error at the output is calculated, and the weights are adjusted. Learning is complete when the output values are approximately equal to the expected output values. Then, the ANN uses these weights in the network to classify new sets of information at the output. This ANN accepts 3 bits and outputs 2 bits.

Once the information has been collected and possibly interpreted, the information is commonly delivered back to the user. Also, information can be delivered to the users' contacts via email or text message, and sometimes information needs to be delivered to databases for storage. Some methods of delivery require advanced methods that are discussed in the next section.

2.4 Advanced Delivery Methods

The delivery of information in tablet-based apps can be intended for the app user or a user's contact. Advanced delivery methods to app users include interactive HTML tables, booklet displaying, and interactive videos. Advanced delivery methods for user's contacts include sending text message and emails from within the app.

Within the Starling/Feathers framework, displaying information in a table format and displaying booklets required special attention since the framework did not explicitly create these functionalities. The tables used in the apps are HTML-based tables and are built with JS libraries—Tidy Table and JQuery [41], [42]. An in-app web browser is required to load and view the local HTML files. The HTML table script is a table generator script that accepts JavaScript Object Notation (JSON) formatted data and populates the HTML table in the web browser—allowing the app to handle the generation of all the data, and the HTML to only view and populate the table. Displaying Portable Document Format (PDF) booklets in app can be done with the in-app web browser using HTML and JS libraries such as PDF.js or directly embedding the PDF using HTML tags [43]. However, additional functionality for handling the PDF files requires scripting outside of the app language using HTML/JS and relies on the web browser engine for rendering. With these apps, PDF files were first parsed into separate image files using common external software and loaded into the app. This allows for in-app swipe gesturing, zooming, and image transitions using common AS3 functions.

Interactive videos can be an effective method of teaching concepts and can be used in many applications. The interactive video object developed for these apps is essentially a video that accepts touch-events[5] with a playback protocol. The video object has a set of protocol functions that the user calls in an external configuration file. This configuration file is in JavaScript Object Notation (JSON) format, which is a human readable format, and can be edited by the user after the app has been compiled, allowing for in-app adjustments as needed. This

[5] The interactive video accepts touch-events similar to the HTML image map described in section 2.2.

configuration file is referred to as a 'storyboard' because it describes how the video will play and what additional content will be displayed. For example, the storyboard can tell a video object to start playing a video from the beginning, add subtitles every 2 seconds, pause at 20 seconds, display a question, and wait for the user to respond by clicking on a corresponding location on the video. The storyboard also defines what the video object will do if a right or wrong response is selected, such as begin playing a separate video describing why the user's response was wrong, then navigating back to where the original video left off. An example of a video object following a storyboard can be seen in Figure 2.9. The interactive video object also has a navigation bar at the bottom of the page allowing the user to manually play/pause, mute/unmute, and seek forward/backward through the video.

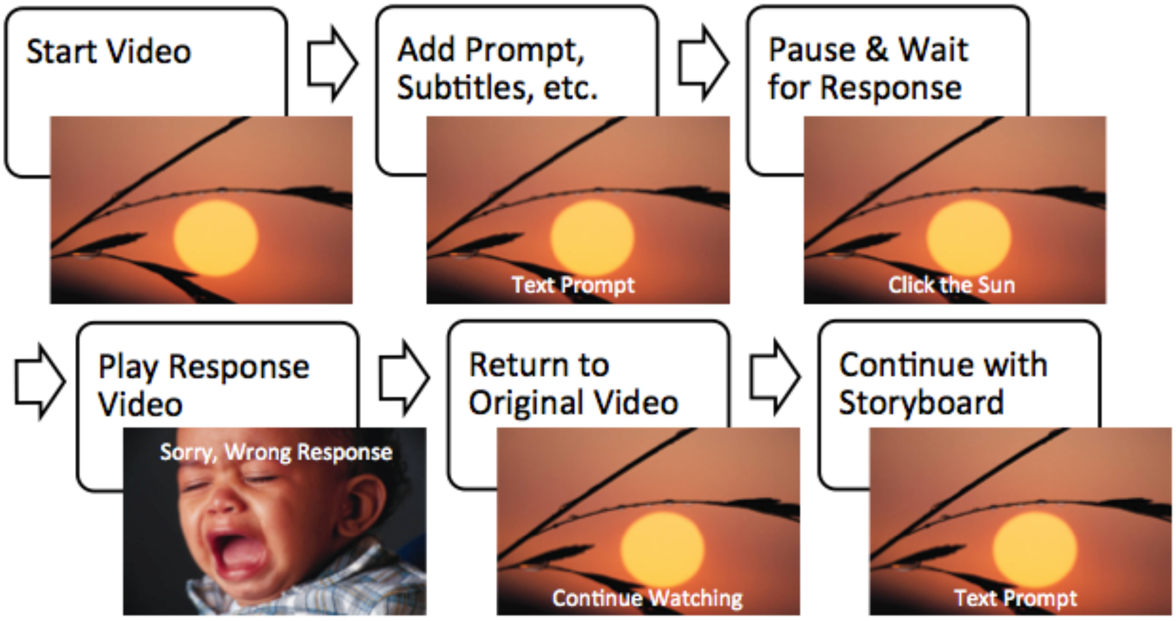


Figure 2.9 Example Interactive Video Flow Diagram. The interactive video is executing functionalities described by the storyboard (configuration file). Each frame displayed is at a user-defined moment in time.

Delivering information to the user's contacts is done through text messaging and emailing within the app. Text messages can be useful in applications where small alerts or reminders are needed to be sent to contacts, since only 160 characters can be sent using Short

Message Services (SMS). Sending text messages in-app follows the same methods as sending emails; however, the user must also know the contact's cellular carrier as well as cellular phone number. Sending emails within app requires the creation of a Simple Mail Transfer Protocol (SMTP) object and defining its parameters such as host, port, authentication, sender email address, sender password and text-based message. To send the email, a Transport Layer Security (TLS) Socket object has to be created and attached to the SMTP object. Then the email can then be sent at the activation of an in-app GUI component. To send text messages, the sender email address is the contact's cellular phone number appended by the corresponding cellular carrier email directory. For instance, the sender email address for a contact with a Verizon wireless carrier would be xxx-xxx-xxxx@vtext.com and for AT&T would be xxx-xxx-xxxx@txt.att.net. The corresponding email directories for other carriers are openly available on the web. AS3 extension libraries are used for creating SMTP and TLS Socket objects [44], [45].

With these advanced functionalities with collecting, interpreting, and delivering information, as well as general functionalities and a standard app layout, multiple healthcare apps can be created with multiple applications. In the next chapters, the motivation and development methods will be discussed for each healthcare app.

CHAPTER 3 IMPOVERISHED YOUTH HEALTH SURVEYING

3.1 Motivation

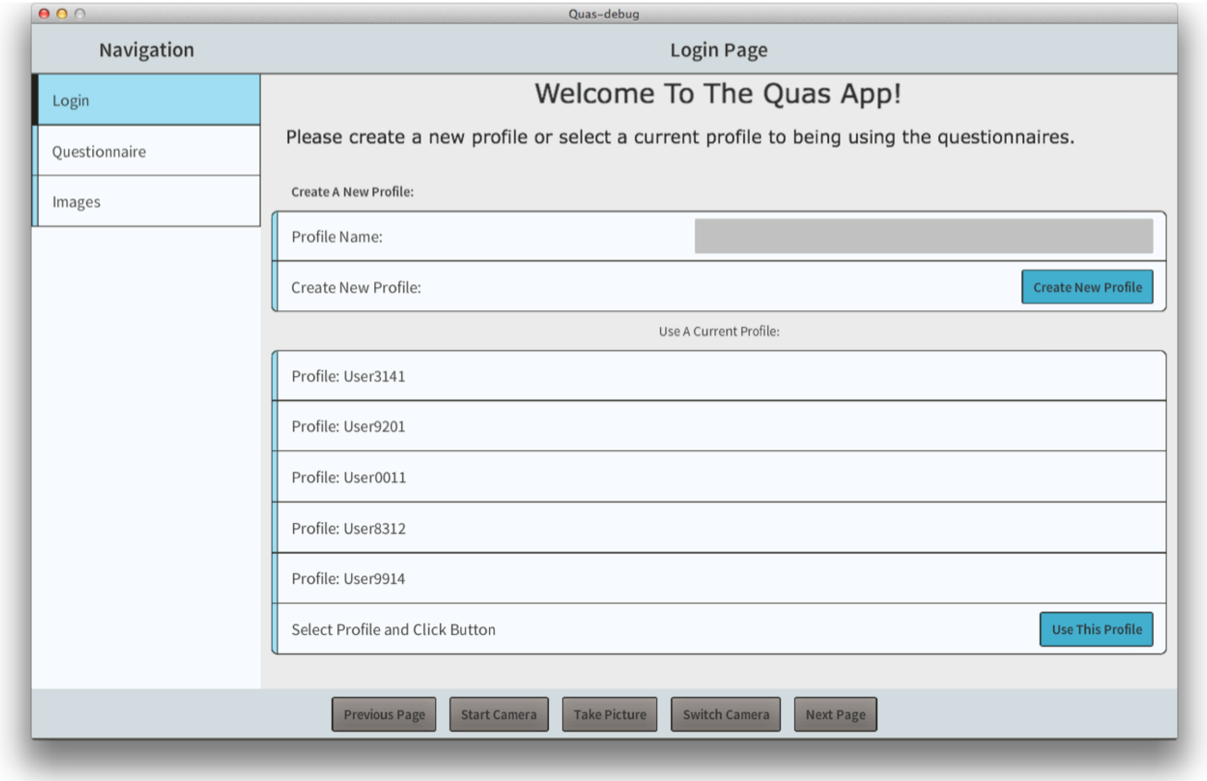
Youth raised in impoverished environments often fail to fully develop relationship-oriented psychological processes such as empathy and altruism due to a lack of positive role-models displaying these behaviors [46]. Approximately 44% of the world's population is below the $2 per day international poverty line, making them susceptible to this poor psychological development [47]. In particular, rural areas in the country of Swaziland, Africa has been identified displaying extreme poverty [48]. Approximately 84% of the country's poor live in rural communities where 66% of the population is unable to meet basic food needs and 43% of the population lives in chronic poverty, with a further concentration extreme poverty in areas of unfavorable climates and low agricultural productivity [49]. Furthermore, Swaziland has the highest HIV prevalence in the world at 26% of its population, also having an effect on a youth's development [50]. Collecting information about a youth's developments and environment require a team of researchers to survey a youth in-person. Traditional methods of surveying uses paper-based interviewing, and separate audio/visual electronics to capture dynamic responses from the interviewees [51]. However, the equipment required for these surveying methods (video cameras, tape recorders, computers, etc.) can be bulky, expensive and fragile, prohibiting extensive surveys in rural locations. New mobile technologies, specifically tablet devices, are all-in-one surveying solutions because they are inexpensive, small, have extensive battery life, and are capable of capturing text based information, along with audio and visual information.

3.2 Approach

This app, referred to as the Quas App, is focused on collecting questionnaire information from youths raised in impoverished environments. This app will be deployed in Swaziland, Africa to a team of researchers from the School of Social Ecology, University of California, Irvine lead by Drs. Jodi Quas and Richard Matthew. These researchers will use this app in the surveying process as they investigate the connections between relationship-oriented psychological effects in youths and impoverish environments. The main purpose of the app is to collect questionnaire information using a highly mobile and electronic solution allowing for a more comprehensive research study.

The Quas app will use the advanced collection method as described in Chapter 2 concerning the use of HTML input forms. Previously created codebooks will contain all the questions and formatting of the HTML forms. Once the codebooks are converted to HTML documents and loaded onto the tablet's external SD card, the Quas app can begin using the HTML forms.

When the app is first opened, the user will be navigated to the Login module. The login home page asks the user to create a new profile or select a profile from the list of existing profiles. The profiles act as 'sessions' within the app—or a set of logged questionnaire answers over a given period of time. This allows a single tablet-app to collect many information sets each identifiable by a unique profile name. The login page contains title and body text, and two grouped lists with text input and button components—and can be seen in Figure 3.1. Note that this app has a static toolbar at the bottom of the screen that provides the user with camera control, and questionnaire page navigation control.



Welcome To The Quas App!

Please create a new profile or select a current profile to being using the questionnaires.

Create A New Profile:

Profile Name:

Create New Profile:

Use A Current Profile:

Profile: User3141

Profile: User9201

Profile: User0011

Profile: User8312

Profile: User9914

Select Profile and Click Button

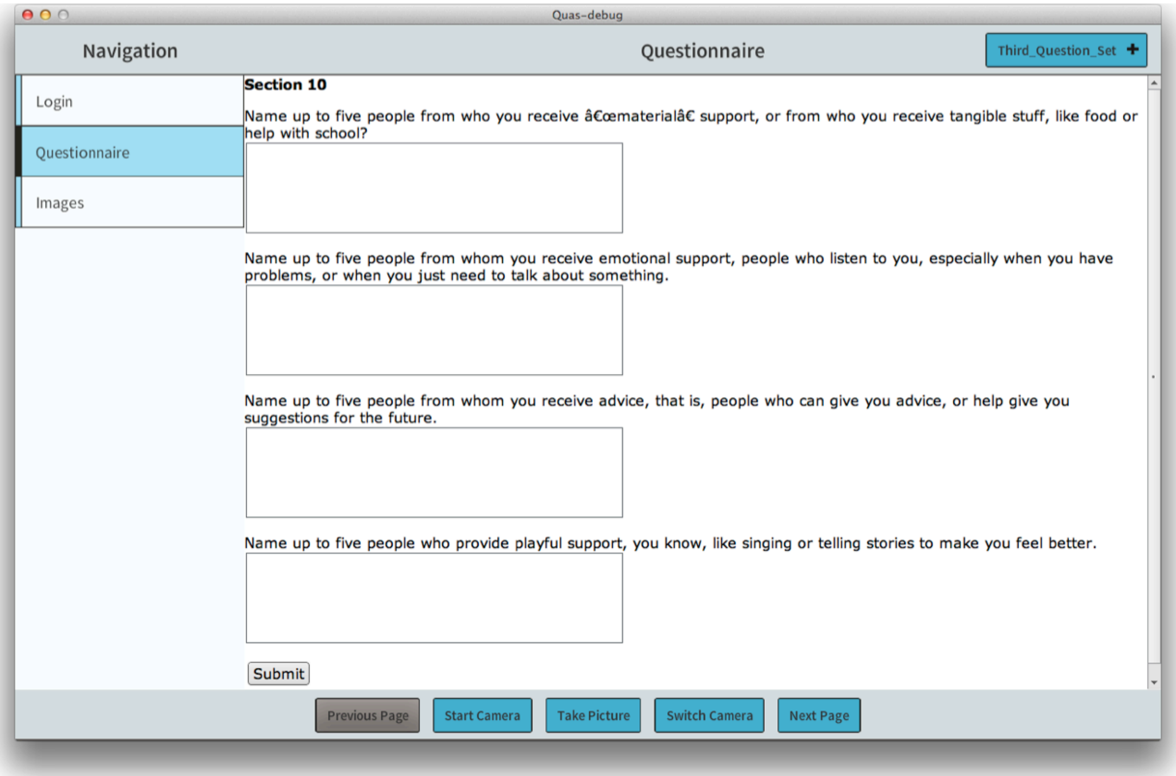
Figure 3.1 Quas App Login Page. This page first appears when the app is started and asks the user to create a new profile or select from an already created profile. As the user completes the questionnaires, the profile will save the answers from each page. Note the tool bar at the bottom of the app containing camera controls and questionnaire page controls.

Once a profile is selected, the user is navigated to the questionnaire module where the user can begin collecting information.

3.2.1 HTML Questionnaire Collection

The main purpose of the Quas app is collecting customizable text-based information. Since the framework has been built to easily create form pages, the app can contain hundreds of pages worth of questions with similar formatting features. So, this section will only show screenshots of the functionalities of only a few pages.

The questionnaire module main page displays a web browser with the HTML input form displayed and a dropdown list on the right side of the header. The dropdown list lets the user select a question set—or a user-defined set of HTML form pages. The previous page button is disabled since this is the first page in the question set. The general view of the page can be seen in Figure 3.2 and the functionality of the dropdown list can be seen in Figure 3.3.[6]



Section 10

Name up to five people from who you receive â€œmaterialâ€ support, or from who you receive tangible stuff, like food or help with school?

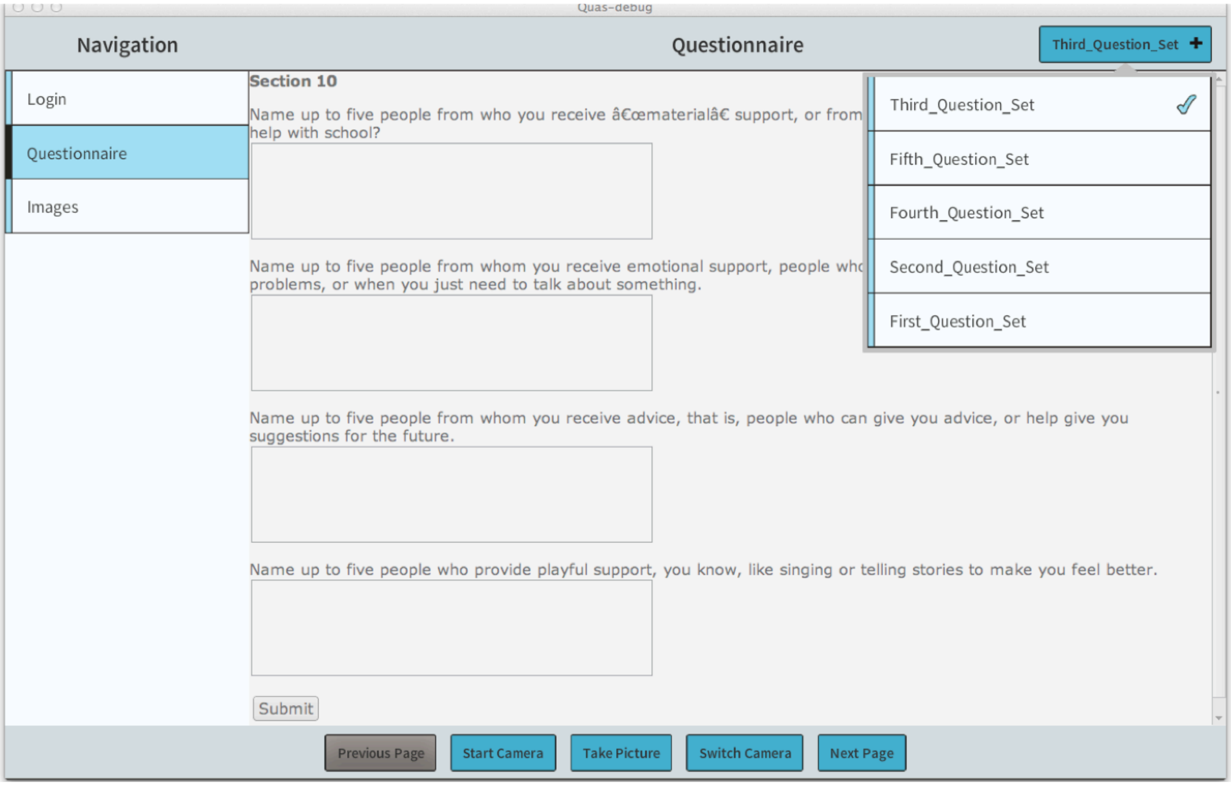
Name up to five people from whom you receive emotional support, people who listen to you, especially when you have problems, or when you just need to talk about something.

Name up to five people from whom you receive advice, that is, people who can give you advice, or help give you suggestions for the future.

Name up to five people who provide playful support, you know, like singing or telling stories to make you feel better.

Figure 3.2 Quas App Questionnaire Module. This page shows the first section of questions. At the bottom of every section, the submit button allows the user to save the inputted information. The previous page button is disabled since this is the first page in the question set.

[6] When using the web browser, all GUI components in the same area are displayed underneath the web browser window—or the web browser sits on top of all display objects. So, when activating the dropdown list, the web browser must first be hidden. The web browser hides by taking an in-app screenshot of the web browser, removing the web browser, showing the screenshot in the same location, and setting the transparency of the image to 50%. This functionality can be seen in Figure 3.3.



Section 10

Name up to five people from who you receive â€œmaterialâ€ support, or from help with school?

Name up to five people from whom you receive emotional support, people who problems, or when you just need to talk about something.

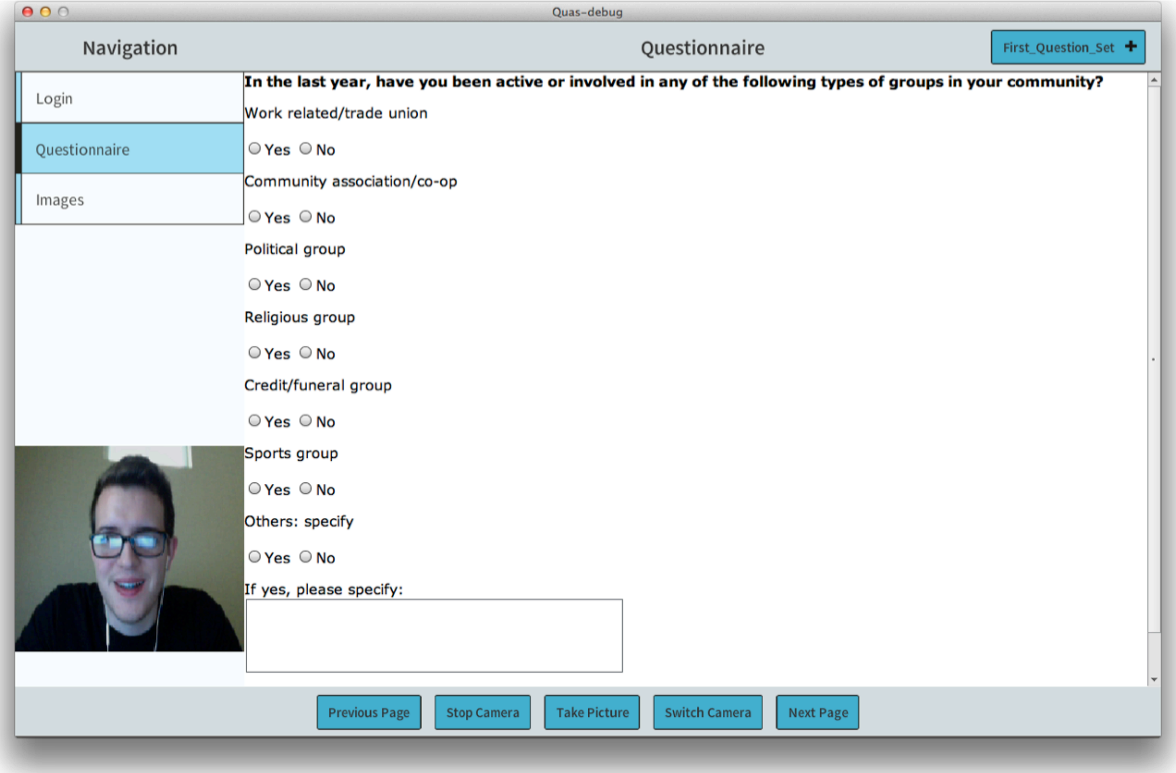
Name up to five people from whom you receive advice, that is, people who can give you advice, or help give you suggestions for the future.

Name up to five people who provide playful support, you know, like singing or telling stories to make you feel better.

Figure 3.3 Quas App Questionnaire Module. This screenshot shows the dropdown list displaying other user-defined question sets. The content providers that created the questions also created the question sets in the dropdown list. Each question set corresponds to a particular topic that will be investigated.

If a different question set is selected, or the next/previous page buttons are pressed, the corresponding form page will be displayed. This can be seen in Figure 3.4.

Another functionality of collection used within the app is image capturing using the tablet's camera. This functionality is useful to capture facial expressions of the interviewee or the local environment corresponding to a question or set of questions. The camera viewer appears on the left side of the screen underneath the navigation panel in an invisible widget container. This feature can be seen in Figure 3.4.



In the last year, have you been active or involved in any of the following types of groups in your community?

Work related/trade union

○ Yes ○ No

Community association/co-op

○ Yes ○ No

Political group

○ Yes ○ No

Religious group

○ Yes ○ No

Credit/funeral group

○ Yes ○ No

Sports group

○ Yes ○ No

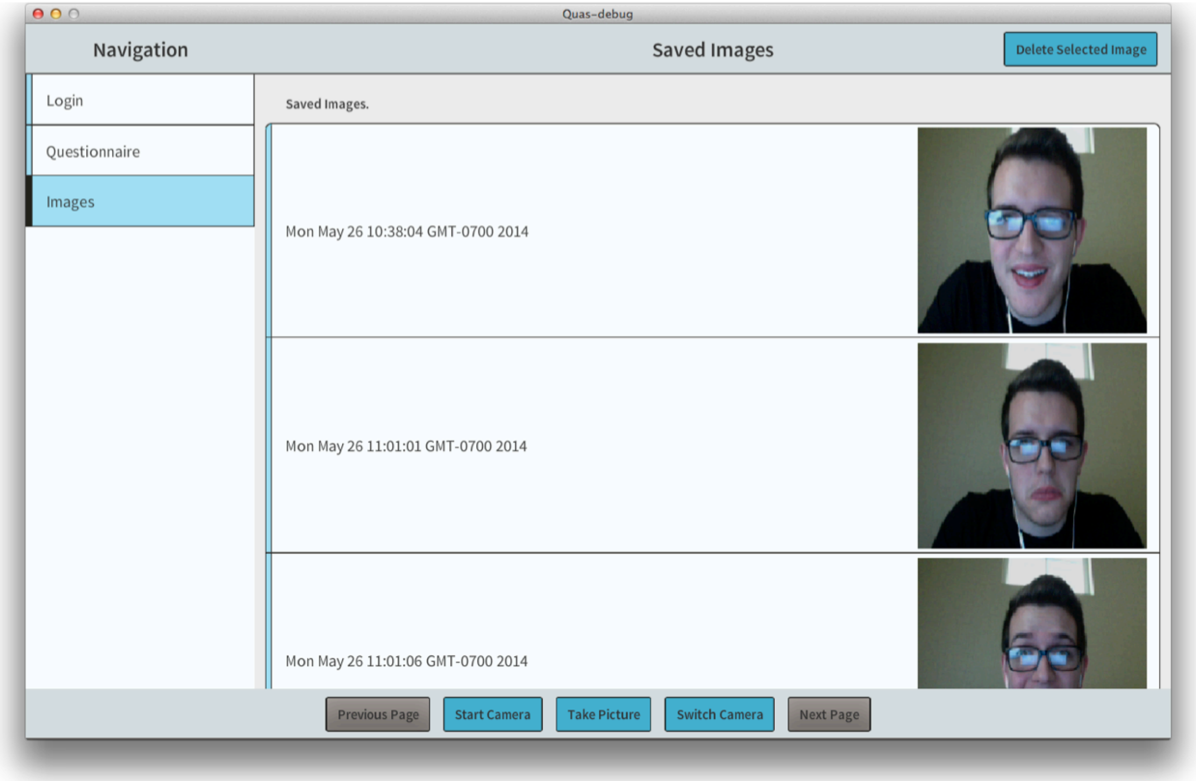
Others: specify

○ Yes ○ No

If yes, please specify:

Figure 3.4 Quas App Camera Functionality. This screenshot shows the use of the camera under the navigation panel in an invisible widget container. The picture can be saved and viewed at a later time. Pictures can be useful to help describe a person's environment or facial expression corresponding to a question or question set.

The saved images for a profile can be viewed in the Images module. The images page displays a grouped list with all the images and a date/time stamp of when the picture was taken. Individual images can be deleted by selecting the image then clicking the delete button at the top right of the page.



Mon May 26 10:38:04 GMT-0700 2014

Mon May 26 11:01:01 GMT-0700 2014

Mon May 26 11:01:06 GMT-0700 2014

Figure 3.5 Quas App Images Module. This page displays the images taken for a specific profile. Individual images can be deleted by touching the image and pressing the delete button at the top of the app.

The questionnaire information from each profile is saved onto the SD card in a tab-delimited format and can be viewed simply with common text-viewing software, such as Microsoft Excel or other tablet-based software. Also, the images corresponding to each profile is saved on the SD card and can be viewed later on a PC outside of the app. This allows the user to post-process the information on the user's PC at a later time.

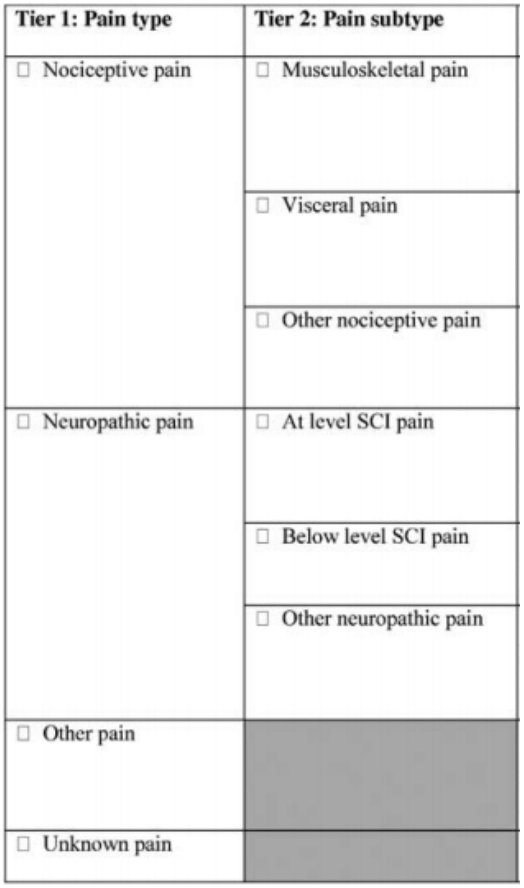
CHAPTER 4 SPINAL CORD INJURY PAIN CLASSIFICATION

4.1 Motivation

Spinal cord injuries (SCI) can result from blunt or penetrating trauma to the spinal cord, causing symptoms such as pain or paralysis [52]. Paralysis is a common symptom and depends on the location and severity of the injury, falling into two categories: complete or incomplete [53]. A complete SCI yields a loss of all sensory and motor abilities at and below the level of injury, and an incomplete SCI yields some functionality at and below the level of injury [54]. Spinal cord injuries occur most in the age range of 16-30, more than all other age ranges combined, with the most common causes being auto accident, falls and gunshots [55]. Chronic pain can also accompany paralysis and can be present in areas of the body with or without sensation, regardless of the type of paralysis [56]. In 2012, 56 expert medical professions in the SCI community developed a standard SCI pain classification to categorize SCI pain into two main categories: nociceptive (irritation at nerve endings) and neuropathic (malfunction of nervous system) pain, among other sub-categories [57]. However, even with a pain classification system, doctors can interpret the same pain differently, classifying it into different categories, yielding a range of treatments from physical interventions (physical therapy, acupuncture, etc.), to psychological treatments (biofeedback, hypnosis, etc.), to medications (narcotics, anesthetics, etc.), and to surgical treatments (dorsal column stimulator, intrathecal pumps, etc.) [58]. A classifier algorithm based on statistical analysis to classify pain based on its characteristics could assist in providing more appropriate treatments for patients with SCI pain.

4.2 Approach

This app, referred to as the Pain Classification App, is focused on interpreting patient pain information for doctors. This app will be deployed at the Department of Veterans Affairs, Long Beach, California to doctors in the Spinal Cord Injury and Disorder (SCI/D) department. The interpretation of pain information will be completed using machine-learning algorithms within the app. The doctors in the SCI/D department will provide the learning sets for the machine-learning algorithms—specifically, a supervised-learning artificial neural network will be used. The learning set will consist of a few dozen true or false questions and the corresponding classifications from the question sets. The final classification categories are based on the International Spinal Cord Injury Pain (ISCIP) Classification [59]. Two of three tiers from the ISCIP classification will be used for the Pain Classification app and is shown in Figure 4.1.



Tier 1: Pain type	Tier 2: Pain subtype
□ Nociceptive pain	□ Musculoskeletal pain
	□ Visceral pain
	□ Other nociceptive pain
□ Neuropathic pain	□ At level SCI pain
	□ Below level SCI pain
	□ Other neuropathic pain
□ Other pain	▨
□ Unknown pain	▨

Figure 4.1 International Spinal Cord Injury Pain (ISCIP) Classification Table [59]**. This figure displays the two tiers of interest for the Pain Classification App.**

The app will be deployed on multiple tablet devices accessing the same learning set on an external server. Since most of the coding efforts for the app went into integrating the ANN algorithm in the app and accessing the database through the server, the app only has two pages in one module. When the app is first opened, the app receives the newest version of the learning set, and then the user can start answering the questions about the patient's pain. When the user submits the answers, the ANN algorithm begins processing the information, and the app navigates to the results page when processing is completed. Finally, the results page displays the classification to a degree of certainty and gives the user the option to submit the question set and classification to the learning set. This app usage explanation can be seen graphically in Figure 4.2.

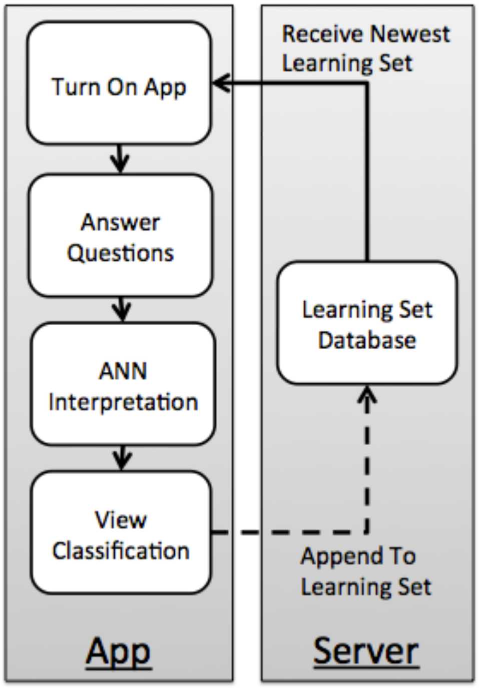
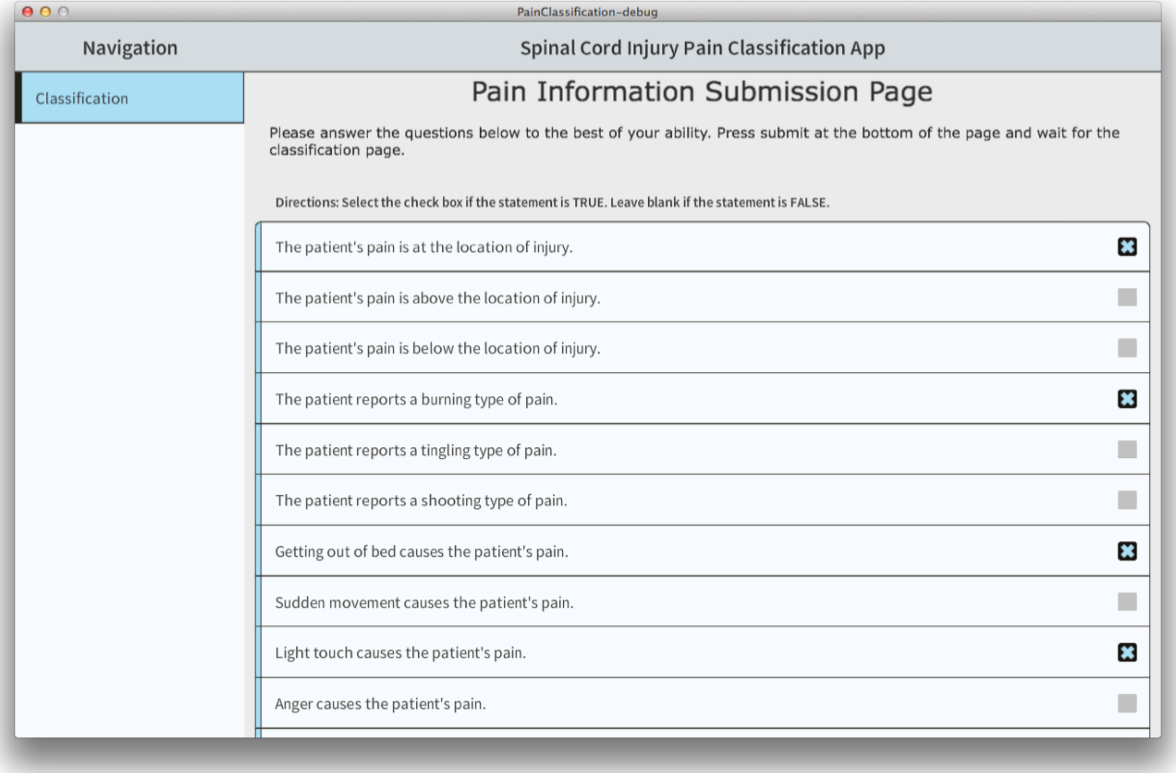


Figure 4.2 Pain Classification App Usage Diagram. This app communicates with a common database that app users on different tablets communicate with. The usage of this app flows in one direction: turn on app, answer questions, ANN interpretation, and view results.

The classification page within the app contains title and body text, and a grouped list with check boxes the question set. When the questions are submitted, an alert screen pops-up notifying the user to wait while the app processes the question data. Then the results page displays title and body text, an image of the ISCIPC table, and a grouped list allowing the user to send the question set and classification to the learning set on the server. Screenshots of these pages can be seen in Figures 4.3 through 4.5.


PainClassification-debug

Navigation

Spinal Cord Injury Pain Classification App

Classification

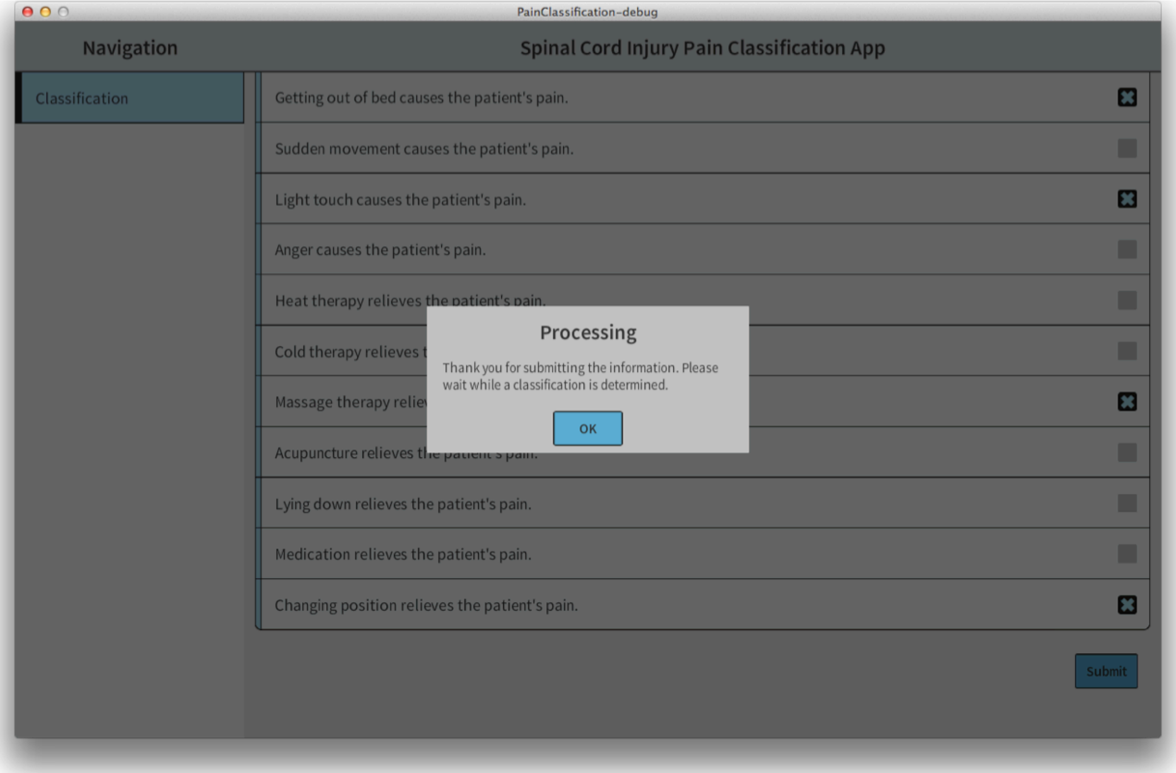
Pain Information Submission Page

Please answer the questions below to the best of your ability. Press submit at the bottom of the page and wait for the classification page.

Directions: Select the check box if the statement is TRUE. Leave blank if the statement is FALSE.

- The patient's pain is at the location of injury. ☒
- The patient's pain is above the location of injury. □
- The patient's pain is below the location of injury. □
- The patient reports a burning type of pain. ☒
- The patient reports a tingling type of pain. □
- The patient reports a shooting type of pain. □
- Getting out of bed causes the patient's pain. ☒
- Sudden movement causes the patient's pain. □
- Light touch causes the patient's pain. ☒
- Anger causes the patient's pain. □

Figure 4.3 Pain Classification App Home Page. This page asks the user to answer and submit the questions to be interpreted and classified in-app.


PainClassification-debug

Navigation

Spinal Cord Injury Pain Classification App

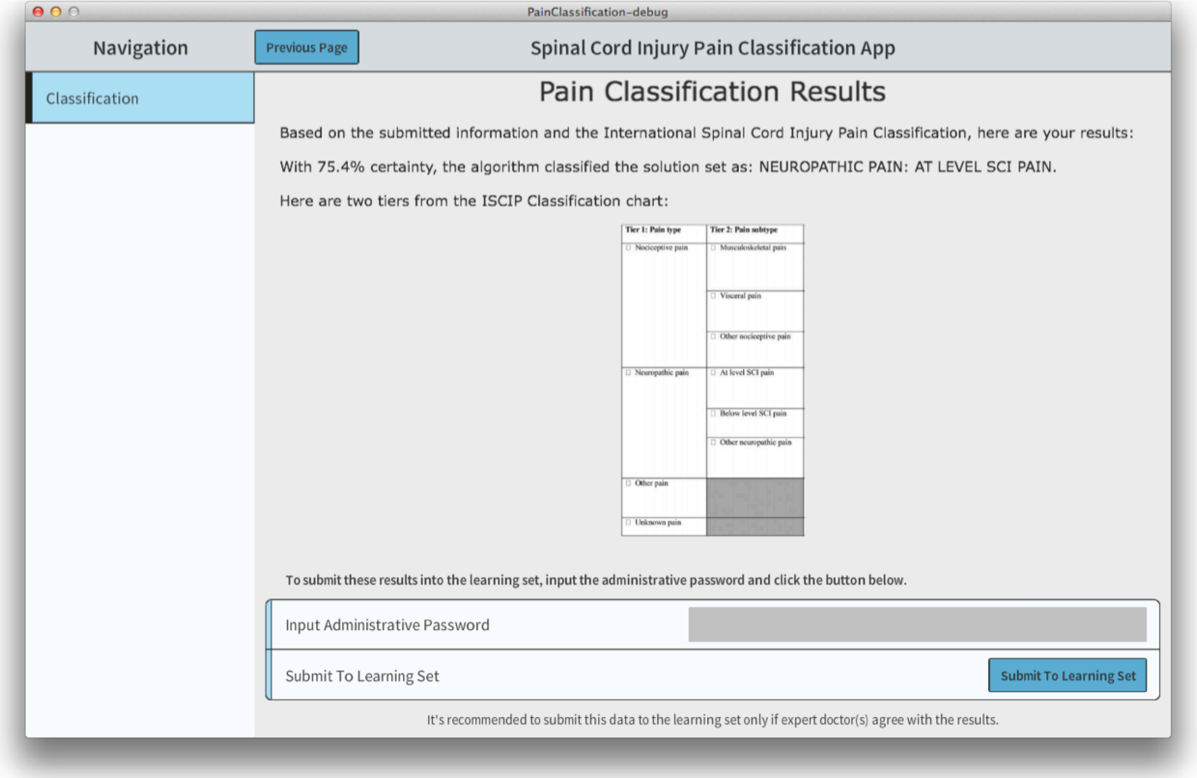
Classification

- Getting out of bed causes the patient's pain. ☒
- Sudden movement causes the patient's pain. □
- Light touch causes the patient's pain. ☒
- Anger causes the patient's pain. □
- Heat therapy relieves the patient's pain. □
- Cold therapy relieves t □
- Massage therapy relie ☒
- Acupuncture relieves the patient's pain. □
- Lying down relieves the patient's pain. □
- Medication relieves the patient's pain. □
- Changing position relieves the patient's pain. ☒

Processing

Thank you for submitting the information. Please wait while a classification is determined.

Figure 4.4 Pain Classification App Processing Screen. This screen appears when the user submits the pain information and while the app processes the information for interpretation.



Pain Classification Results

Based on the submitted information and the International Spinal Cord Injury Pain Classification, here are your results:

With 75.4% certainty, the algorithm classified the solution set as: NEUROPATHIC PAIN: AT LEVEL SCI PAIN.

Here are two tiers from the ISCIP Classification chart:

Tier 1: Pain type	Tier 2: Pain subtype
□ Nociceptive pain	□ Musculoskeletal pain
	□ Visceral pain
	□ Other nociceptive pain
□ Neuropathic pain	□ At level SCI pain
	□ Below level SCI pain
	□ Other neuropathic pain
□ Other pain	
□ Unknown pain	

To submit these results into the learning set, input the administrative password and click the button below.

It's recommended to submit this data to the learning set only if expert doctor(s) agree with the results.

Figure 4.5 Pain Classification App Results Page. This page displays the outputted classification and the certainty of the classification. Also, this page lets the user submit this data set and classification to the learning set. The app requires the user to input the administrative password and urges the user to be sure when submitting the data set.

Explanations of the artificial neural network corresponding to question answers and the access of the learning set through a python-based server to a MySQL database are explained in the next sections.

4.2.1 ANN Implementation

An artificial neural network is the main computational analysis tool used in classifying pain information in this app. As seen in previous figures, the user only answers true or false questions, which is enough information, allowing the app to use the ANN. Once the answers are submitted, each answer is converted to an integer data type—1 for true and 0 for false. Then the new answer set is arranged in an array of 1s and 0s. The answer set is then provided to the ANN, where each entry corresponds to an input node in the network. The answer set is then processed by the network, converting the integer data types to float data types as manipulated by the weights of the ANN as defined by the learning set.[7] Then the floats are rounded to corresponding integers, certainties are calculated, and a resulting integer array is outputted. The final integer array is then interpreted by the app, and the final classification is displayed to the user. This explanation of the interface between the GUI and the ANN is shown in Figure 4.6.

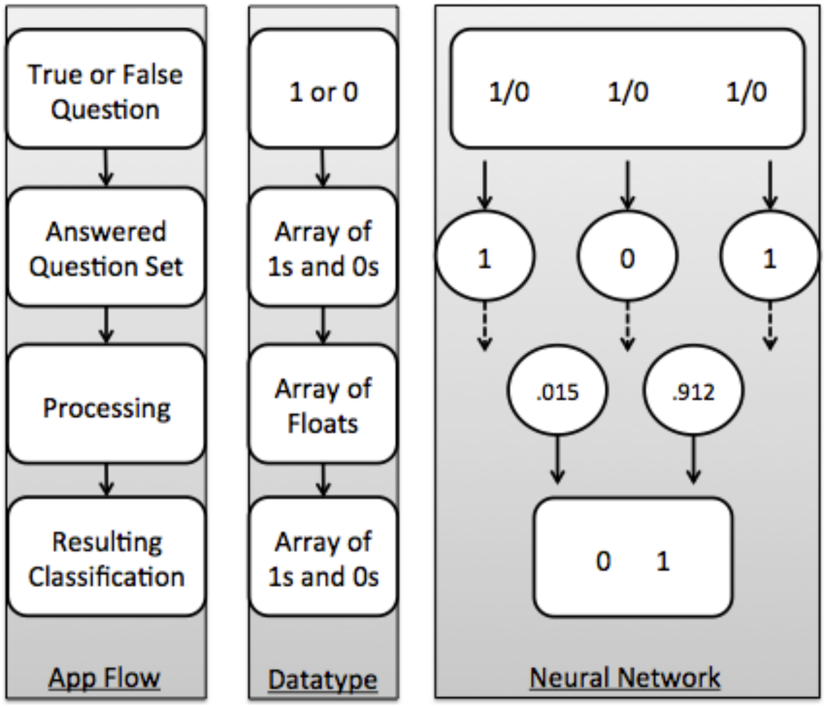


Figure 4.6 Artificial Neural Network App Implementation Diagram. This diagram shows how app commands translate to computer data types and the ANN. This neural network is only an approximate network with arbitrary values inputted—a more complete explanation of ANNs is in Chapter 2.

Before the ANN runs for the first time, the ANN needs to adjust the weights of the network accordingly based on the learning set. This learning set is stored on an external server, and accessing the learning set is described in the next section.

[7] This is assuming the ANN already learned from the learning set.

4.2.2 Python-Based Server with MySQL Database

Since the learning set needs to be accessible by multiple tablet-apps and all tablet-apps need to access the most recent learning set, it is simplest for the users to have the learning set stored on an external server. This allows tablet-apps to pull from and make changes to the learning set within the app itself—essentially negating the need for any file management using external software and hardware.

There are three physical components for accessing the learning set: the tablet hosting the app, a router hosting a local area network, and a PC hosting the server and learning set. The learning set is stored in a MySQL database, an open-source database management system [60]. The python-based server is created with the Twisted Networks library hosting a local socket with a Transmission Control Protocol (TCP) [61], [62]. The app sends Hypertext Transfer Protocol (HTTP) requests to the server, passing a MySQL query string. The server receives the request, passes the query to the database, receives the database output, and sends a string of data back to the app. This process is outlined and can be seen in Figure 4.7.

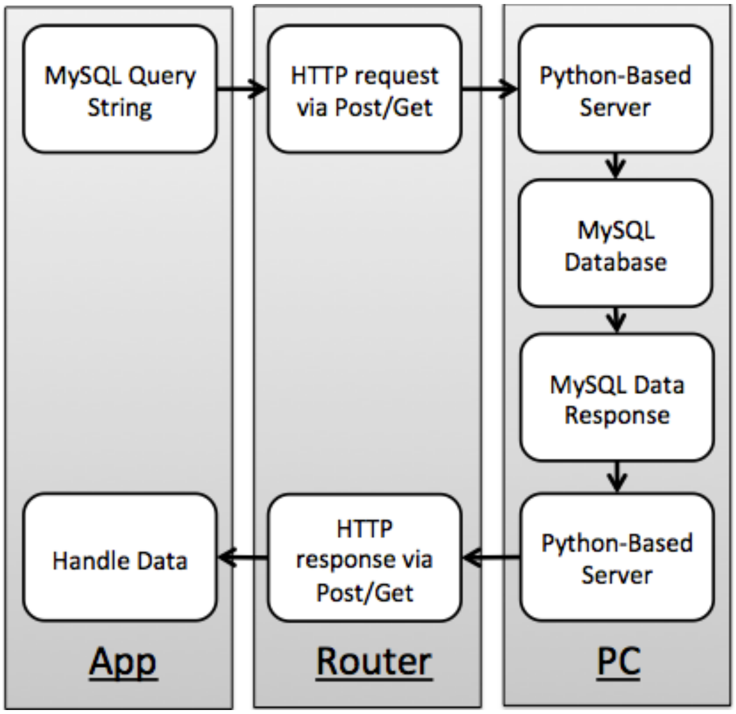


Figure 4.7 Pain Classification App Tablet to Server Communication Diagram. The app communicates with the database through a Python-based server by sending HTTP requests/responses between the tablet and PC. This allows for multiple tablets to communicate with the same database.

This combination of tablet-based app, router hosting a local area network, and PC completes the mHealth application for pain classification. Once data is interpreted, it can be delivered, which is seen in the next two applications.

CHAPTER 5 PRESSURE ULCER PREVENTION TRAINING

5.1 Motivation

Pressure ulcers are a common complication among senior citizens and people with physical disabilities [63]. Pressure ulcers develop when a portion of the skin has an applied force for a long enough period of time to disrupt blood flow in the local capillary network, depriving the tissues of oxygen and nutrients, causing tissue damage [64]. Prevalence rates of pressure ulcers are upwards of 32% in hospital settings and 22% in nursing homes [65], [66]. Other complications can develop along with pressure ulcers such as pain, infection, and decreased mobility, all of which can increase the length of stay in a hospital during recovery [67]. Because of the extensive care, the cost of pressure ulcer treatment was at one time the third highest after healthcare costs for cancer and cardiovascular diseases, with estimated US treatment costs of $11 billion per year [68], [69]. However, the risk of developing pressure ulcers can be minimized with a targeted preventative approach [70]. Occupational therapists with the proper training to develop personal pressure ulcer prevention programs with patients should reduce the prevalence of pressure ulcers among senior citizens and people with physical disabilities.

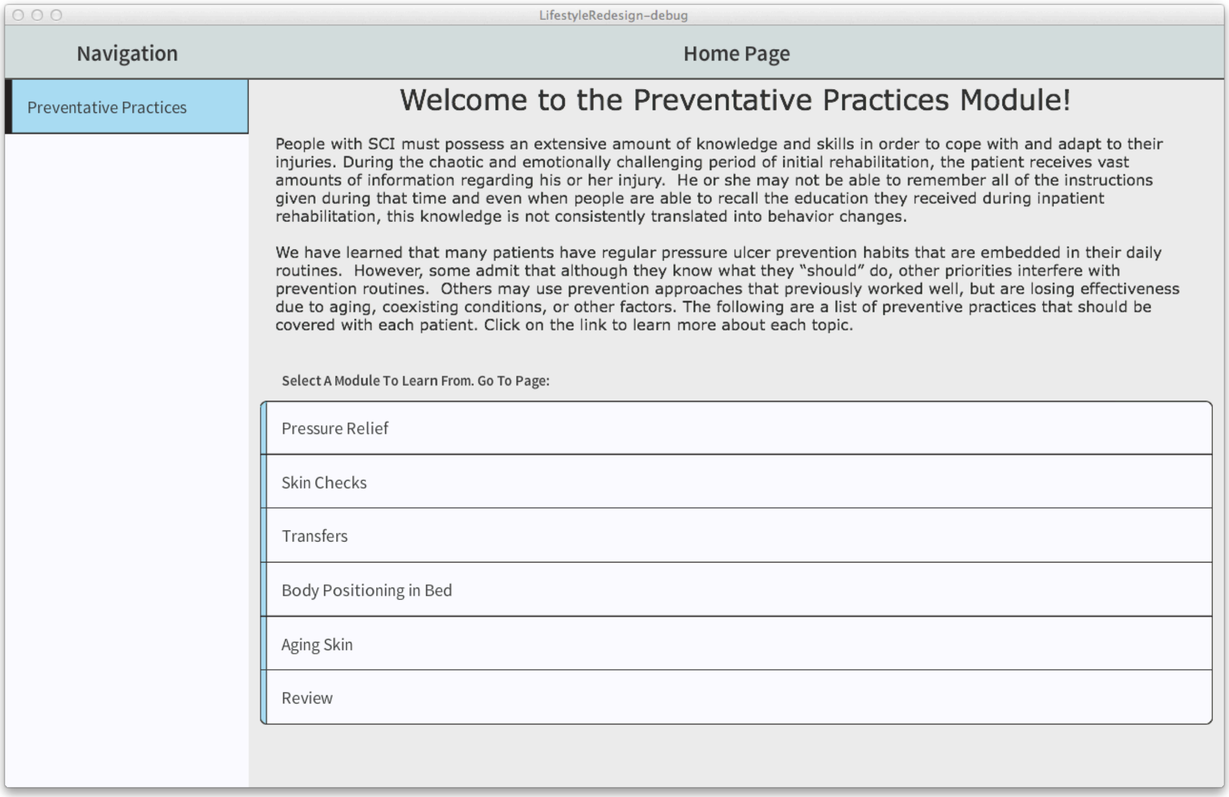
The University of Southern California (USC), Division of Occupational Science and Occupational Therapy is actively conducting research in the area of pressure ulcer prevention for the spinal cord injury community, termed Lifestyle Redesign® [71]. This research investigates the possibility of a lifestyle intervention program for preventing pressure ulcers by addressing the day-to-day activities of patients to help them form proper habits. The Department of Veterans Affairs of Long Beach, California (VALB) currently has one of the largest SCI/D centers within the VA system and is also interested in Lifestyle Redesign® for their SCI/D population. The

VALB is working with USC and University of California, Irvine (UCI) department of Electrical Engineering to develop a training system for occupational therapists applying the Lifestyle Redesign® intervention methods to the SCI/D community at the VALB. Specifically, a tablet-based app will be developed by UCI to train therapists with Lifestyle Redesign® content from USC.

5.2 Approach

This app, referred to as the Lifestyle Redesign app, is focused on delivering training-based information to therapists. This app will be deployed at the Department of Veteran Affairs, Long Beach, California to occupational therapists working with veterans with spinal cord injury and disorders (SCI/D). The content in the app is developed to supplement material based on the Lifestyle Redesign manual from USC. Each module has a focus on one particular topic and contains pages describing the topic further. The contents in each page will be combination of text, images, quizzes and interactive videos. The last page in each module is a review and quiz page. And, the app has a similar general structure as explained in Chapter 2.

Figure 5.1 shows the layout of a module's home page and the navigation to additional pages in the module. The home page has a welcoming title text and body text describing the contents of the module. An audio clip will also be played when the home page is first displayed. The audio clip will be a person's voice reading the body text aloud. The user can navigate to additional pages by selecting a labeled entry in the grouped list at the bottom half of the page.



Welcome to the Preventative Practices Module!

People with SCI must possess an extensive amount of knowledge and skills in order to cope with and adapt to their injuries. During the chaotic and emotionally challenging period of initial rehabilitation, the patient receives vast amounts of information regarding his or her injury. He or she may not be able to remember all of the instructions given during that time and even when people are able to recall the education they received during inpatient rehabilitation, this knowledge is not consistently translated into behavior changes.

We have learned that many patients have regular pressure ulcer prevention habits that are embedded in their daily routines. However, some admit that although they know what they "should" do, other priorities interfere with prevention routines. Others may use prevention approaches that previously worked well, but are losing effectiveness due to aging, coexisting conditions, or other factors. The following are a list of preventive practices that should be covered with each patient. Click on the link to learn more about each topic.

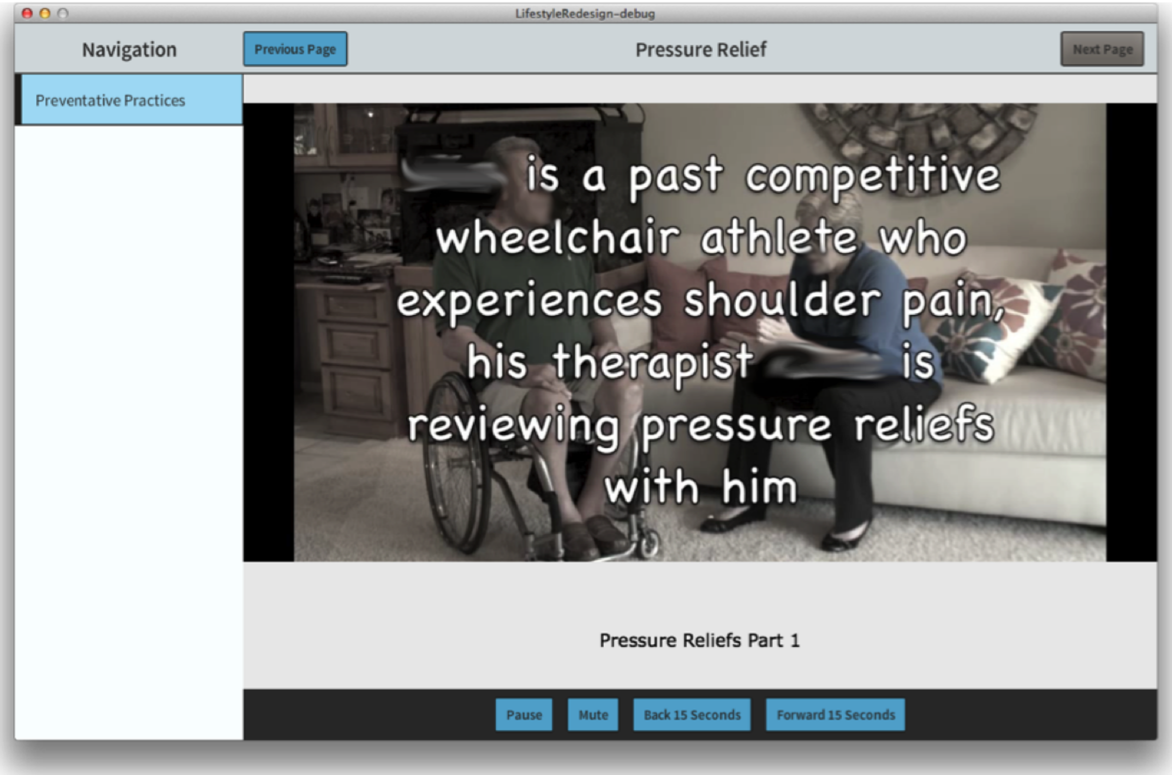
Figure 5.1 Lifestyle Redesign App Example Module Home Page. This page has a welcoming title text and body text describing the contents of the module. The grouped list at the bottom of the page lets the user navigate to additional pages in the module. An audio clip of a person reading the body text will play when the home page is first accessed.

The training videos were developed with collaboration from the USC School of Cinematic Arts. The videos are recordings of therapists explaining the module topic. Specifically, the videos intend to teach therapy techniques by displaying therapists working directly with patients in the patients' homes doing the therapy. Throughout the videos, the therapists are annotating the events that are happening in the videos and why techniques are important or useful. Also, subtitles are added underneath the video to allow the user to complete the training video without sound enabled in the app.

5.2.1 Interactive Training

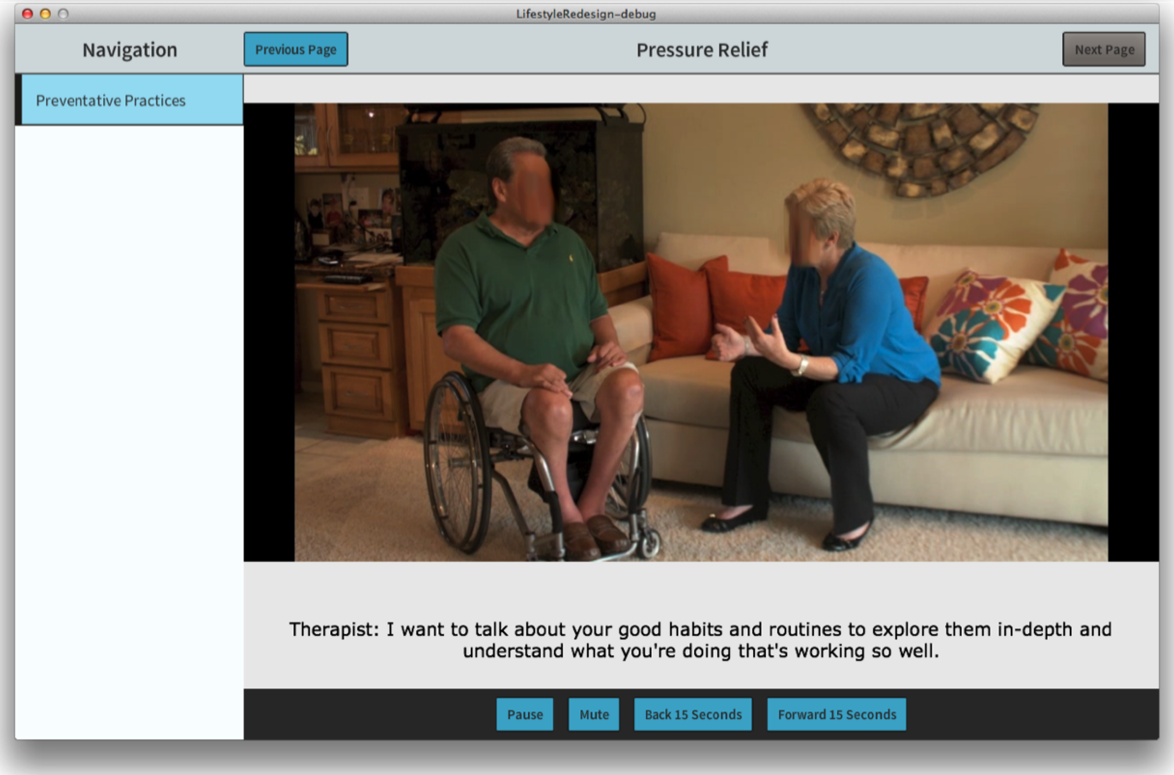
The Lifestyle Redesign app uses interactive training throughout the pages to dynamically deliver information. The interactive training consists of dynamic video, text-based quizzes, and video-based quizzes. Majority of the pages will display dynamic video. This section of the chapter will show example screenshots of a training page in use.

The Pressure Reliefs page in the Preventative Practices module displays a dynamic video about pressure relief for patients in wheelchairs. Pressure reliefs are the methods used to relieve pressure in areas at risk of pressure ulcers. This video shows the therapist working with a patient and elaborating on pressure relief techniques. The introduction of the video displays information about the person receiving therapy. As the video progresses, subtitles under the video appear and annotate the audio from the video. The therapist then describes what the therapist would like to complete with this training—specifically, see how the patient does pressure reliefs, describe its successes, and possibly suggest new methods. Two screenshots of the video is shown in Figure 5.2 showing the introduction text and the therapist presenting the topic of the video.



[redacted] is a past competitive wheelchair athlete who experiences shoulder pain, his therapist [redacted] is reviewing pressure reliefs with him

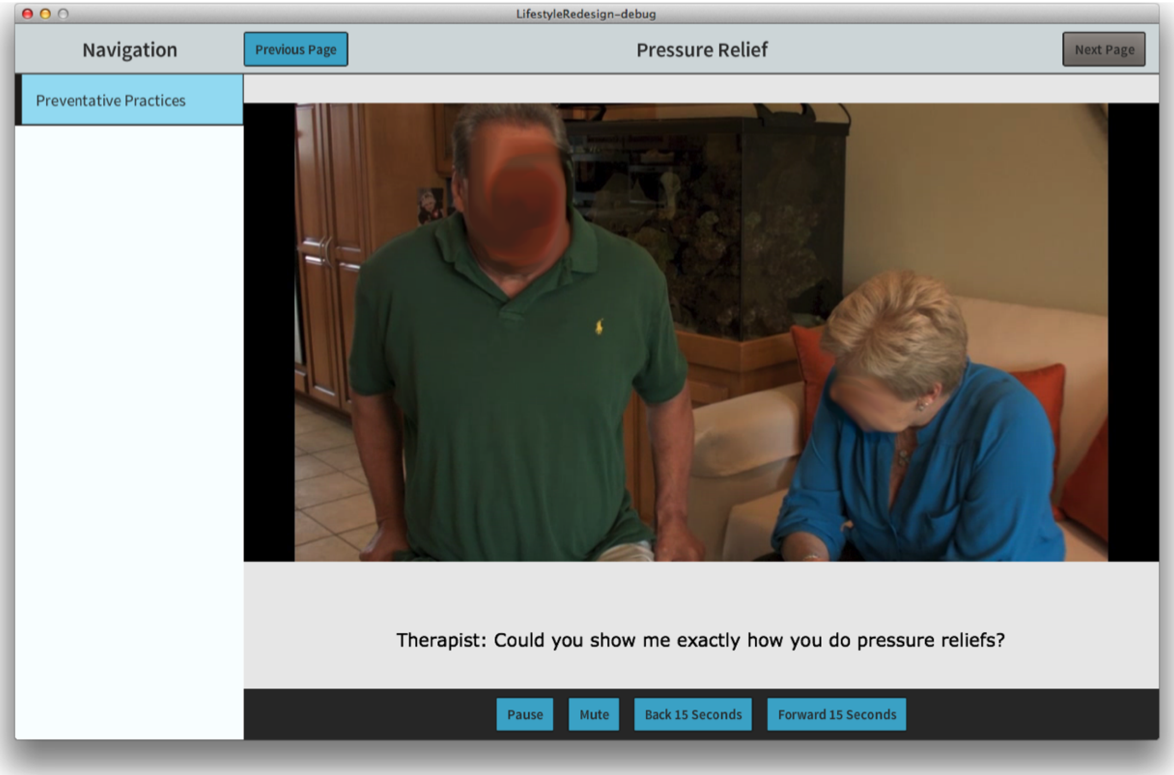
Pressure Reliefs Part 1



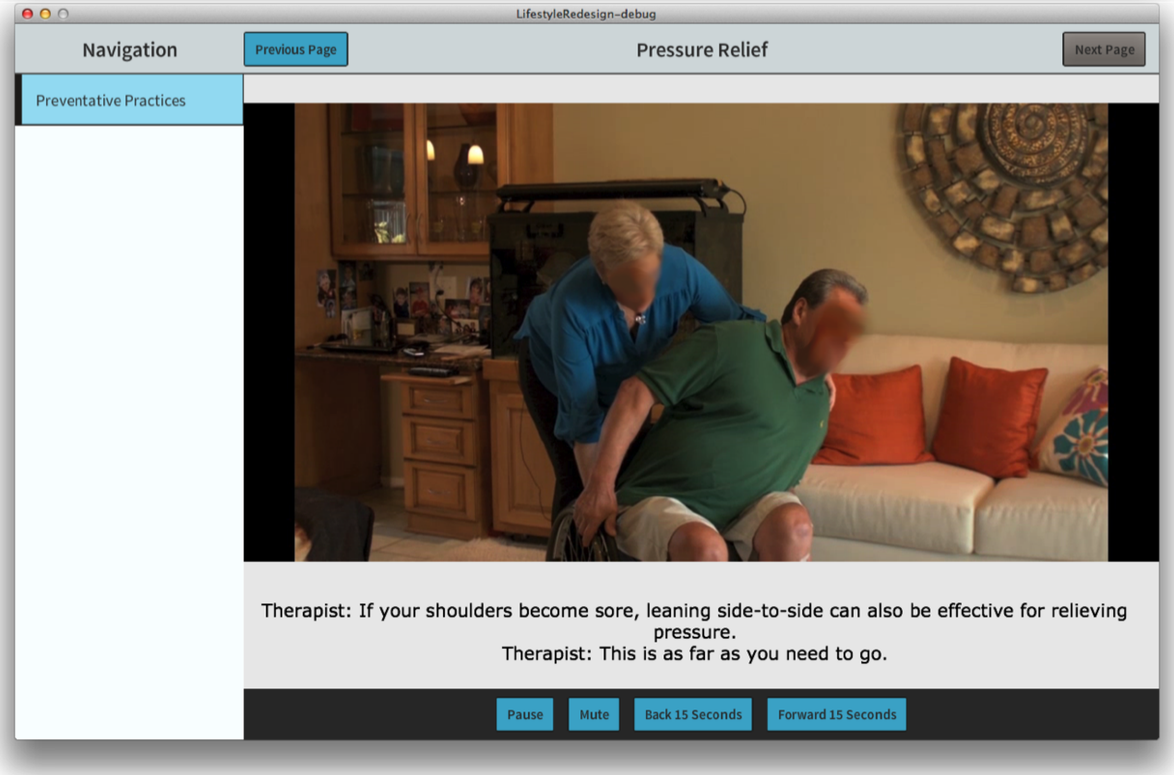
Therapist: I want to talk about your good habits and routines to explore them in-depth and understand what you're doing that's working so well.

Figure 5.2 Lifestyle Redesign Pressure Relief Page. The first screenshot shows the introduction of the training video with a general overview of the two people in the video. The second screen shows the therapist explaining what this training video will cover.

The video continues to progress as the therapist views the person's current pressure relief methods. The therapist then suggests other methods for pressure relief. Screenshots of the video with these events occurring can be seen in Figure 5.3.



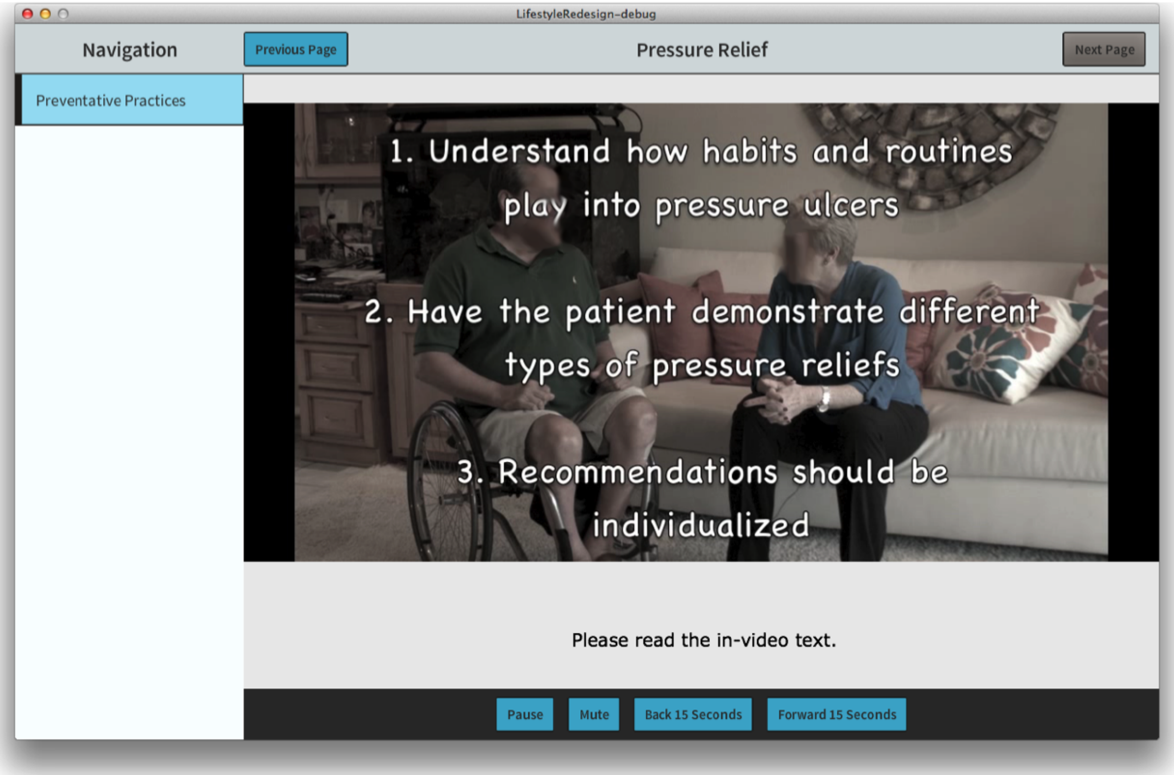
Therapist: Could you show me exactly how you do pressure reliefs?



Therapist: If your shoulders become sore, leaning side-to-side can also be effective for relieving pressure.
Therapist: This is as far as you need to go.

Figure 5.3 Lifestyle Redesign Pressure Relief Page. The first screenshot shows the therapist viewing the person's relief method. The second screenshot shows the therapist describing a new method to the person.

The video then concludes with closing remarks. These remarks are displayed on top of the video screen. The subtitles remind the app-user to read the remarks—as they can be used later for quizzes. This can be seen in Figure 5.4.



1. Understand how habits and routines play into pressure ulcers

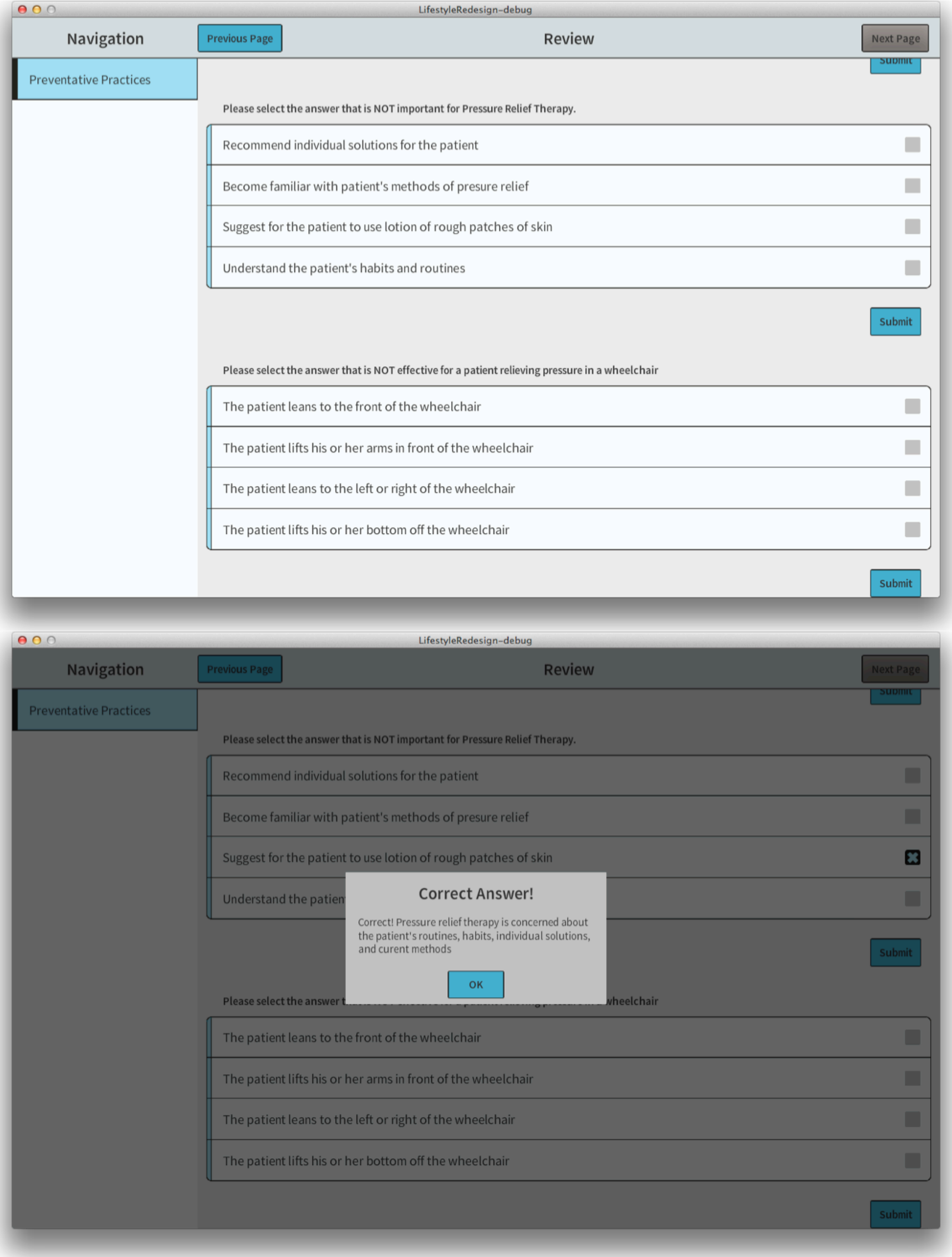
2. Have the patient demonstrate different types of pressure reliefs

3. Recommendations should be individualized

Please read the in-video text.

Figure 5.4 Lifestyle Redesign App Pressure Relief Page. This screenshot shows the final remarks at the end of the video recapping key points that the user should learn from the video.

Quizzes in the Lifestyle Redesign app are intended to be learning tools, delivering information, opposed to collection tools quantifying the amount the user learned from the app. Since this is the case, the correct answer with an explanation is displayed after the user submits their answer. The Review page in the Preventative Practices modules reiterates the key points described at the end of training videos. Then, the final section of the page contains quiz questions for the user to answer from. This can be seen in Figure 5.5.



Please select the answer that is NOT important for Pressure Relief Therapy.

- Recommend individual solutions for the patient □
- Become familiar with patient's methods of presure relief □
- Suggest for the patient to use lotion of rough patches of skin □
- Understand the patient's habits and routines □

Submit

Please select the answer that is NOT effective for a patient relieving pressure in a wheelchair

- The patient leans to the front of the wheelchair □
- The patient lifts his or her arms in front of the wheelchair □
- The patient leans to the left or right of the wheelchair □
- The patient lifts his or her bottom off the wheelchair □

Submit

Please select the answer that is NOT important for Pressure Relief Therapy.

- Recommend individual solutions for the patient □
- Become familiar with patient's methods of presure relief □
- Suggest for the patient to use lotion of rough patches of skin ☒
- Understand the patien □

Correct Answer!

Correct! Pressure relief therapy is concerned about the patient's routines, habits, individual solutions, and curent methods

OK

Submit

Please select the answer t ... wheelchair

- The patient leans to the front of the wheelchair □
- The patient lifts his or her arms in front of the wheelchair □
- The patient leans to the left or right of the wheelchair □
- The patient lifts his or her bottom off the wheelchair □

Submit

Figure 5.5 Lifestyle Redesign App Review Page. The first screenshot shows the text-base quiz portion of the Review page with two questions. The second screen shows when a correct answer is activated; a pop-up screen appears describing the correct answer.

Other modules and pages will be implemented in the app as the content-providers create the videos and training information. These add-ons will be deployed in subsequent versions of the app.

The Lifestyle Redesign app uses interactive video as an advanced method of delivering information. As shown, this functionality allows for content providers to create video-based information and app developers to easily implement text-based content corresponding to video events. App developers can pause the video, ask the user to click on locations on the video screen, and respond to the click events appropriately.

CHAPTER 6 ANTICOAGULANT MEDICATION ASSISTANCE

6.1 Motivation

Patients are commonly prescribed anticoagulant medications to minimize the risk of heart attack, stroke, and other heart diseases by preventing the formation of blood clots in the blood vessels [72]. Of all anticoagulant medications, Warfarin, brand name Coumadin, has been the most commonly prescribed oral anticoagulant medication in the US [73]. However, the use of other medications and some foods interact negatively with Warfarin. For instance, foods high in vitamin K reduce the effectiveness of Warfarin [74]. So, patients are recommended to log their blood test reports, particularly their Prothrombin Time / International Normalized Ratio (PT/INR), or the time it takes blood to clot, to know the effectiveness of their anticoagulant medication [75]. Also, safety is emphasized to patients prescribed to anticoagulants because the risk of severe bleeding is increased, potentially leading to hemorrhage in the brain or spinal cord [76]. The development of a health-reporting and information delivery system would allow for patients prescribed to anticoagulants to handle all information regarding their medication. Specifically, this health-reporting and information delivery system could be implemented in a tablet-based app allowing for a lightweight, electronic, and mobile system.

The Study on Health Technology for Older Adults (SHTOA) in the Program in Nursing Science, UC Irvine lead by Dr. Jung-Ah Lee is conducting research to determine the viability of a mobile health system assisting patients prescribed to anticoagulants. Tablet-based apps will be developed to assist in this study for the collection of self-health and delivery of medication information.

6.2 Approach

This app is named the Mobile App for Savvy Seniors (MASS) and focuses on self-health reporting and medication information delivery. One purpose of self-health reporting is to collect more accurate health information to relay to healthcare professionals. By reporting health events when they occur, rather than recollecting the event at a routine health visit, healthcare professionals receive a more accurate account of a patient's health. Also, medication information may be difficult or inconvenient to access for senior citizens. Having general medication safety information readily available within the tablet, the app-user can access the information as needed at the appropriate times, promoting better health for the user.

MASS apps will be delivered to a Hispanic population of patients (n = 20) prescribed to anticoagulant medication in the local Orange County, California area. The apps will be installed on tablets and physically loaned to the patients for a 3-month period while the study is being completed. The apps will be installed on Samsung Galaxy Tab 2.0 tablets with display resolution of 1280x800 pixels and diagonal display size of 10.1 inches. The tablets will also come with pre-paid 3G data plans allowing app usage in areas without Wi-Fi availability.

6.2.1 Self-Health Reporting

The MASS app contains self-health reporting for the following health events: anticoagulant medication daily routine, PT/INR blood test results, recent body bruising and bleeding events, sickness events, and other medication events. Figures 6.3 through 6.9 show the form input pages and the corresponding health report pages for the above events. Accessing the form input pages require the user to navigate to the input modules: My Page, Medication, Body and Blood Test. Accessing the report pages require the user to navigate to My Page and select the corresponding report page button, which can be seen in Figure 6.1. Some of the input and report pages are combined: My Sicknesses, and My Other Medications. Figure 6.2 shows example module home pages and the corresponding navigation buttons for report input and viewing.

The My Page module allows for navigation to self-health report pages and can be seen in Figure 6.1. This module will be used to provide the users' doctors with more accurate recollections of previous health events. The image in the center of the screen is user defined and intended to help the user feel more welcomed when using the app. Each button on the page navigates to an individual report page and can be seen in Figures 6.3 through 6.9.

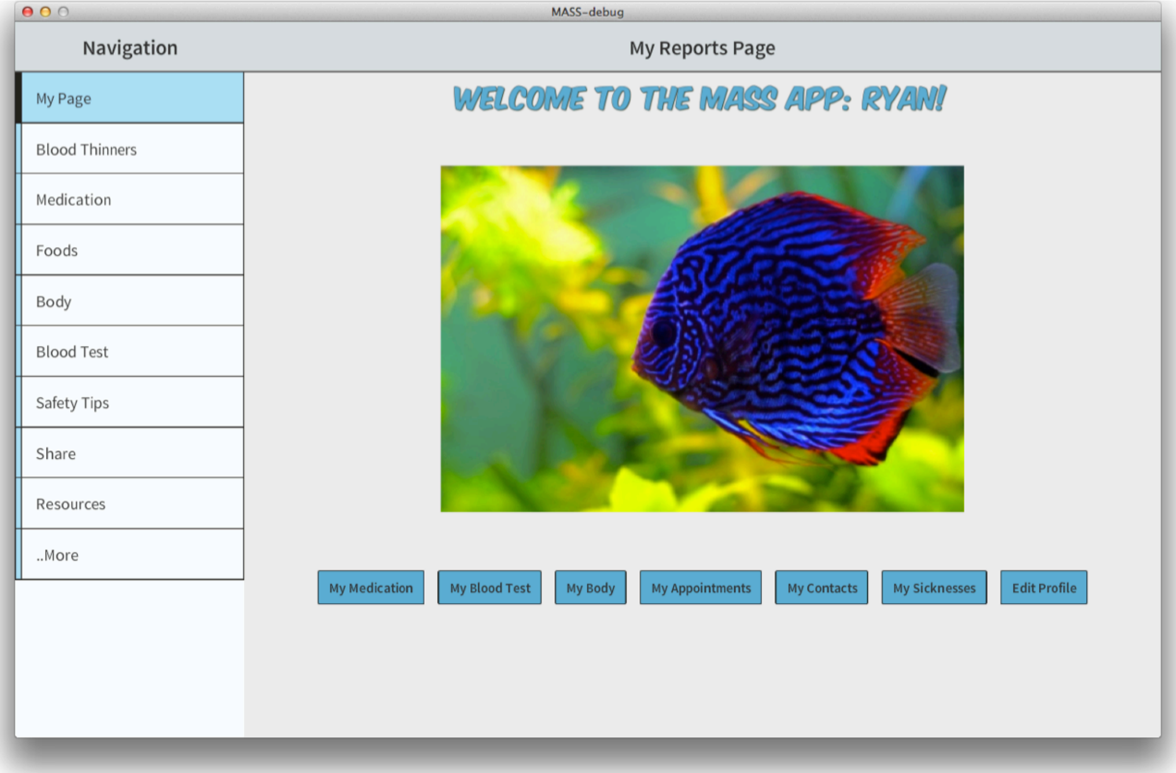
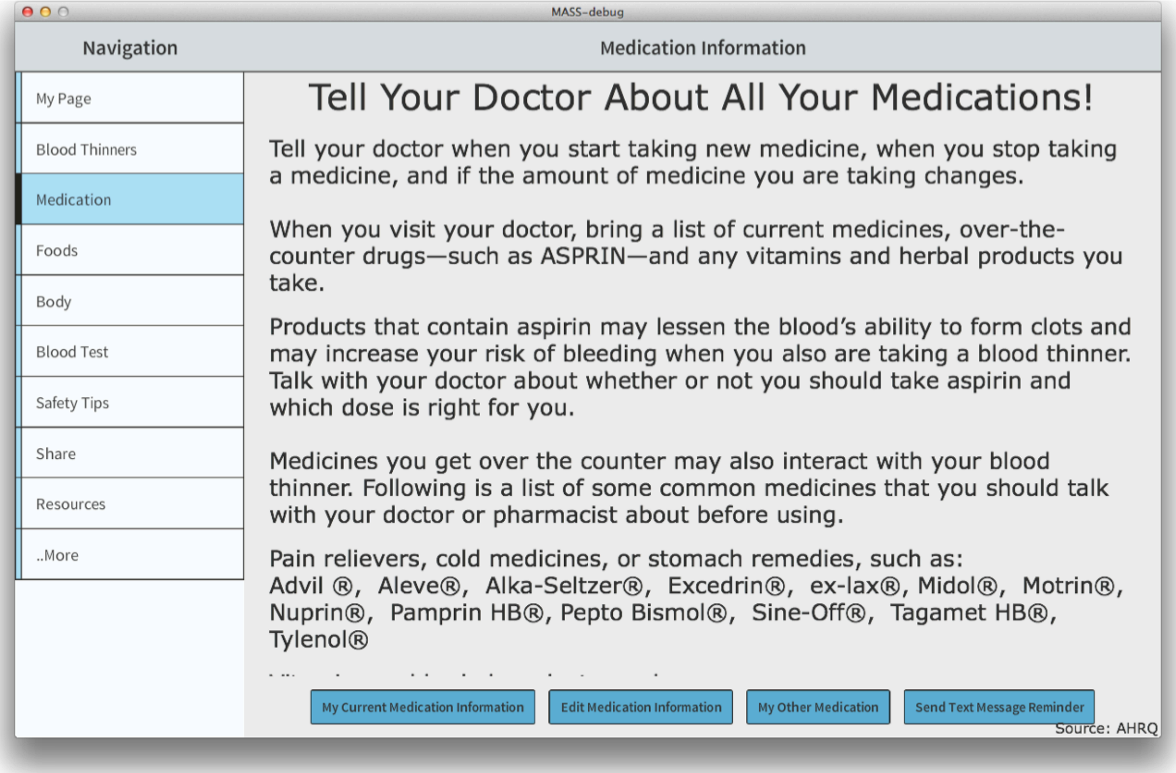


Figure 6.1 MASS App Reports Page. This page contains navigation buttons for viewing reports of self-health information collected in other modules. The image in the center is user-defined and used as a welcoming image when the app is first opened.

Each module displays a home page when first selected. The home page displays anticoagulant safety information in relation to the module topic. Also, the home page displays navigation buttons to pages for inputting and viewing report information. The Medication module home page and the Body module home page can both be seen in Figure 6.2.



Tell Your Doctor About All Your Medications!

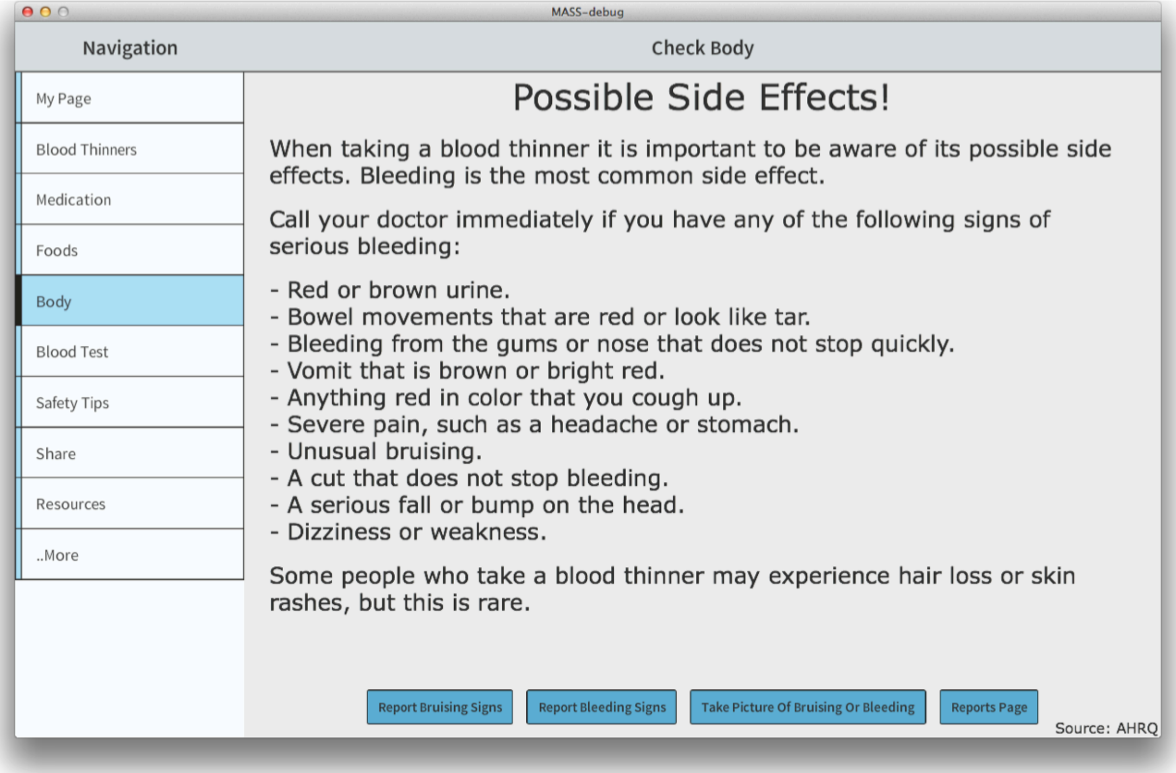
Tell your doctor when you start taking new medicine, when you stop taking a medicine, and if the amount of medicine you are taking changes.

When you visit your doctor, bring a list of current medicines, over-the-counter drugs—such as ASPRIN—and any vitamins and herbal products you take.

Products that contain aspirin may lessen the blood's ability to form clots and may increase your risk of bleeding when you also are taking a blood thinner. Talk with your doctor about whether or not you should take aspirin and which dose is right for you.

Medicines you get over the counter may also interact with your blood thinner. Following is a list of some common medicines that you should talk with your doctor or pharmacist about before using.

Pain relievers, cold medicines, or stomach remedies, such as:
Advil ®, Aleve®, Alka-Seltzer®, Excedrin®, ex-lax®, Midol®, Motrin®, Nuprin®, Pamprin HB®, Pepto Bismol®, Sine-Off®, Tagamet HB®, Tylenol®



Possible Side Effects!

When taking a blood thinner it is important to be aware of its possible side effects. Bleeding is the most common side effect.

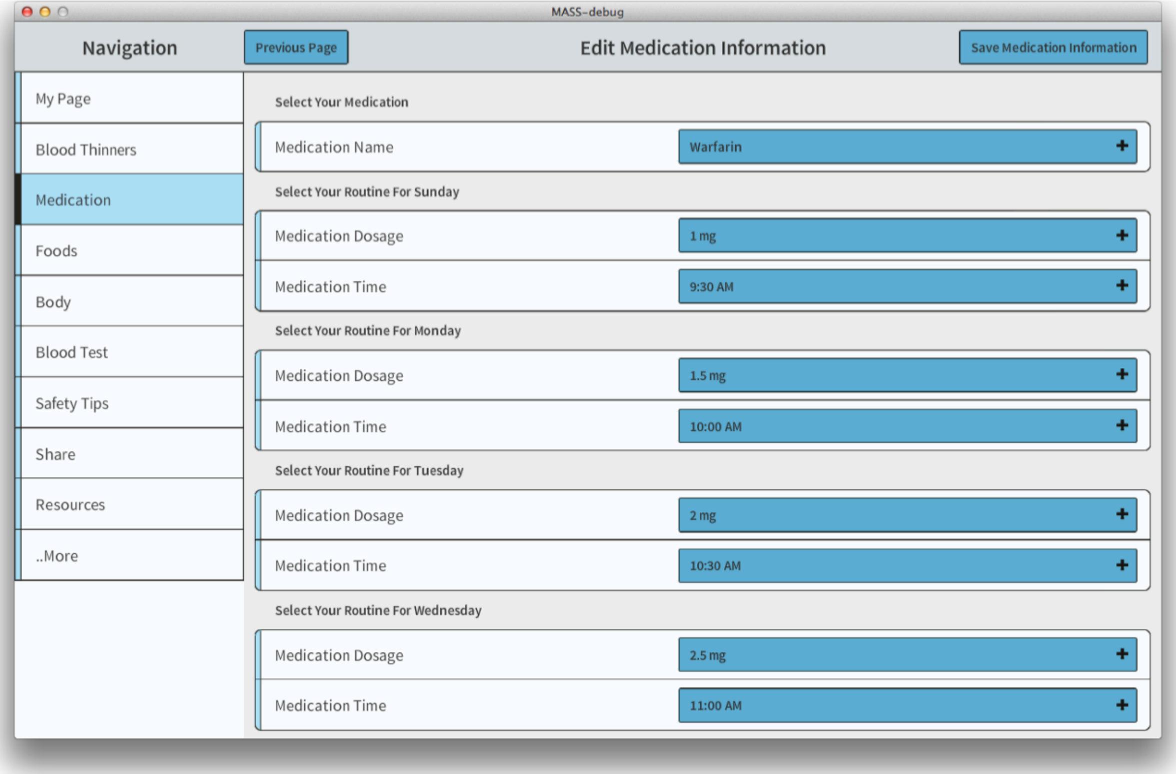
Call your doctor immediately if you have any of the following signs of serious bleeding:

- Red or brown urine.
- Bowel movements that are red or look like tar.
- Bleeding from the gums or nose that does not stop quickly.
- Vomit that is brown or bright red.
- Anything red in color that you cough up.
- Severe pain, such as a headache or stomach.
- Unusual bruising.
- A cut that does not stop bleeding.
- A serious fall or bump on the head.
- Dizziness or weakness.

Some people who take a blood thinner may experience hair loss or skin rashes, but this is rare.

Figure 6.2 MASS App Module Home Pages. These pages display anticoagulant safety information relating to the module topic and navigation buttons to input and view report information.

The Medication Information Page asks the user to input the user's daily medication schedule with information including medication name, dosage, and time for each day. The saved information is then displayed in a HTML table, and both pages can be seen in Figure 6.3. This medication schedule reminds the user and healthcare providers of the user's medication schedule, and this information is also used in other pages within the app.



Edit Medication Information

Select Your Medication

Medication Name: Warfarin

Select Your Routine For Sunday

Medication Dosage: 1 mg

Medication Time: 9:30 AM

Select Your Routine For Monday

Medication Dosage: 1.5 mg

Medication Time: 10:00 AM

Select Your Routine For Tuesday

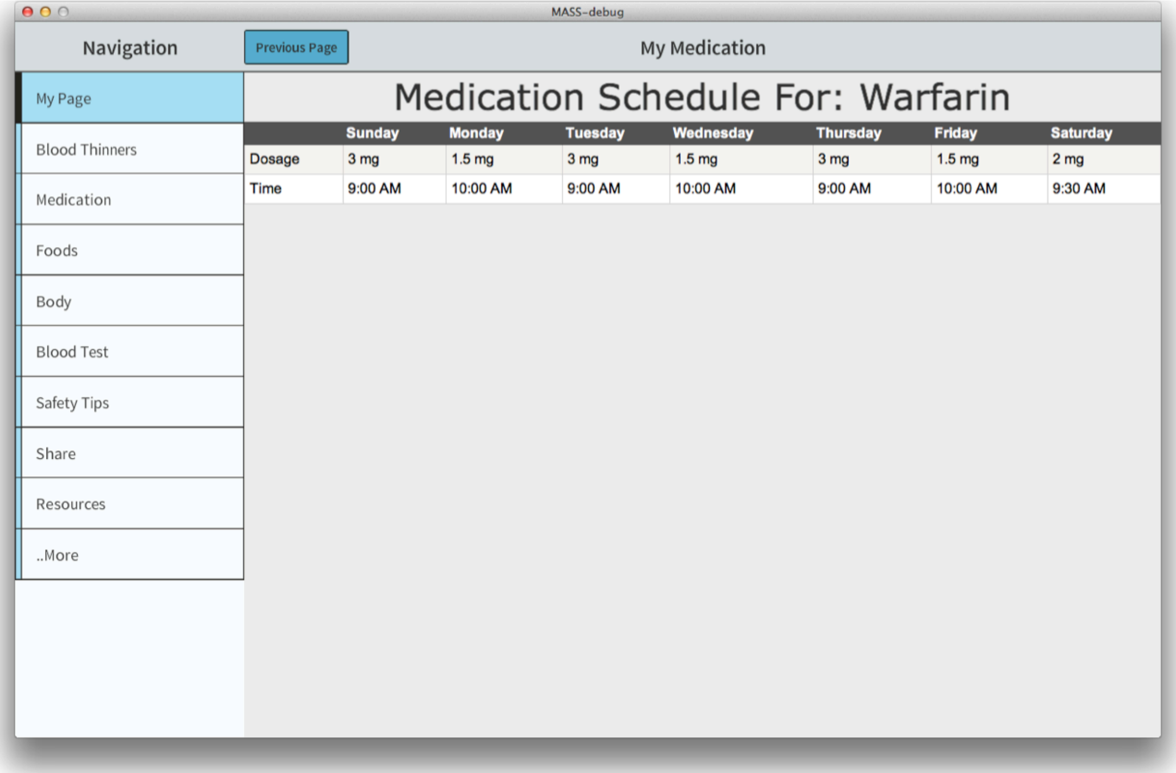
Medication Dosage: 2 mg

Medication Time: 10:30 AM

Select Your Routine For Wednesday

Medication Dosage: 2.5 mg

Medication Time: 11:00 AM



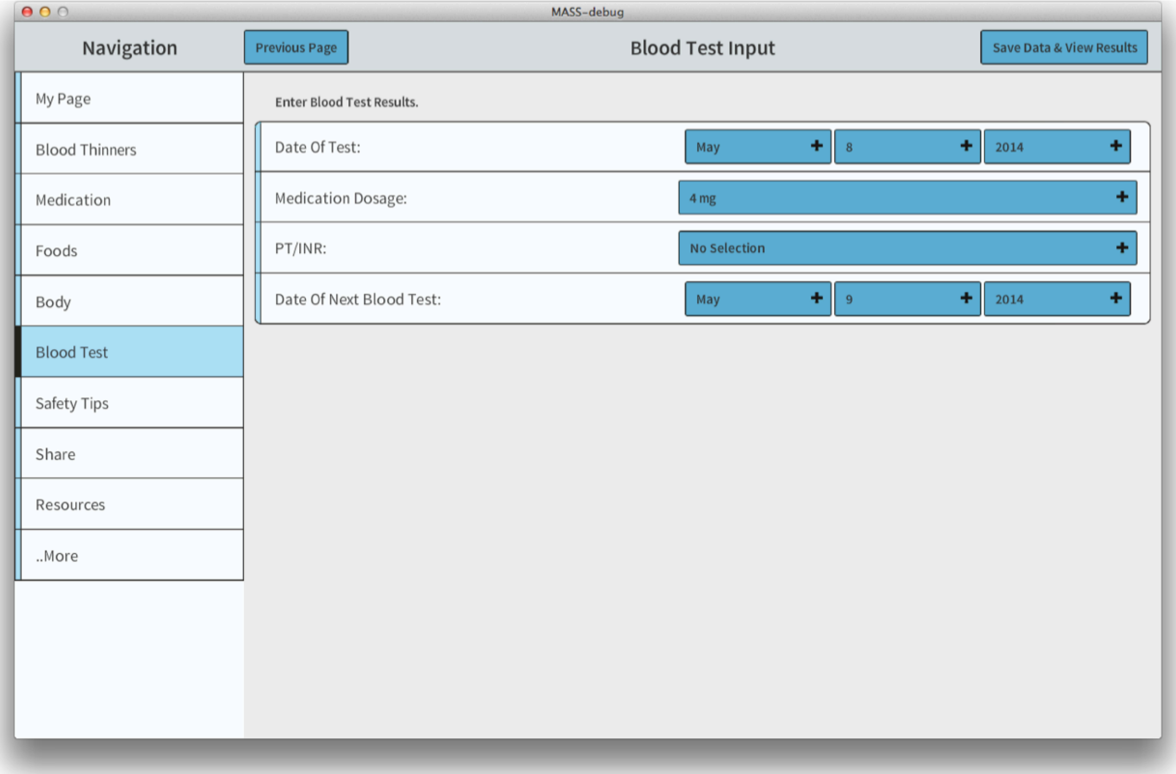
My Medication

Medication Schedule For: Warfarin

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Dosage	3 mg	1.5 mg	3 mg	1.5 mg	3 mg	1.5 mg	2 mg
Time	9:00 AM	10:00 AM	9:00 AM	10:00 AM	9:00 AM	10:00 AM	9:30 AM

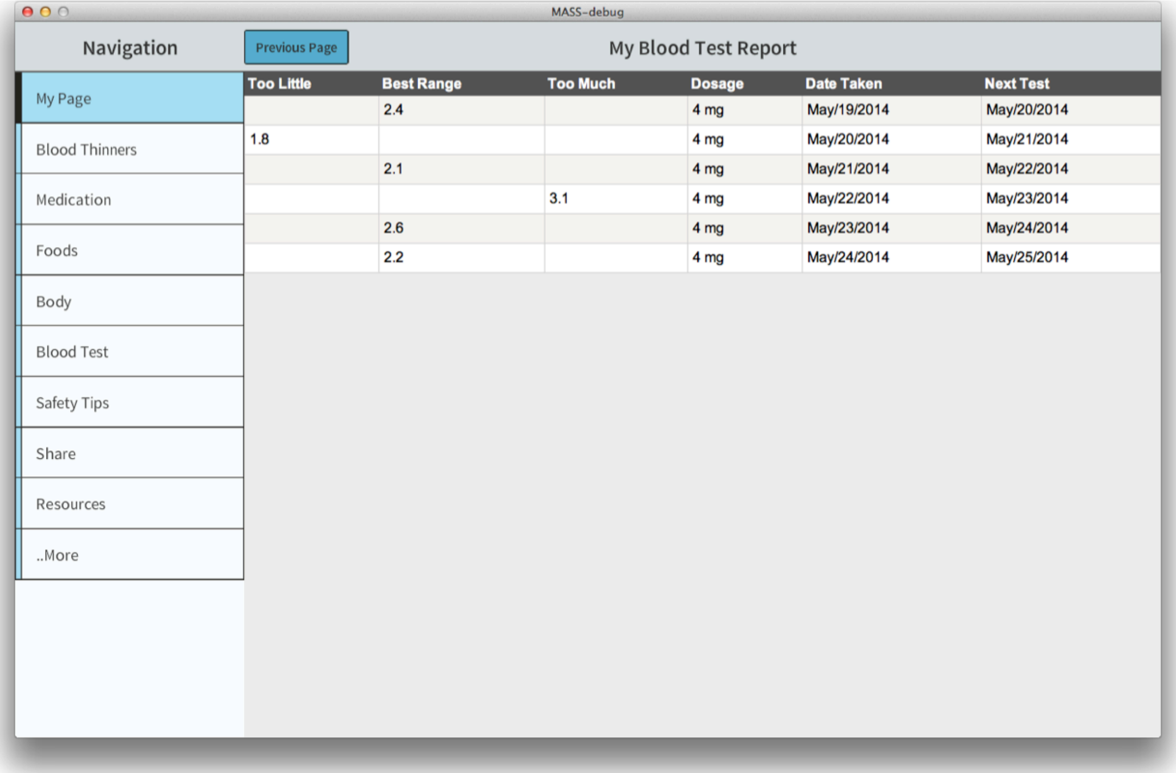
Figure 6.3 MASS App Medication Schedule Input and Report Pages. The first page contains dropdown lists to input the medication type, dosage, and time for each day of the week. The second page displays the medication information in an HTML table for referencing.

The Blood Test Input Page asks the user to input information regarding the user's most recent blood test results. The user inputs the date of the most recent test, the medication dosage from that day, the PT/INR result value, and the date of the next test. The PT value is the Prothrombine Time, or the time it takes for the blood to clot, and is used by healthcare providers to see the effect of the medication and general health of the patient. INR stands for international normalized ratio and standardizes the PT value regardless of the testing method. The results from the blood test input page are then saved and displayed in an HTML table in the Blood Test Report page. The blood test report page also comments on the PT value being low, best range, or high based on general information from the AHRQ website. These pages can be seen in Figure 6.4.



Enter Blood Test Results.

Date Of Test:	May	8	2014
Medication Dosage:	4 mg		
PT/INR:	No Selection		
Date Of Next Blood Test:	May	9	2014

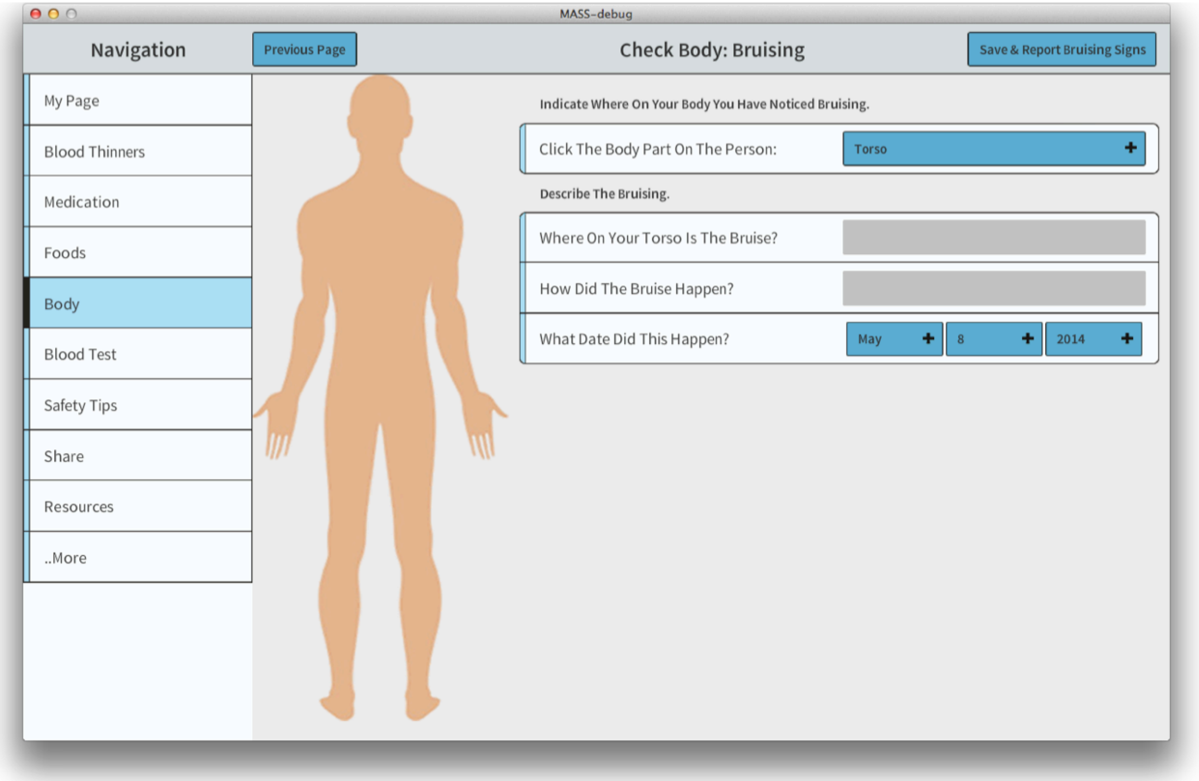


My Blood Test Report

Too Little	Best Range	Too Much	Dosage	Date Taken	Next Test
	2.4		4 mg	May/19/2014	May/20/2014
1.8			4 mg	May/20/2014	May/21/2014
	2.1		4 mg	May/21/2014	May/22/2014
		3.1	4 mg	May/22/2014	May/23/2014
	2.6		4 mg	May/23/2014	May/24/2014
	2.2		4 mg	May/24/2014	May/25/2014

Figure 6.4 MASS App PT/INR Blood Test Pages. The first page contains dropdown lists for inputting the dates, medication dosage amount, and PT/INR result value. The second page contains an HTML table displaying the saved blood test results and comments on the magnitude of the PT/INR values.

Since bruising events provide information about effect of anticoagulant medication, the Body Bruising Input Page asks the user to input information regarding the user's most recent bruising events. This page has a clickable HTML image map overlaid on a picture of anatomical person allowing the user to click on the body part corresponding to the bruising location on the user's body. There are also text input boxes and drop down lists for the user to input additional information about and date of the bruising event. This page can be seen in Figure 6.5, and the report page for bruising can be seen in Figure 6.6.



Indicate Where On Your Body You Have Noticed Bruising.

Click The Body Part On The Person: Torso

Describe The Bruising.

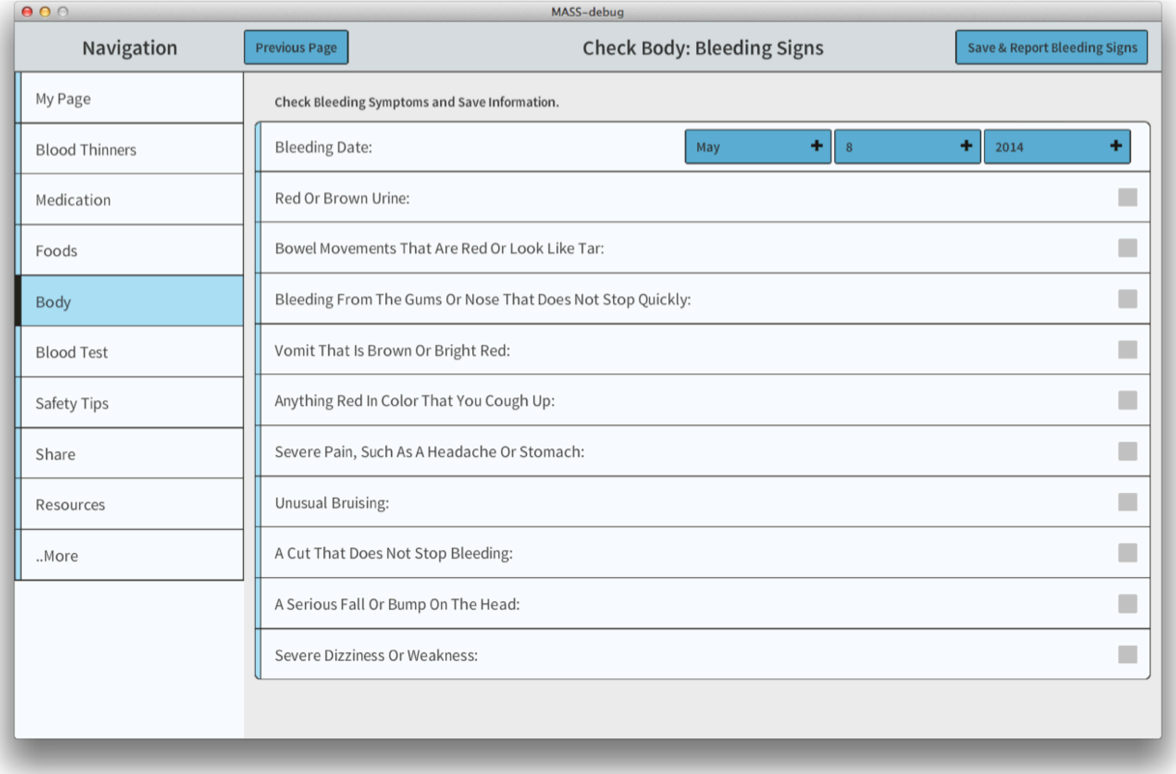
Where On Your Torso Is The Bruise?

How Did The Bruise Happen?

What Date Did This Happen? May 8 2014

Figure 6.5 MASS App Body Bruising Input Page. This page contains dropdown lists for the location, date of bruising, text inputs for the details of bruising, and a clickable image map of the body to select bruising location.

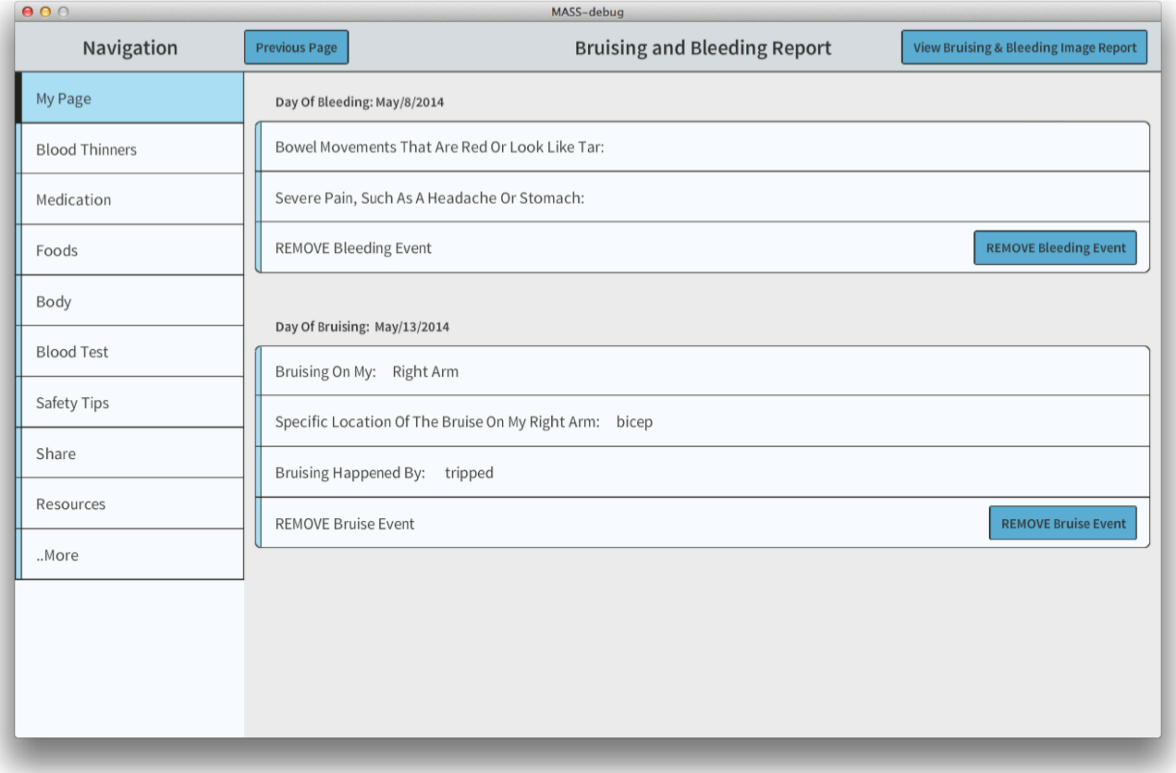
Since specific bleeding events can be a result of anticoagulant medication, the Body Bleeding Input Page asks the user to input information regarding the user's recent bleeding events. This page has a drop down list for the date and a list of bleeding events with corresponding check boxes that the user can select to describe the user’s most recent bleeding event. The list of bleeding events were selected from the AHRQ website as relevant events for healthcare providers to be aware about. The saved data is then displayed on the body bruising and bleeding report page. Both of these pages can be seen in Figure 6.6.



Check Body: Bleeding Signs

Check Bleeding Symptoms and Save Information.

Bleeding Date:	May + 8 + 2014 +
Red Or Brown Urine:	□
Bowel Movements That Are Red Or Look Like Tar:	□
Bleeding From The Gums Or Nose That Does Not Stop Quickly:	□
Vomit That Is Brown Or Bright Red:	□
Anything Red In Color That You Cough Up:	□
Severe Pain, Such As A Headache Or Stomach:	□
Unusual Bruising:	□
A Cut That Does Not Stop Bleeding:	□
A Serious Fall Or Bump On The Head:	□
Severe Dizziness Or Weakness:	□



Bruising and Bleeding Report

Day Of Bleeding: May/8/2014

Bowel Movements That Are Red Or Look Like Tar:

Severe Pain, Such As A Headache Or Stomach:

REMOVE Bleeding Event

Day Of Bruising: May/13/2014

Bruising On My: Right Arm

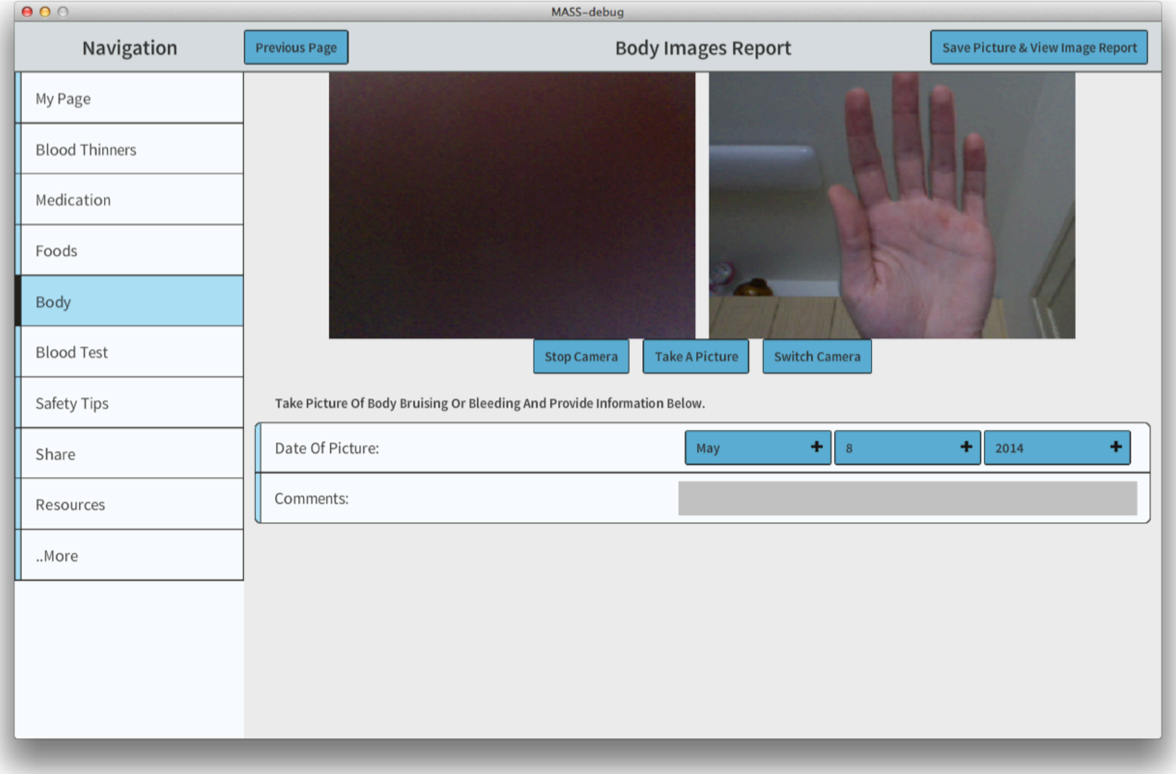
Specific Location Of The Bruise On My Right Arm: bicep

Bruising Happened By: tripped

REMOVE Bruise Event

Figure 6.6 MASS App Body Bleeding Input and Body Report Pages. The first page contains check boxes to select bleeding events and a dropdown list for the bleeding event date. The second page displays the saved bleeding and bruising events.

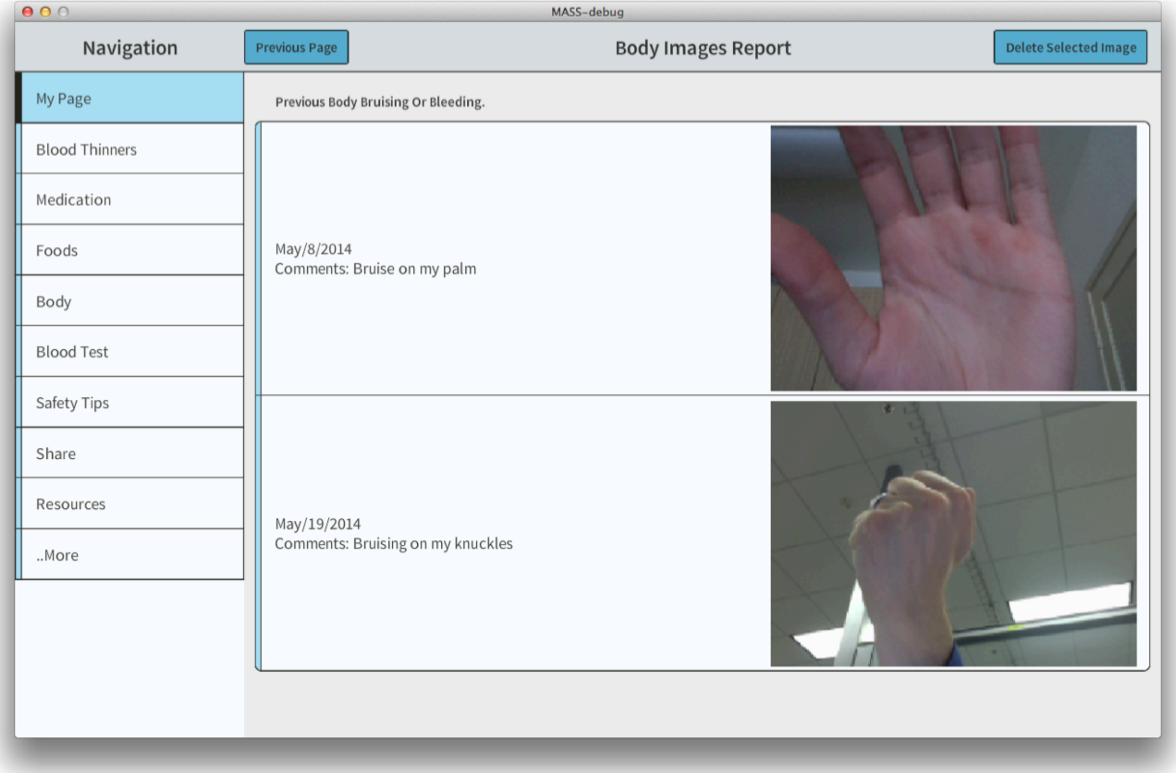
Since bruising and bleeding events can best be described by a picture of the event, the Body Images Report Pages ask the user to take an image of body bruising or bleeding events. This page activates the tablet's camera and has buttons to control the camera: start/stop the camera, take a picture, and switch between front/back cameras. This page also contains drop down lists to save the date of the event and a text box to input additional comments about the image. The saved images are then displayed in a grouped list in the body images report page, displaying the date, comment and image of the report. These pages can be seen in Figure 6.7.



Take Picture Of Body Bruising Or Bleeding And Provide Information Below.

Date Of Picture: May 8 2014

Comments:



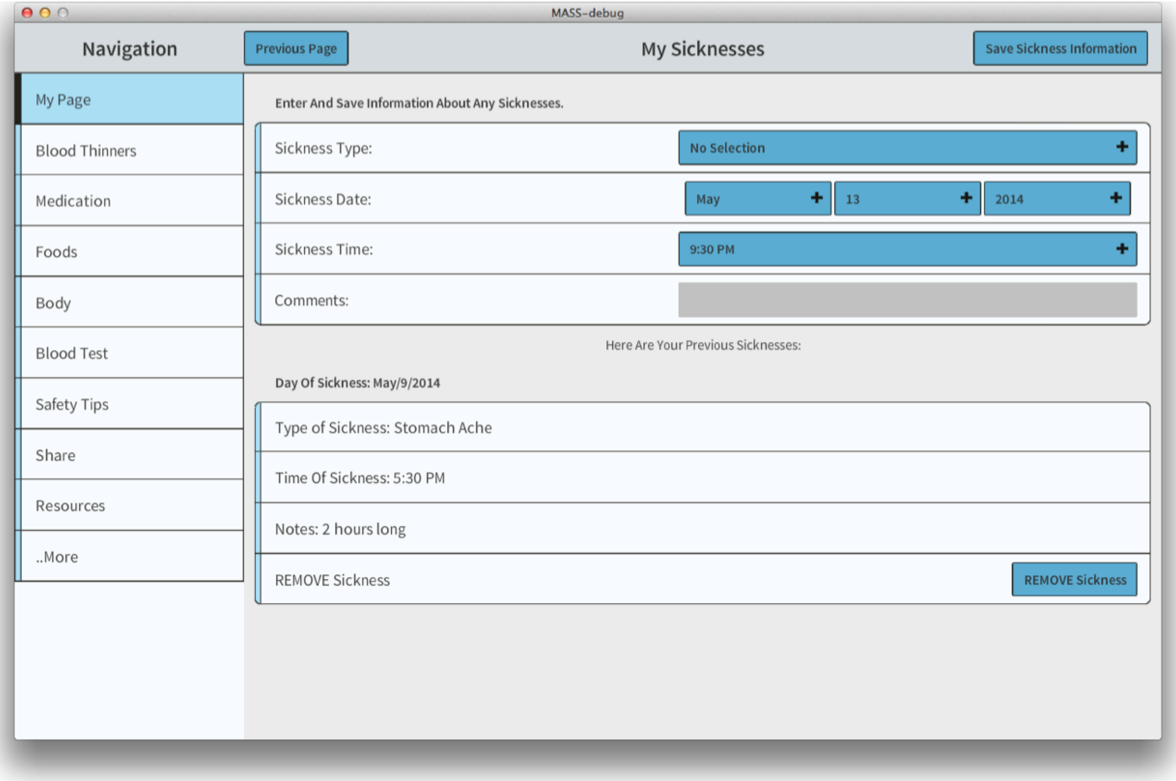
Previous Body Bruising Or Bleeding.

May/8/2014
Comments: Bruise on my palm

May/19/2014
Comments: Bruising on my knuckles

Figure 6.7 MASS App Body Image Input and Report Pages. The first page contains a camera port for taking pictures of bleeding or bruising events, buttons to control the camera and has a dropdown list for the date and text input for image comments. The second page displays the saved image data.

Since sicknesses can be caused by anticoagulant medication, the My Sicknesses Page asks the user to input information regarding recent sicknesses aside from bruising and bleeding events. Sickness information includes headache, fever, flu, stomach ache, vomiting, and diarrhea. This page contains drop down lists to select the sickness type, date, and time and a text input box for additional comments. Also, this page has the report directly below the form input section, displaying saved information in an editable grouped list. This page can be seen in Figure 6.8.



My Sicknesses

Enter And Save Information About Any Sicknesses.

Sickness Type: No Selection

Sickness Date: May 13 2014

Sickness Time: 9:30 PM

Comments:

Here Are Your Previous Sicknesses:

Day Of Sickness: May/9/2014

Type of Sickness: Stomach Ache

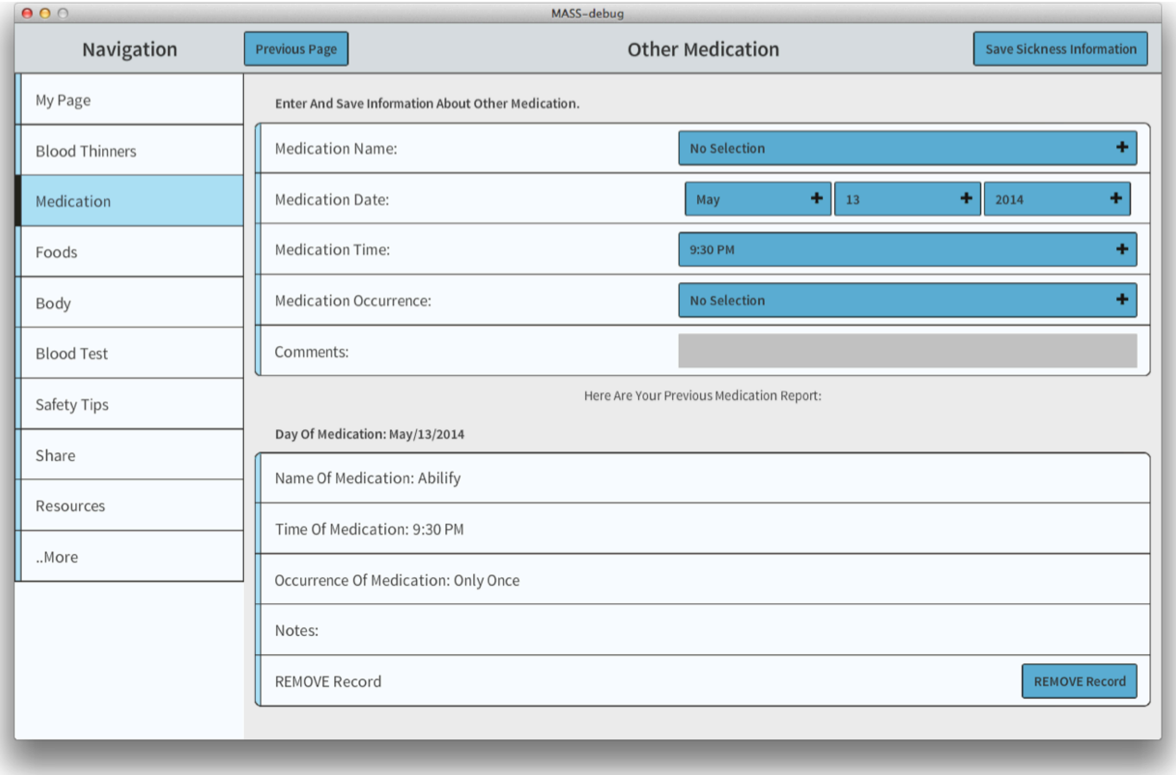
Time Of Sickness: 5:30 PM

Notes: 2 hours long

REMOVE Sickness

Figure 6.8 MASS App Recent Sicknesses Page. This page contains a form input section and the report section directly below. The form input section contains dropdown lists for type, date, and time of sickness and text input for additional comments. The bottom of the page displays the sickness report.

Since other medications can interact negatively with anticoagulant medication, the Other Medication Input Page asks the user to input information regarding any other medication that the user is taking. This page has drop down lists to select the medication type, date, time, and occurrence and a text input box for additional comments. The report section is also directly below the form input section and displays previous medications the user has taken. This page can be seen in Figure 6.9.



Enter And Save Information About Other Medication.

Medication Name: No Selection

Medication Date: May 13 2014

Medication Time: 9:30 PM

Medication Occurrence: No Selection

Comments:

Here Are Your Previous Medication Report:

Day Of Medication: May/13/2014

Name Of Medication: Abilify

Time Of Medication: 9:30 PM

Occurrence Of Medication: Only Once

Notes:

REMOVE Record

Figure 6.9 MASS App Other Medications Page. This page contains the form input section and the report section directly below. The form input section contains dropdown lists for type, date, time, and occurrence of other medications taken and a text input for additional comments. Below is also the log of previous other medication events.

Each report helps better describe the overall health of the user between healthcare visits, which can be a few months at a time, assisting the healthcare provider with adjusting anticoagulant medication dosages.

6.2.2 Health Information Delivery

Health information delivery has two applications within the MASS app. One application is to directly provide the user with anticoagulant medication safety information, and the other application is to share self-health information with the user’s contacts. Figures 6.10 through 6.13

show how the MASS app delivers information to the user. This information includes the AHRQ blood thinner booklet and video, a database of vitamin K content in foods, a safety tips page, and access to the complete AHRQ website. Figures 6.14 through 6.16 show how content is shared to the user's contacts and has two applications: sharing self-health information with a contact, and requesting a contact to remind the user to take their medication.

The AHRQ has detailed information for patients prescribed to anticoagulant medication guiding them how to take their medication safely. The AHRQ keeps this information in the forms of a booklet and a video, among other methods, and can be viewed by the user in the Blood Thinners module. Figure 6.10 shows the About Blood Thinners: Booklet and About Blood Thinners: Video pages and their functionality. The booklet page displays each page of the book at a high resolution, requiring the user to scroll vertically to view each page in entirety. Also, the user can use a horizontal swipe gesture to go through pages of the booklet. The video page plays the video from the AHRQ website and has control buttons for viewing the video, such as play/pause, mute/unmute, seek backward 30 seconds, and seek forward 30 seconds.

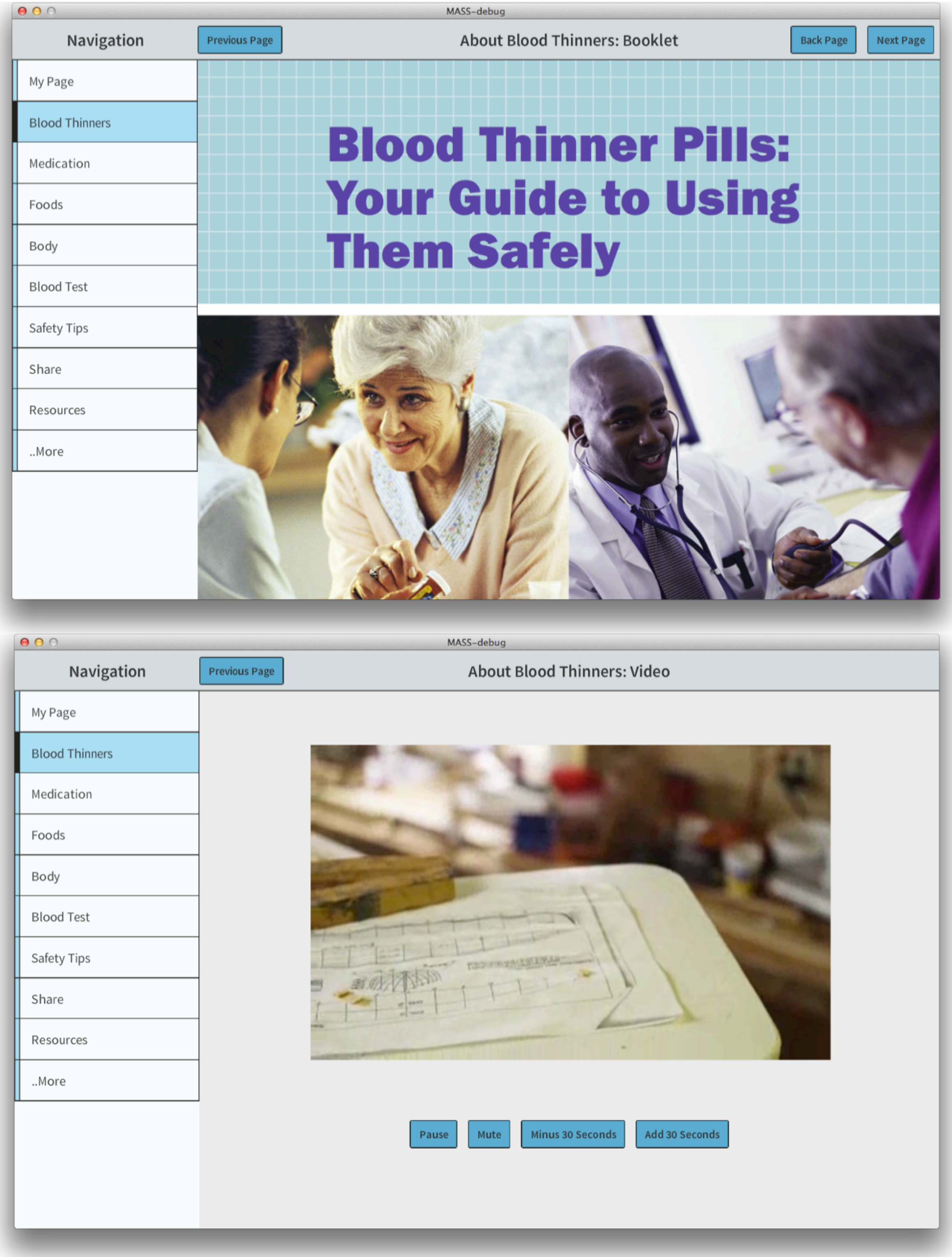
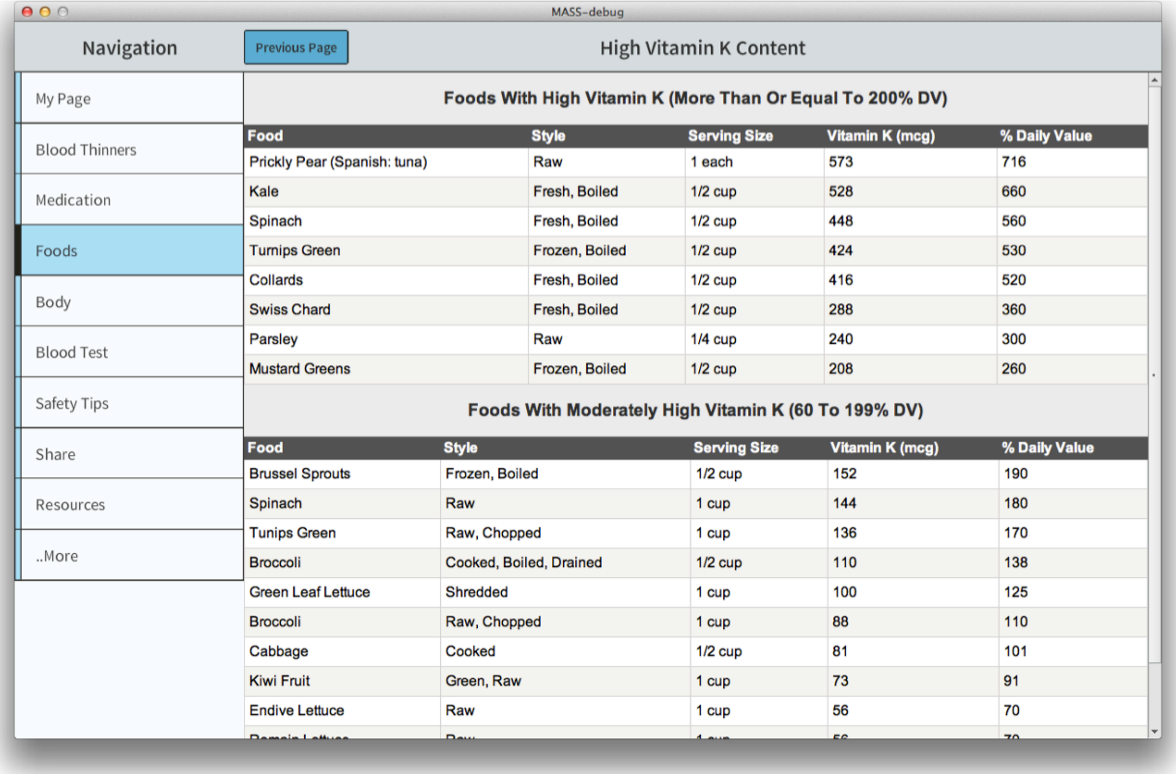


Figure 6.10 MASS App Blood Thinner Information Pages: Booklet and Video. The blood thinner booklet page displays high-resolution pages from the AHRQ booklet allowing the user to pan vertically and swipe between pages. The blood thinner video page displays a video with similar content as the booklet and has video control buttons.

Since vitamin K can minimize the effect of anticoagulant medication, the user needs to be aware of the vitamin K content in their foods. The Foods module has pages to display common foods high in vitamin K content and lets the user search the USDA National Nutrient Database for the vitamin K content in specific foods. These pages can be seen in Figure 6.11. The High Vitamin K Content page displays 2 tables of foods high in vitamin K with a Daily Value at or above 200% and a Daily Value from 60% to 199%. The Search For Food page lets the user input the name of a food item and generate the corresponding table with food information. The food information includes vitamin K level (safe, low, moderate, high, very high), food description, weight of the serving, serving size, and vitamin K content in [micro-grams].



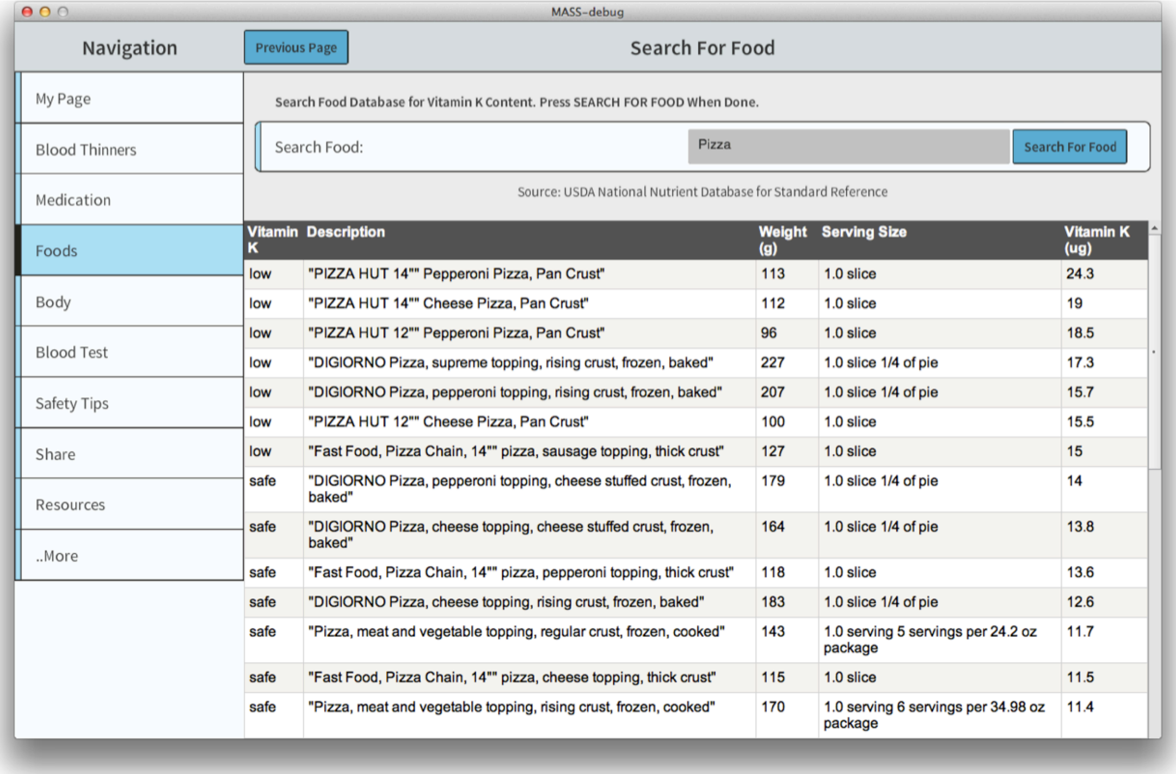
High Vitamin K Content

Foods With High Vitamin K (More Than Or Equal To 200% DV)

Food	Style	Serving Size	Vitamin K (mcg)	% Daily Value
Prickly Pear (Spanish: tuna)	Raw	1 each	573	716
Kale	Fresh, Boiled	1/2 cup	528	660
Spinach	Fresh, Boiled	1/2 cup	448	560
Turnips Green	Frozen, Boiled	1/2 cup	424	530
Collards	Fresh, Boiled	1/2 cup	416	520
Swiss Chard	Fresh, Boiled	1/2 cup	288	360
Parsley	Raw	1/4 cup	240	300
Mustard Greens	Frozen, Boiled	1/2 cup	208	260

Foods With Moderately High Vitamin K (60 To 199% DV)

Food	Style	Serving Size	Vitamin K (mcg)	% Daily Value
Brussel Sprouts	Frozen, Boiled	1/2 cup	152	190
Spinach	Raw	1 cup	144	180
Tunips Green	Raw, Chopped	1 cup	136	170
Broccoli	Cooked, Boiled, Drained	1/2 cup	110	138
Green Leaf Lettuce	Shredded	1 cup	100	125
Broccoli	Raw, Chopped	1 cup	88	110
Cabbage	Cooked	1/2 cup	81	101
Kiwi Fruit	Green, Raw	1 cup	73	91
Endive Lettuce	Raw	1 cup	56	70
Romain Lettuce	Raw	1 cup	56	70



Search For Food

Search Food Database for Vitamin K Content. Press SEARCH FOR FOOD When Done.

Search Food: Pizza

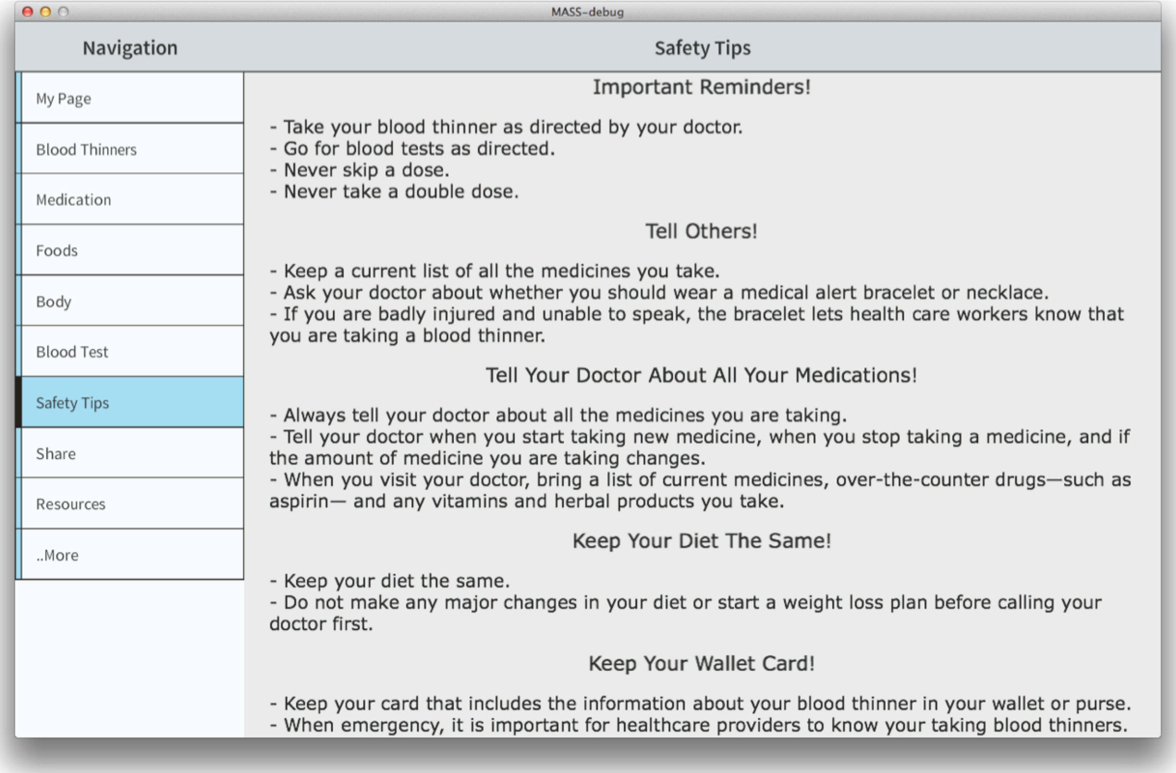
Source: USDA National Nutrient Database for Standard Reference

Vitamin K	Description	Weight (g)	Serving Size	Vitamin K (ug)
low	"PIZZA HUT 14"" Pepperoni Pizza, Pan Crust"	113	1.0 slice	24.3
low	"PIZZA HUT 14"" Cheese Pizza, Pan Crust"	112	1.0 slice	19
low	"PIZZA HUT 12"" Pepperoni Pizza, Pan Crust"	96	1.0 slice	18.5
low	"DIGIORNO Pizza, supreme topping, rising crust, frozen, baked"	227	1.0 slice 1/4 of pie	17.3
low	"DIGIORNO Pizza, pepperoni topping, rising crust, frozen, baked"	207	1.0 slice 1/4 of pie	15.7
low	"PIZZA HUT 12"" Cheese Pizza, Pan Crust"	100	1.0 slice	15.5
low	"Fast Food, Pizza Chain, 14"" pizza, sausage topping, thick crust"	127	1.0 slice	15
safe	"DIGIORNO Pizza, pepperoni topping, cheese stuffed crust, frozen, baked"	179	1.0 slice 1/4 of pie	14
safe	"DIGIORNO Pizza, cheese topping, cheese stuffed crust, frozen, baked"	164	1.0 slice 1/4 of pie	13.8
safe	"Fast Food, Pizza Chain, 14"" pizza, pepperoni topping, thick crust"	118	1.0 slice	13.6
safe	"DIGIORNO Pizza, cheese topping, rising crust, frozen, baked"	183	1.0 slice 1/4 of pie	12.6
safe	"Pizza, meat and vegetable topping, regular crust, frozen, cooked"	143	1.0 serving 5 servings per 24.2 oz package	11.7
safe	"Fast Food, Pizza Chain, 14"" pizza, cheese topping, thick crust"	115	1.0 slice	11.5
safe	"Pizza, meat and vegetable topping, rising crust, frozen, cooked"	170	1.0 serving 6 servings per 34.98 oz package	11.4

Figure 6.11 MASS App Vitamin K Content in Foods Pages. These pages describe the vitamin K content in foods taken from the USDA National Nutrient Database to warn the users against foods with high vitamin K content. The second page lets the user search for specific food in the database.

The AHRQ provides the booklet and video guides to taking anticoagulant medication safely; however, a more direct method of delivering safety topics is in a basic list displayed on a single page[8]. The Safety Tips module summarizes all the safety guide information in a single page with vertical scrolling capabilities, and can be seen in Figure 6.12.

[8] Topic specific information is also displayed on the home page of each module and can be seen in Figure 6.2.



Safety Tips

Important Reminders!

- Take your blood thinner as directed by your doctor.
- Go for blood tests as directed.
- Never skip a dose.
- Never take a double dose.

Tell Others!

- Keep a current list of all the medicines you take.
- Ask your doctor about whether you should wear a medical alert bracelet or necklace.
- If you are badly injured and unable to speak, the bracelet lets health care workers know that you are taking a blood thinner.

Tell Your Doctor About All Your Medications!

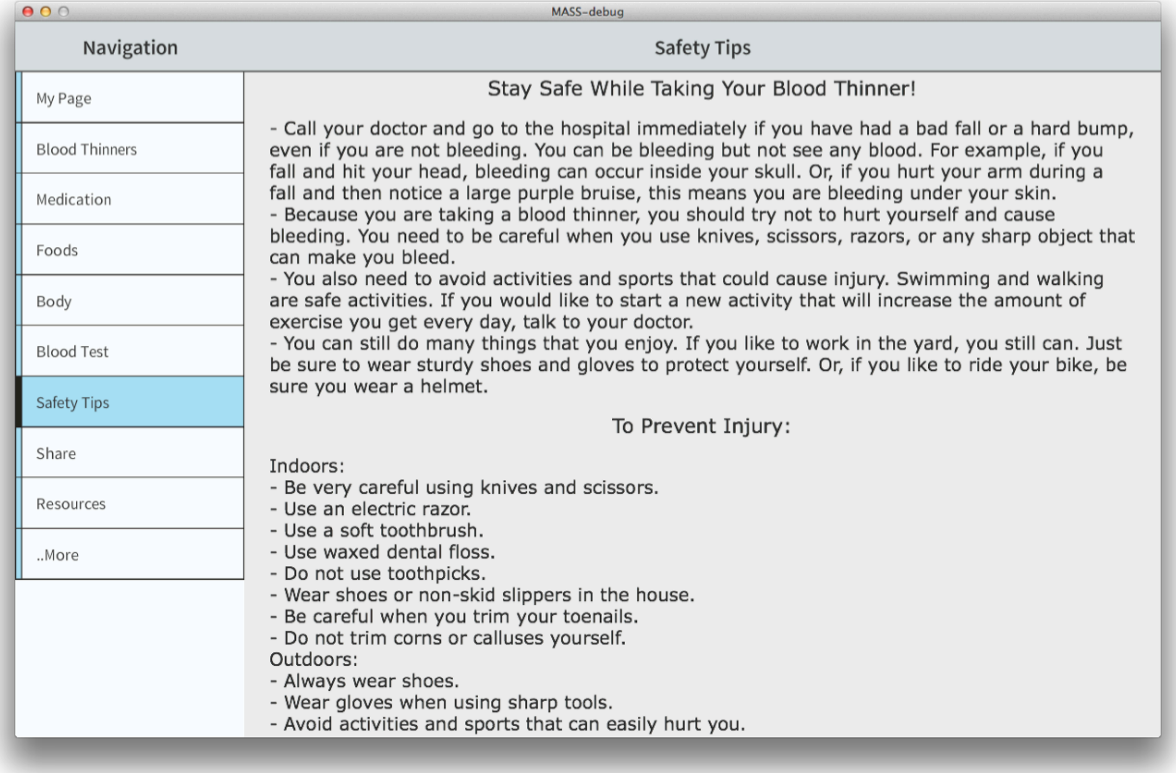
- Always tell your doctor about all the medicines you are taking.
- Tell your doctor when you start taking new medicine, when you stop taking a medicine, and if the amount of medicine you are taking changes.
- When you visit your doctor, bring a list of current medicines, over-the-counter drugs—such as aspirin— and any vitamins and herbal products you take.

Keep Your Diet The Same!

- Keep your diet the same.
- Do not make any major changes in your diet or start a weight loss plan before calling your doctor first.

Keep Your Wallet Card!

- Keep your card that includes the information about your blood thinner in your wallet or purse.
- When emergency, it is important for healthcare providers to know your taking blood thinners.



Safety Tips

Stay Safe While Taking Your Blood Thinner!

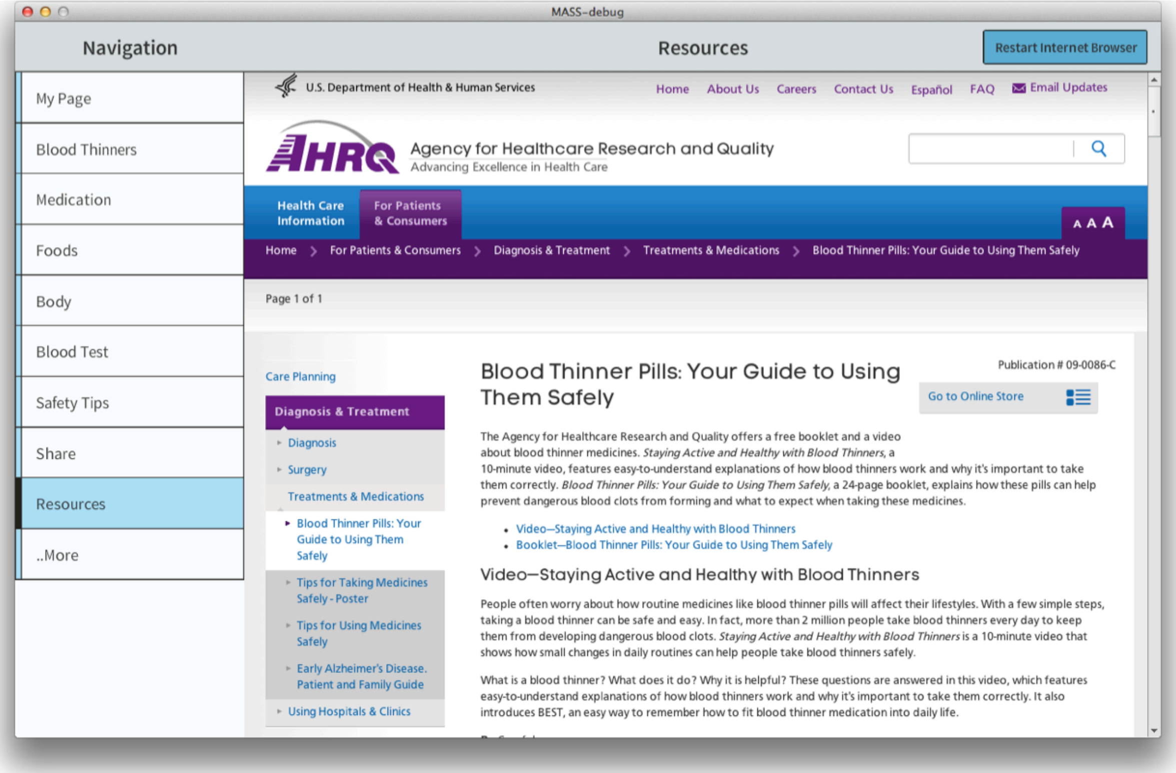
- Call your doctor and go to the hospital immediately if you have had a bad fall or a hard bump, even if you are not bleeding. You can be bleeding but not see any blood. For example, if you fall and hit your head, bleeding can occur inside your skull. Or, if you hurt your arm during a fall and then notice a large purple bruise, this means you are bleeding under your skin.
- Because you are taking a blood thinner, you should try not to hurt yourself and cause bleeding. You need to be careful when you use knives, scissors, razors, or any sharp object that can make you bleed.
- You also need to avoid activities and sports that could cause injury. Swimming and walking are safe activities. If you would like to start a new activity that will increase the amount of exercise you get every day, talk to your doctor.
- You can still do many things that you enjoy. If you like to work in the yard, you still can. Just be sure to wear sturdy shoes and gloves to protect yourself. Or, if you like to ride your bike, be sure you wear a helmet.

To Prevent Injury:

Indoors:
- Be very careful using knives and scissors.
- Use an electric razor.
- Use a soft toothbrush.
- Use waxed dental floss.
- Do not use toothpicks.
- Wear shoes or non-skid slippers in the house.
- Be careful when you trim your toenails.
- Do not trim corns or calluses yourself.
Outdoors:
- Always wear shoes.
- Wear gloves when using sharp tools.
- Avoid activities and sports that can easily hurt you.

Figure 6.12 MASS App Safety Tips Module. This module contains text-based pages describing safety tips for topics including: preventing injury, telling others, and maintaining diet. All the text is in a scrollable container with a vertical layout.

Finally, the user can directly view the website version of the AHRQ guide to anticoagulant safety using a web browser within the Resources module. This page allows the user to navigate freely within the website and also contains a URL reset button, incase the user decides to return to the AHRQ guide 'home page.' This page can be seen in Figure 6.13.


MASS-debug
Navigation
Resources
Restart Internet Browser
My Page
Blood Thinners
Medication
Foods
Body
Blood Test
Safety Tips
Share
Resources
..More
U.S. Department of Health & Human Services
Home
About Us
Careers
Contact Us
Español
FAQ
Email Updates
AHRQ
Agency for Healthcare Research and Quality
Advancing Excellence in Health Care
Health Care Information
For Patients & Consumers
A A A
Home > For Patients & Consumers > Diagnosis & Treatment > Treatments & Medications > Blood Thinner Pills: Your Guide to Using Them Safely
Page 1 of 1
Care Planning
Diagnosis & Treatment
Diagnosis
Surgery
Treatments & Medications
Blood Thinner Pills: Your Guide to Using Them Safely
Tips for Taking Medicines Safely - Poster
Tips for Using Medicines Safely
Early Alzheimer's Disease. Patient and Family Guide
Using Hospitals & Clinics
Publication # 09-0086-C
Go to Online Store

Blood Thinner Pills: Your Guide to Using Them Safely

The Agency for Healthcare Research and Quality offers a free booklet and a video about blood thinner medicines. *Staying Active and Healthy with Blood Thinners*, a 10-minute video, features easy-to-understand explanations of how blood thinners work and why it's important to take them correctly. *Blood Thinner Pills: Your Guide to Using Them Safely*, a 24-page booklet, explains how these pills can help prevent dangerous blood clots from forming and what to expect when taking these medicines.

- Video—Staying Active and Healthy with Blood Thinners
- Booklet—Blood Thinner Pills: Your Guide to Using Them Safely

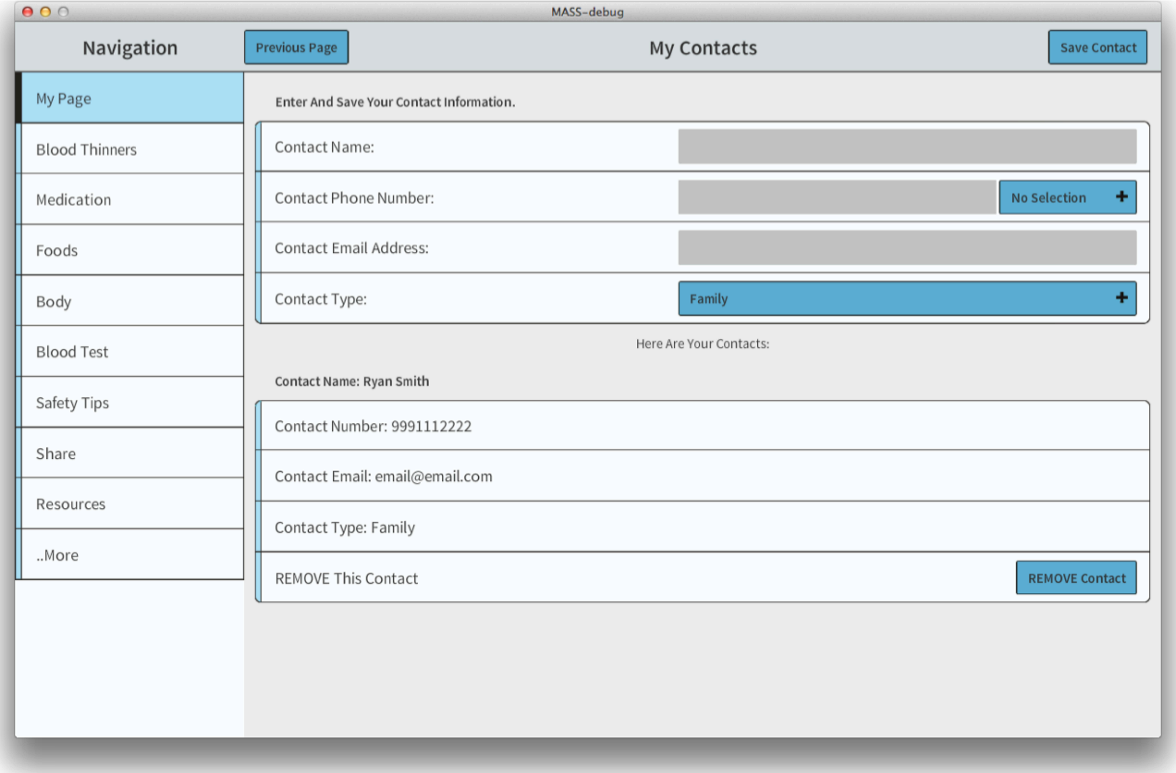
Video—Staying Active and Healthy with Blood Thinners

People often worry about how routine medicines like blood thinner pills will affect their lifestyles. With a few simple steps, taking a blood thinner can be safe and easy. In fact, more than 2 million people take blood thinners every day to keep them from developing dangerous blood clots. *Staying Active and Healthy with Blood Thinners* is a 10-minute video that shows how small changes in daily routines can help people take blood thinners safely.

What is a blood thinner? What does it do? Why it is helpful? These questions are answered in this video, which features easy-to-understand explanations of how blood thinners work and why it's important to take them correctly. It also introduces BEST, an easy way to remember how to fit blood thinner medication into daily life.

Figure 6.13 MASS App AHRQ Resources Module. This module gives the option of opening a web browser within the page allowing the user to view the entire Blood Thinner Pills page in the AHRQ website.

Sharing self-health information with a contact and requesting a contact reminder both require the user to first add contact information in the My Page module under the My Contacts page. Contact information includes the person's name, cellular phone number, cellular carrier, email address, and a description of the contact, which can all be seen in Figure 6.14.



My Contacts

Enter And Save Your Contact Information.

Contact Name:

Contact Phone Number:

Contact Email Address:

Contact Type: Family

Here Are Your Contacts:

Contact Name: Ryan Smith

Contact Number: 9991112222

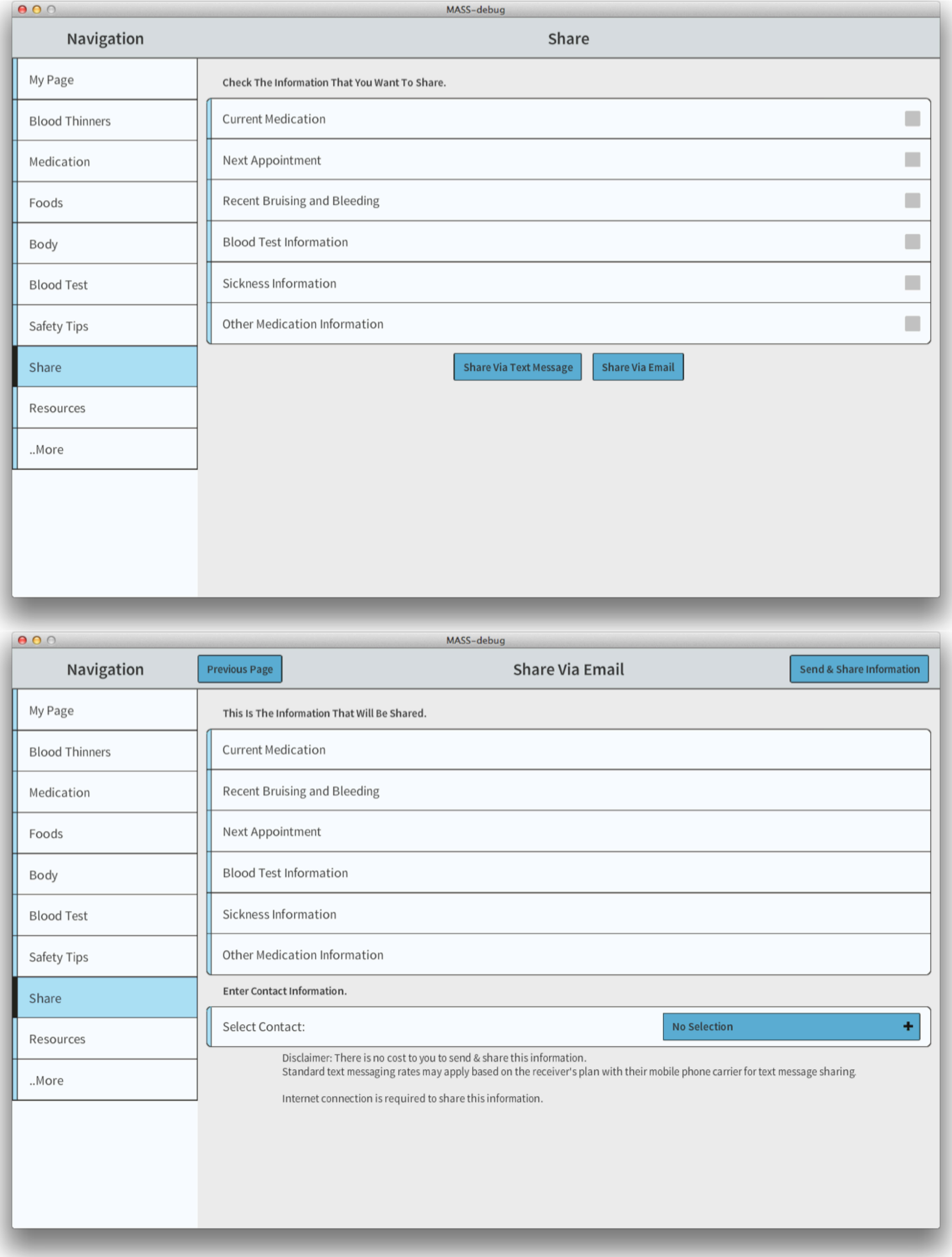
Contact Email: email@email.com

Contact Type: Family

REMOVE This Contact

Figure 6.14 MASS App User Contacts Page. This page lets the user save contact information that will be used to share health reports and medication reminders. The user must select the correct cellular carrier plan for the contact in order to send text messages. Below the input form a grouped list of current contacts.

The Share module then allows the user to share self-health reports with a contact. The user first selects which information to share, and clicks the buttons at the bottom to share the information via text message or email. The app then navigates to the second share page allowing the user select a contact person and send the reports, which can be seen in Figure 6.15. The content of the text message tells the contact to request specified health reports from the user. The content of the email has text versions of all the specified health reports except for the body bruising and bleeding images.



Check The Information That You Want To Share.

- Current Medication □
- Next Appointment □
- Recent Bruising and Bleeding □
- Blood Test Information □
- Sickness Information □
- Other Medication Information □

This Is The Information That Will Be Shared.

- Current Medication
- Recent Bruising and Bleeding
- Next Appointment
- Blood Test Information
- Sickness Information
- Other Medication Information

Enter Contact Information.

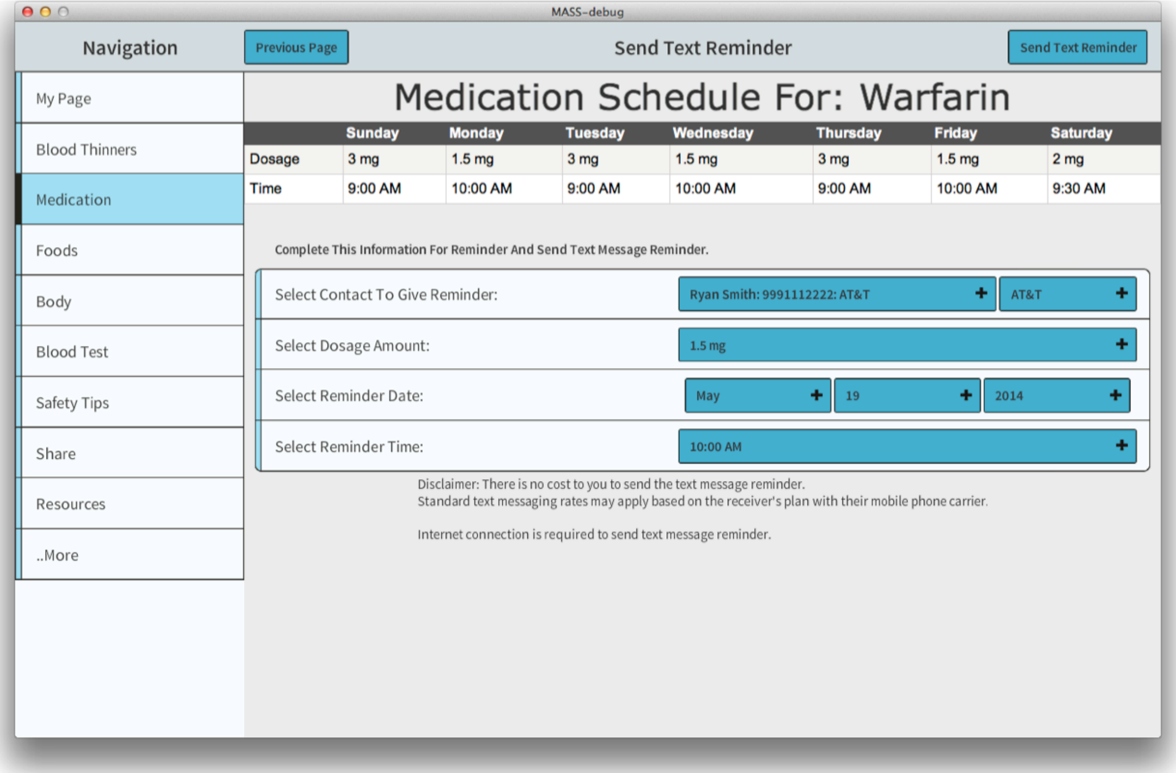
Select Contact: No Selection

Disclaimer: There is no cost to you to send & share this information.
Standard text messaging rates may apply based on the receiver's plan with their mobile phone carrier for text message sharing.

Internet connection is required to share this information.

Figure 6.15 MASS App Share Module. This module lets the user share their self-health reports to a contact person via text message or email. The user first selects which reports to send, then selects to send via text message or email, then selects the contact person, and finally sends the reports.

Within the Medication module, the user can send a text message requesting the contact person to give a reminder for the user to take a specific dosage of medication at a specific date and time, which can be seen in Figure 6.16. The user can see their current medication schedule on the same page and base their decision from their current schedule. Also, the bottom of the page provides a disclaimer for the user to be aware that sending text messages may cost money for the contact person depending on the contact person's cellular plan.



Medication Schedule For: Warfarin

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Dosage	3 mg	1.5 mg	3 mg	1.5 mg	3 mg	1.5 mg	2 mg
Time	9:00 AM	10:00 AM	9:00 AM	10:00 AM	9:00 AM	10:00 AM	9:30 AM

Complete This Information For Reminder And Send Text Message Reminder.

Select Contact To Give Reminder:	Ryan Smith: 9991112222: AT&T +	AT&T +
Select Dosage Amount:	1.5 mg +	
Select Reminder Date:	May + 19 + 2014 +	
Select Reminder Time:	10:00 AM +	

Disclaimer: There is no cost to you to send the text message reminder.
Standard text messaging rates may apply based on the receiver's plan with their mobile phone carrier.

Internet connection is required to send text message reminder.

Figure 6.16 MASS App Send Text Message Reminder Page. This page lets the user send a text message to a contact person requesting the contact person to provide a reminder for the user to take a specific dosage of medication at a specific date and time.

The collection of self-health reporting and information delivery modules make up majority of the MASS App. Additional modules and pages are to edit app options, and references for the module contents, such as AHRQ and USDA references.

CONCLUSION

Health informatics is a multidisciplinary field using computing and IT to handle health information. Historically, health informatics was limited by the computing and IT capabilities such as cost, size, availability and processing power of the computing device. In the past two decades, computing and IT capabilities overcame these limitations enabling an array of Health Informatics applications.

This thesis discussed the app development to satisfy the needs of 4 separate mHealth applications. A tablet-based app with advanced collection functionalities using customizable HTML input forms was developed for surveying youth in Swaziland to find the connections between relationship-oriented psychological effects and impoverished environments. Another tablet-based app with advanced interpretation functionalities using artificial neural networks and a python-based server with a MySQL database was developed for classifying pain in veterans with spinal cord injuries and disorders to help standardize classification process. Another tablet-based app with advanced delivery functionalities using interactive videos and quizzes was developed to train occupational therapists working with veterans with spinal cord injuries and disorders to prevent the onset of pressure ulcers. Finally, a tablet-based app with advanced collection and delivery functionalities using HTML image maps, HTML tables, and email/text message capabilities was developed for senior citizens prescribed to anticoagulant medication to yield healthier senior citizens.

Future work with these mHealth applications would be directed in determining the effectiveness of the tablet-based apps. Initially, the button and navigation components could be tracked based on how often they were accessed, providing insight into usage, and could be correlated with personal surveys about satisfaction and efficacy of the apps. With the pain classification app, the statistical effectiveness of the ANN classifications could be determined by comparing them to expert doctor classifications.

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