

Expanding MYeHealthAppCY - Integration of BLE Medical Devices

by

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Abstract

The digital health sector is transforming healthcare, offering increased accessibility, convenience, and personalization of care. In this context, this thesis presents an expansion of the MYeHealthAppCY, a comprehensive eHealth solution designed by the University of Cyprus. Specifically, this work focused on integrating Bluetooth Low Energy (BLE) medical devices into the existing app to enrich its utility and support data-driven healthcare decision-making.

To accomplish this, the research delved into understanding the intricacies of Bluetooth Low Energy (BLE) technology, focusing on implementing a software extension that allows seamless communication between the medical devices and the app. With an in-depth exploration of the Android Bluetooth Low Energy API, the extension was designed to support the integration of various BLE-enabled medical devices, making the app a comprehensive tool for monitoring health parameters.

The extension allows the app to discover devices, establish connections, and communicate with the devices to gather health data. This collected data is then displayed within the app and stored for future reference, thereby providing an effective tool for longitudinal health tracking.

Challenges encountered in the project included discovering the services and characteristics UUIDs of the medical devices, decrypting the binary data sent by the devices, and understanding proprietary write commands necessary to request data from certain devices. User testing and validation were essential aspects of the project, helping to identify areas of improvement for the implemented functionality.

The thesis concludes by acknowledging the limitations of the current project and suggesting future work, including integrating more diverse medical devices, improving data interpretation, and enhancing the user interface and overall experience of the app.

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Contents

Abstract	iii
Acknowledgments	iv
1 Introduction	1
1.1 Background	1
1.2 Purpose and Aims	2
1.3 Research Questions and Objectives	3
1.4 Methodology Overview	5
2 Similar Applications	7
2.1 HealthManager Pro	7
2.1.1 Strengths	7
2.1.2 Weaknesses	8
2.2 Microlife Connected Health+	9
2.2.1 Strengths	9
2.2.2 Weaknesses	10
3 Devices	11
3.1 Beurer FT95 Thermometer	11
3.1.1 Features and Capabilities	11
3.1.2 Performance and Accuracy	12
3.1.3 Digital Integration and Data Management	12
3.2 Microlife NC 150 BT Thermometer	13
3.2.1 Device Specifications and Features	13
3.3 Microlife WS 200 BT Diagnostic Scale	14
3.3.1 Features and Functions	15
3.3.2 Specifications	15
3.4 Microlife BP A7 Touch BT Blood Pressure Monitor	16
3.4.1 Device Specifications	16

3.4.2	Special Features	17
4	Literature Review	18
4.1	Bluetooth Low Energy	18
4.1.1	Introduction	18
4.1.2	Brief Technical Overview	19
4.1.3	Applications of BLE in Healthcare	21
4.1.4	Challenges and Limitations of BLE in Healthcare	22
4.2	JavaScript/TypeScript	23
4.3	React	24
4.4	React Native	24
4.5	React Native Paper	25
4.6	FHIR	26
4.7	Electronic Health Record	26
4.8	eHealth4u Platform	27
4.9	Microlife SDKs	29
5	Requirements	30
5.1	Gathering and Analyzing Requirements	30
5.2	Collection of information from similar applications	31
5.3	Final Requirements	32
5.3.1	BLE Medical Device Connection	32
5.3.2	User Devices and History	34
5.3.3	Medical Device - Saving and Managing the Retrieved Data	35
6	Implementation	37
6.1	Introduction	37
6.2	Development Environment	38
6.3	Architecture and Design	39
6.4	Feature Implementation	41
6.4.1	Discover Medical Devices	42

6.4.2	User Devices and History	46
6.4.3	Saving and Managing the Retrieved Data	49
6.5	Testing	54
7	Assessment	55
7.1	Introduction	55
7.2	User Manual	56
7.3	Questionnaire	57
7.4	Results	57
8	Conclusions	68
8.1	Summary	68
8.2	Limitations and Challenges	69
8.3	Future Work	70
A	Questionnaire	
B	User Manual	
C	Technical Manual	

List of Abbreviations

°C Degree Celsius. 12–14, 35

API Application Programming Interface. iii, iv, 26, 38, 40, 45, 47, 48

BLE Bluetooth Low Energy. i, iii, 2–5, 14, 15, 18–23, 31–33, 37, 39, 42, 49, 52, 56, 68, 69

BMI Body Mass Index. 15

ECG Electrocardiogram. 7, 21

EHR Electronic health record. 26, 27

FHIR Fast Healthcare Interoperability Resources. 26, 27, 40

GDPR General Data Protection Regulation. 23

IHE Integrating the Healthcare Enterprise. 27

JS JavaScript. 24, 38

mmHg Millimeters of mercury. 16, 35

SDK Software Development Kit. 29

TS TypeScript. 38

UUID Universally Unique Identifier. iii, 44, 52, 69

List of Figures

1	Beurer Health Manger Pro	8
2	Microlife Connected Health+	10
3	Beurer FT95 Thermometer [1]	11
4	Microlife NC 150 BT [2]	13
5	Microlife WS 200 BT [3]	15
6	Microlife BP A7 Touch BT [4]	16
7	eHealth4U architecture [5]	28
8	MYeHealthAppCY app	41
9	Discovering supported devices	43
10	Enabled Bluetooth prompt	43
11	No devices found	44
12	Add or view device	45
13	Supported devices screen	46
14	Medical devices main screen	46
15	Medical devices main screen - no devices	47
16	Medical devices main screen - error	48
17	Temperature measurements history	48
18	Device screen	49
19	Removing a device	50
20	Device measurements category history	51
21	Device not discovered	51
22	Gender demographics	58
23	Age demographics	58
24	Android familiarity	59
25	Ease of accessing the medical devices section	60
26	Ease of accessing the screen for adding a medical device	60
27	Ease of adding a medical device	61
28	Ease of accessing the screen for viewing a medical device	62

29	Ease of obtaining a measurement	62
30	Ease of understanding the data displayed on the app	63
31	Ease of accessing the screen for reading historic measurement data per category	64
32	Ease of reading the data from historic measurements	64
33	Rating of the user manual for the medical devices	65
34	Rating clarity of data presentation	65
35	Overall app experience	66
36	Likelihood of recommending the app	67

1 Introduction

1.1 Background

The digital era has introduced a new paradigm in healthcare management, transforming the traditional in-person patient-caregiver interactions into remote monitoring systems that enhance access to quality healthcare. The University of Cyprus' eHealthLab has started contributing to this shift by creating the MYeHealthAppCY, a comprehensive electronic health solution aimed at improving healthcare accessibility for both patients and providers in Cyprus.

The MYeHealthAppCY offers many features designed to streamline healthcare delivery and management. These include integrated prescription management systems, patient summary views, and a teleconsultation feature that allows patients to connect with healthcare providers via video conferencing. This feature enables patients to consult with their doctors from the comfort of their homes, reducing the need for physical hospital visits and potentially minimizing the risk of exposure to infectious diseases. Moreover, the app incorporates a provision for storing and accessing European Digital COVID certificates, a functionality that allows users to easily share their health information when required.

While the existing features of MYeHealthAppCY are undeniably beneficial, the potential for enhancing the app's capabilities is significant. The integration of a feature that would enable patients to capture measurements from medical devices, visualize them within the app, and upload the data for further use would be a significant advancement. This would provide valuable metrics about the patient's health, which could then be made available to their doctors, enabling informed decision-making and a better understanding of the patient's health status. The potential for enriched, data-driven health management makes this proposed feature a crucial extension to the existing app functionality.

In this context, my research focuses on exploring and implementing this feature within the MYeHealthAppCY, positioning this study at the forefront of digitizing patient-centered care in Cyprus.

1.2 Purpose and Aims

The main purpose of this research is to extend the capabilities of the MYeHealthAppCY by incorporating functionality for reading measurements from medical Bluetooth Low Energy (BLE) devices. This enhancement aims to provide an inclusive platform where patients can view, track, and upload their health metrics, thereby fostering more personalized, data-driven healthcare in Cyprus.

Through achieving these aims, this research strives to make a significant contribution to the field of eHealth in Cyprus, augmenting the existing MYeHealthAppCY with innovative, data-driven capabilities and improving patient-centered care.

1.3 Research Questions and Objectives

The central theme of this research revolves around how the integration of BLE medical devices into the MYeHealthAppCY can enhance patient care by enabling easy access and sharing of health data. To guide this research, several key research questions and objectives have been outlined:

Research Questions:

1. How can the MYeHealthAppCY be extended to discover, connect to, and retrieve data from BLE medical devices?
2. What are the key technical considerations and challenges associated with integrating BLE medical devices into mobile applications?
3. How can the data from these devices be presented in a user-friendly manner within the app, aligning with the existing user interface and user experience?
4. How can a comprehensive user manual be created to guide users through the process of using the newly integrated features?
5. How does the extended MYeHealthAppCY perform in terms of usability, functionality, and user satisfaction?

Research Objectives:

1. To explore the technical requirements and standards associated with integrating BLE medical devices with mobile applications. This step includes understanding the standard BLE medical device communication protocol, the discovery process, and how to retrieve device services and characteristics.
2. To successfully implement the BLE medical device integration into the MYe-HealthAppCY. This integration will allow users to discover, connect to, and retrieve data from their medical devices.
3. To design and implement a user-friendly interface that presents the retrieved data in an easily comprehensible manner. The design should align with the existing app's aesthetic and provide an intuitive experience for the user.
4. To create a comprehensive user manual that thoroughly explains the newly implemented features. This manual will guide users through the process of connecting their devices and interpreting the retrieved data.
5. To validate the new implementation through user testing, soliciting user feedback via questionnaires to assess the functionality, usability, and overall user experience of the new feature.

The answers to these research questions and the achievement of these objectives will help to validate the successful integration of BLE medical devices into the MYe-HealthAppCY, facilitating a comprehensive understanding of the patient's health metrics.

1.4 Methodology Overview

The methodology employed in this research involved a combination of software development, testing, and user assessment. This approach provided a detailed understanding of the complexities of integrating BLE medical devices into a mobile application, particularly in the healthcare setting. Here is an overview of the key steps:

1. Literature Review and Learning Phase: This involved an extensive review of existing literature and resources, covering BLE technology, its usage in healthcare applications, and the potential challenges that may arise in the integration process. This review helped to establish a solid foundation of knowledge about the topic.
2. Development and Implementation Phase: Following the initial learning phase, I began to develop and implement the functionality within the MYeHealthAppCY. This required extending the existing app to discover, connect to, and retrieve data from BLE medical devices. The goal was to ensure seamless integration that aligns with the current design and functionality of the app.
3. Debugging and Optimization Phase: This phase involved identifying and resolving potential issues and bugs that arose during the implementation. It also included optimizing the user interface and user experience to ensure the new features were intuitive and straightforward to use.
4. User Manual Creation: A comprehensive user manual was created, providing detailed instructions on how to use the newly integrated features. This manual was designed to guide users through the process, ensuring they can effectively access and understand the data from their BLE medical devices.
5. Testing and Validation Phase: Manual testing was carried out to confirm the correct operation of the new features. A user assessment was also conducted using a questionnaire, providing valuable insights into user satisfaction, usability, and the overall user experience.

6. Results Analysis: The feedback and data collected from the questionnaire were thoroughly analyzed to assess the success of the implementation and to identify areas for potential improvement.

This methodology allowed for a practical, hands-on approach to the research, enabling real-world testing and validation, and providing valuable user feedback to guide potential future improvements.

2 Similar Applications

2.1 HealthManager Pro

2.1.1 Strengths

The beurer HealthManager Pro app (see Figure 1) positions itself as [6] a comprehensive solution for managing a wide variety of health-related data. One of the key strengths of the app is its compatibility with over 30 Beurer products, making it a versatile tool for keeping track of various health parameters such as blood pressure, weight, and ECG.

The app's approach to health management is centered around personalization. Users can set their own goals, which can be instrumental in maintaining motivation and staying engaged with their health management journey. Moreover, the app provides the capability to interpret and display data in a clear and understandable manner, which can greatly assist users in tracking their progress and identifying trends.

One particularly notable feature is the app's ability to share health data with health-care professionals. This function can streamline communication between patients and medical providers, making it easier for users to discuss their health status and any concerns they may have during consultations. Furthermore, the app also includes a "medicine cabinet" feature where users can manage their medication, a useful tool for those who need to keep track of multiple medications and dosages.

Lastly, the app's commitment to accessibility is also commendable. The app design includes large click areas, easy-to-read fonts, and high contrasts, making it usable for a wide range of users. Additionally, the app allows data to be transferred from the old beurer HealthManager app to the new Pro version, ensuring that users can maintain their health management without interruptions.

2.1.2 Weaknesses

While the beurer HealthManager Pro app offers a range of beneficial features, there are issues that can potentially affect the overall user experience. One such problem is related to the app's design, which in my opinion is outdated. This can have a negative impact on the app's usability and overall aesthetic appeal, potentially discouraging some users from utilizing it regularly.

Other issues include a lack of in-app instructions, which can make it challenging for users to navigate and make full use of the app's features. Also sometimes the connected device did not recognize the selected user, which lead to inaccurate data tracking and analysis. Another significant concern is a bug that logs the user out of the app, causing inconvenience and disrupting the flow of the health management.

Other issues included, loading slowly, or not responding. These technical issues can significantly affect the app's functionality and user experience. Also the app has high battery consumption, which can be a disadvantage for those using the app on portable devices such as smartphones and tablets.

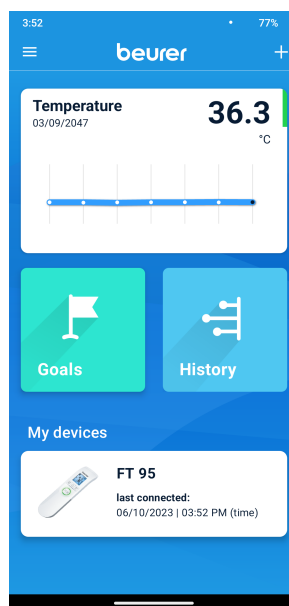


Figure 1: Beurer Health Manger Pro

2.2 Microlife Connected Health+

2.2.1 Strengths

Microlife Connected Health+ (see Figure 2) is [7] a comprehensive health management application designed to facilitate users in tracking their personal health and wellness. One of its core strengths is its compatibility with a variety of Microlife's Bluetooth-enabled devices. This integration allows users to seamlessly transfer their measurement readings from blood pressure monitors, thermometers, body composition scales, and pulse oximeters to the application for review and backup.

Moreover, the application provides an electronic health diary where users can manually input measurement readings. This function enhances its versatility as it can be used even without the proprietary hardware devices. The app provides a feature to review trends and individual entries of measurements, thereby enabling users to monitor their health progress over time.

Further, the Microlife Connected Health+ app supports personal targets, reminders, and data summary reports to assist users in staying on top of their health status and promoting a healthier lifestyle. The customizable personal targets allow users to focus on specific areas of health such as blood pressure, body composition, and oxygen saturation.

2.2.2 Weaknesses

While the Microlife Connected Health+ app offers numerous functionalities, it does come with some drawbacks. First and foremost, the app is very outdated. In order to test the app I had to side-load it since the google play store marks the app as not compatible with Android 13, the latest android version at the time of the testing.

Additionally, the app is "rough around the edges" and visually dated. Also there is a lack of guidance during the first-time setup, since there is not a built-in tutorial for the app.

Also there are some usability issues, particularly with the Bluetooth connection. For instance, there is some difficulty in adding or modifying profiles due to selection buttons being off screen and some times the Bluetooth feature were not accesible.

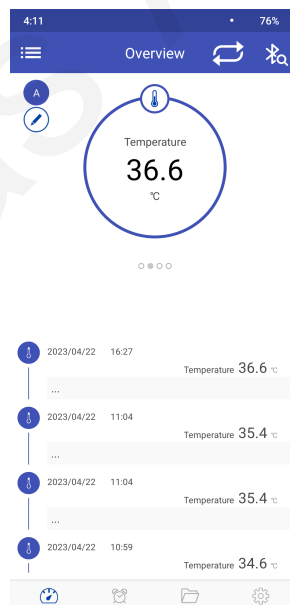


Figure 2: Microlife Connected Health+

3 Devices

3.1 Beurer FT95 Thermometer

The Beurer FT 95 (see Figure 3) is [1] a non-contact thermometer that aims to provide a hygienic and convenient method of temperature measurement. Equipped with Bluetooth capabilities, the device facilitates the easy transfer of temperature readings to the Beurer HealthManager Pro and the Beurer BabyCare apps. By doing so, users can keep track of their temperature readings and have a comprehensive overview of all results in one application.



Figure 3: Beurer FT95 Thermometer [1]

3.1.1 Features and Capabilities

The FT 95 is a 3-in-1 device, allowing for the measurement of body, ambient, and surface temperature. This versatile feature set ensures that the device can be used in a wide range of scenarios, from checking a person's body temperature to monitoring the ambient temperature of a room. It measures temperatures at a distance of 2-3 cm, ensuring a non-intrusive and comfortable user experience.

The device is designed to be lightweight and easy to use. It comes with a storage box and AAA batteries for immediate use, further enhancing its user-friendly nature. As a non-contact thermometer, it offers a hygienic method of taking temperature readings, making it safe for the whole family, including babies, children, and adults.

3.1.2 Performance and Accuracy

The Beurer FT 95 provides a reliable and accurate method of taking temperature. The device has a body temperature measurement accuracy of ± 0.2 °C, with a range of 34 - 42.2 °C. For surface temperature measurements, the range is 0 - 80 °C. This precision ensures that users can have confidence in the results provided by the device.

3.1.3 Digital Integration and Data Management

One of the distinguishing features of the FT 95 is its integration with digital health applications via Bluetooth. The thermometer allows non-contact measurements of body temperature and facilitates the transfer of these values to the Beurer Health Manager App. This provides users with a complete overview of all their results in one application, promoting better health management and record keeping.

Furthermore, the FT 95 boasts 60 memory slots to keep records of readings, offering a substantial amount of data storage and easy access to past temperature readings. This feature can be particularly useful for tracking temperature trends over time or during illness.

3.2 Microlife NC 150 BT Thermometer

The Microlife NC 150 BT (see Figure 4) is [2] a Bluetooth-enabled forehead thermometer designed for easy temperature monitoring without contact. It connects to the "Microlife Connected Health+" app, available for both iOS and Android, enabling users to easily monitor their temperature using Bluetooth Smart.



Figure 4: Microlife NC 150 BT [2]

3.2.1 Device Specifications and Features

This thermometer is light, weighing only 90g with the battery and 67g without. The dimensions of the device are 141.1 x 43.3 x 36.9 mm, and it operates with 2 x 1.5 V alkaline batteries of AAA size. Its measuring range is from 0 to 100.0 °C, with an accuracy of ± 0.2 °C between 36.0 and 39.0 °C.

The NC 150 BT offers a range of features that enhance the user experience. One of its main features is its 3-second measurement capability, which allows for fast and easy measurement without touching the person. It also offers multifunctional measurements, allowing users to measure forehead, object, and ambient temperature within seconds.

It includes a blue LED tracking light that indicates the correct measurement area and distance, and the Silent Glow technology that displays a red light if temperatures exceed 37.4°C. It also has a sound control feature for silent operation, making it suitable for measurements at night.

The device is also equipped with a large illuminated display that shows the date and time, and it has a memory capacity to store up to 30 data entries along with the date and time.

3.3 Microlife WS 200 BT Diagnostic Scale

The Microlife WS 200 BT (see Figure 5) is [3] a diagnostic scale designed to provide an in-depth analysis of body composition. It connects to the Microlife Connected Health+ app via BLE technology. This connection enables the fast analysis of body composition, providing the user with knowledge about excess fat and suggesting the advisable weight based on the user's nutritional condition. This detailed knowledge about body composition can guide proper nutrition and physical activity, both essential for improving quality of life, promoting health, and preventing pathologies



Figure 5: Microlife WS 200 BT [3]

3.3.1 Features and Functions

The Microlife WS 200 BT has a wide range of functionalities. It provides an analysis of body weight, fat and water percentage, muscle and bone mass, and BMI, along with active and basic metabolic rates. The scale uses Bluetooth technology to automatically transfer this data to the Microlife Connected Health+ app for quick analysis. The scale also features an ITO (Indium Tin Oxide) electrode with a safety glass weighing platform, contributing to its durability and safety.

3.3.2 Specifications

The Microlife WS 200 BT is a compact and lightweight scale, measuring 305 x 305 x 24 mm and weighing 1.92 kg. It can accommodate a capacity of up to 180 kg, with a resolution of 0.1 kg. It uses BLE for communication, compatible with iOS 8.0 or newer and Android 4.4 or newer. The scale is powered by 4 x 1.5 V alkaline batteries (size AAA), expected to last for 8 months when used three times a day. The scale's service life is estimated at 20,000 measurements.

3.4 Microlife BP A7 Touch BT Blood Pressure Monitor

The Microlife BP A7 Touch BT (see Figure 6) is [4] an innovative medical device designed for non-invasive blood pressure measurement. It is intended for use by individuals aged 12 years and older, catering to a wide range of age groups. Its design and functionality aim to make blood pressure monitoring more accessible, accurate, and user-friendly. The device is clinically validated for patients with hypertension and hypotension, ensuring its reliability for diverse health conditions.



Figure 6: Microlife BP A7 Touch BT [4]

3.4.1 Device Specifications

The BP A7 Touch BT is a compact and lightweight device, measuring 160 x 82 x 35 mm and weighing 312g, inclusive of batteries. The device can be powered using either four 1.5 V AAA alkaline batteries or a mains adapter with a voltage of DC 6V, 600 mA. The device's measuring range for blood pressure is between 20 and 280 mmHg, and for pulse, it is between 40 and 200 beats per minute. These broad ranges allow for the accommodation of various physiological states and health conditions.

3.4.2 Special Features

A significant feature of the Microlife BP A7 Touch BT is its patented technology that detects atrial fibrillation, a condition that could potentially lead to stroke if left undetected. This feature underlines the device's focus on preventative care, enabling users to monitor their health more closely and take appropriate actions promptly if required. The device is also Bluetooth-enabled, which allows it to connect with smartphone apps or PC software for easier monitoring and data management. This integration with digital technology enhances user convenience and promotes consistent tracking of health metrics.

4 Literature Review

4.1 Bluetooth Low Energy

4.1.1 Introduction

4.1.1.1 What is BLE?

Bluetooth Low Energy (BLE), also known as Bluetooth Smart, is a power-efficient variant of the classic Bluetooth technology, which is designed for short-range wireless communication between devices. Introduced by the Bluetooth Special Interest Group (SIG), BLE is [8] optimized for low power consumption, enabling it to be used in battery-powered devices such as wearable fitness trackers, medical sensors, and other IoT (Internet of Things) devices. Unlike classic Bluetooth, which is primarily used for continuous, streaming data applications such as audio streaming, BLE is designed for sporadic, short bursts of data transfer, making it ideal for applications where power efficiency is critical.

4.1.1.2 Key Features and Advantages

The biggest advantage of BLE is its low power consumption, enabling devices to operate for months or even years on tiny coin-cell batteries. This is especially crucial for wearable and portable devices where frequent battery replacement or charging is not desirable.

BLE also supports robust, secure communication, with features such as LE Secure Connections for authenticated encryption and privacy features to protect from device tracking. Furthermore, it has a flexible, developer-friendly architecture, with the ability to define custom profiles and services to fit the application's specific needs.

BLE operates in the 2.4 GHz ISM band, which is globally unlicensed and accepted, ensuring international operability of devices. It also features good interference handling capabilities due to the use of frequency hopping spread spectrum technology.

Finally, given the widespread adoption of Bluetooth technology in smartphones, tablets, and computers, BLE devices can seamlessly connect and communicate with a vast array of existing devices, enabling a wide range of applications, including the healthcare sector.

4.1.2 Brief Technical Overview

4.1.2.1 How BLE Works

BLE operates on a client-server model. The server is a device that has data to share, like a heart rate monitor, and the client is the device that connects to the server to read this data, such as a smartphone. In BLE terminology, the server is typically called a "Peripheral" device, and the client is typically called a "Central" device.

BLE communication is based on small packets of data, known as "Advertisements", that are broadcast by the peripheral device at a regular interval. These advertisements are sent on three separate channels to reduce the chance of interference. When a central device receives an advertisement and wishes to connect, it sends a connection request to the peripheral device.

Once connected, the peripheral and central devices can exchange data, with the peripheral device providing data from its GATT (Generic Attribute Profile) server, which consists of "Services" and "Characteristics" that define the data the device can provide.

4.1.2.2 BLE Protocol Stack

The BLE protocol stack is [9] divided into two main parts: the Controller and the Host.

The Controller includes the physical layer (PHY), which is the actual radio that transmits and receives signals, and the Link Layer, which manages physical communication and provides basic security features.

The Host includes the Logical Link Control and Adaptation Protocol (L2CAP), which provides multiplexing of data between different higher layer protocols. It also contains the Attribute Protocol (ATT), the Generic Access Profile (GAP), and the Generic Attribute Profile (GATT).

ATT is the protocol used for reading and writing data to a server device, while GAP provides roles and modes of operation for devices (e.g., Peripheral or Central roles). GATT is used on top of ATT to organize data into hierarchical services and characteristics.

4.1.2.3 Key BLE Profiles and Services

BLE profiles are defined by the Bluetooth SIG and provide a standardized way to use the GATT for a specific use case. Each profile consists of one or more services, which are collections of characteristics. Characteristics are the smallest data entities defined by GATT and contain a value as well as properties that define how the value can be accessed.

Some key BLE profiles used in healthcare applications include the Heart Rate Profile, Health Thermometer Profile, Blood Pressure Profile, and Glucose Profile. These profiles define how a device can communicate data like heart rate, temperature, blood pressure, and blood glucose levels, respectively.

In addition to the standardized profiles, BLE also supports custom profiles and services. This flexibility allows developers to define their own services and characteristics to meet the specific needs of their application.

4.1.3 Applications of BLE in Healthcare

4.1.3.1 Remote Patient Monitoring

One of the key applications of BLE in healthcare is remote patient monitoring. Devices such as heart rate monitors, glucose meters, and blood pressure monitors can leverage BLE to transmit data to a central device such as a smartphone or a dedicated gateway. This data can then be further transmitted to healthcare providers, allowing for continuous monitoring of patients' health status without the need for hospitalization. This not only improves the quality of care but also significantly reduces healthcare costs.

4.1.3.2 Medical Device Connectivity

BLE is widely used for connectivity between medical devices. For example, a wearable ECG monitor can use BLE to transmit data to a handheld device for real-time viewing of ECG waveforms. In hospital settings, devices such as infusion pumps, patient monitors, and ventilators can use BLE for wireless data transmission, reducing the clutter of wires and improving patient mobility and comfort.

4.1.3.3 Wearable Health Technology

The low power consumption of BLE makes it ideal for wearable health technology. Devices such as fitness trackers, smartwatches, and [10] wearable sensors use BLE to connect with smartphones, transmitting data such as steps walked, heart rate, sleep patterns, and more. This data can be used by individuals to monitor and improve their health and wellness. In some cases, it can also be shared with healthcare providers for medical monitoring or research purposes.

4.1.3.4 Indoor Positioning and Navigation in Healthcare Facilities

BLE beacons can be used to implement indoor positioning and navigation systems in healthcare facilities. These beacons can [11] transmit signals that are picked up by a smartphone or other BLE-enabled devices, allowing for precise indoor positioning. This can be used to guide patients and visitors through large hospitals, locate medical equipment, or even monitor the location of staff and patients for safety and efficiency purposes. The use of BLE for indoor positioning is attractive due to its low power consumption and the widespread availability of BLE support in smartphones and other devices.

4.1.4 Challenges and Limitations of BLE in Healthcare

4.1.4.1 Technical Limitations

Despite its many advantages, BLE also has some technical limitations that can pose challenges in healthcare applications. One of the primary limitations is range. While BLE is designed for short-range communications, in some healthcare settings, a greater range may be desirable.

Another limitation is data rate. While BLE is suitable for transmitting small packets of data, it is not designed for high data rate applications, such as streaming high-resolution medical imaging data.

Finally, the performance of BLE can be impacted by interference from other devices operating in the 2.4 GHz band, including Wi-Fi devices, microwave ovens, and other Bluetooth devices. This can potentially lead to dropped connections or reduced data rate.

4.1.4.2 Security and Privacy Concerns

Security and privacy are paramount in healthcare applications, and while BLE includes security features such as [12] pairing and encryption, these are not without their vulnerabilities. For instance, devices must be correctly configured to use these features, and older devices may not support the latest security features.

Moreover, the privacy of BLE devices can potentially be compromised due to the broadcasting nature of the technology. BLE devices can be tracked based on their advertising packets, raising potential privacy concerns.

Lastly, there is the challenge of ensuring data privacy when health data is transmitted from a device to a smartphone or other central device, and potentially onto cloud servers. Compliance with regulations such as GDPR is crucial and requires careful attention to how data is handled and stored.

4.2 JavaScript/TypeScript

JavaScript is [13] dynamic and interpreted programming language, is fundamental to web development, enabling interactivity and dynamic content on web pages. Its specification, ECMAScript (ES), has seen significant updates, most notably ES6 in 2015, which introduced features making JavaScript more suited for large-scale applications.

However, JavaScript's dynamic typing can lead to runtime errors in complex applications. TypeScript, a statically typed superset of JavaScript, was developed to address this issue. Introduced by Microsoft in 2012, TypeScript adds optional types, classes, and modules to JavaScript, improving development tooling and allowing for type checking at compile-time, thereby detecting errors before runtime.

4.3 React

React, developed by Facebook in 2013, is [14] an open-source JS library designed for building user interfaces, particularly for single-page applications. It allows developers to create large web applications that can update and render efficiently in response to data changes, without requiring a full page reload.

React's core philosophy is the component-based architecture. Applications are built using isolated pieces of code called components, each responsible for rendering a part of the user interface. Components can maintain internal state, which along with props (short for properties), determines what is rendered on the screen. This approach encourages reusability, maintainability, and modular development.

One of the notable features of React is the virtual DOM (Document Object Model). When a component's state or props change, React creates a new virtual DOM and compares it with the old one. It then updates only the real DOM nodes that changed, rather than updating the entire page. This diffing algorithm optimizes performance by minimizing the costly DOM operations.

4.4 React Native

React Native, also developed by Facebook and released in 2015, is [15] an open-source framework for building mobile applications using JS and React. It extends the principles of React to mobile development, allowing developers to use the same declarative UI paradigm and JavaScript code to create applications for both iOS and Android platforms.

React Native utilizes the same fundamental UI building blocks as regular iOS and Android apps. Instead of using Swift, Kotlin, or Java, developers write applications in JS that are "native," meaning they can leverage platform-specific features and have performance close to traditional mobile apps.

The architecture of React Native is fundamentally the same as React: developers design the UI using self-contained components that manage their own state and props. However, these components correspond to native iOS and Android UI components, which enables the applications to have a look, feel, and performance of native apps.

4.5 React Native Paper

React Native Paper is [16] a Material Design library that offers pre-built components for React Native applications, designed to deliver a native-like look and feel on different platforms. It provides platform-specific styling, supports the latest Material Design standards, and focuses on creating responsive, fast, and reliable interfaces.

The library simplifies the process of building complex components, letting developers focus on UI logic and user experience. It includes a variety of components and interactions, easing the development process and minimizing the need for intricate platform-specific code.

React Native Paper also offers features like platform adaptation, full theming support, and accessibility. It supports switching between dark and light modes, customizing colors, and is compatible with screen readers, readability tools, and right-to-left languages. Developed in partnership with React Native Core Contributors and official Facebook partners, Callstack, React Native Paper is widely used across different industries to improve React Native products.

4.6 FHIR

Fast Healthcare Interoperability Resources (FHIR), developed by Health Level Seven International (HL7), is [17] a standard designed to improve interoperability in healthcare data exchange. Introduced in 2014, FHIR enables the exchange of healthcare information through discrete data elements called "resources", which represent specific types of healthcare information.

These resources are defined in a structured format with a standardized data schema, and can be represented in multiple formats, including XML, JSON, and RDF. FHIR leverages RESTful APIs, aligning with modern web technologies and making it compatible with mobile applications, cloud services, EHR data sharing, and other distributed environments.

FHIR supports a wide range of healthcare workflows and includes provisions for extending resources to meet specific use cases. In essence, FHIR provides a flexible, standardized structure for health data, fostering more effective sharing and utilization of health information across various systems and platforms, thereby improving patient care, healthcare operations, and health research.

4.7 Electronic Health Record

Electronic Health Records (EHRs) have emerged as a critical technical innovation in the healthcare business, [18] transforming the way patient data is captured, stored, and accessed. An electronic health record (EHR) is a computerized version of a patient's paper-based medical record that includes medical history, diagnosis, prescriptions, allergies, test findings, and radiological pictures. EHRs, as opposed to traditional paper-based records, allow healthcare providers to store and communicate patient information more efficiently within and across healthcare institutions, supporting improved coordination and continuity of care.

EHRs increase healthcare delivery quality by promoting improved communication and collaboration among healthcare professionals. Healthcare workers can use EHRs to access real-time patient data, allowing them to make more informed clinical decisions and give prompt and appropriate interventions. Furthermore, EHRs can improve workflows and eliminate errors caused by manual data input, handwritten prescriptions, and unreadable documentation. The use of standardized templates and organized data entry in EHR systems increases information consistency and accuracy, ensuring a complete picture of the patient's health state and medical history. Furthermore, EHRs empower patients to actively participate in their own care by providing access to their medical information, appointment scheduling, and educational resources through online portals, boosting patient engagement and empowerment.

4.8 eHealth4u Platform

The eHealth4U research project [5] aims to develop a prototype of a national integrated Electronic Health Record (EHR) system in Cyprus, aligning with the country's Electronic Health Law. The project emphasizes a citizen-centric approach, designing the EHR system to cater to the needs of individuals rather than focusing solely on healthcare institutions. Interoperability, a significant challenge in the healthcare industry, is addressed through the use of state-of-the-art standards and profiles, including the Fast Healthcare Interoperability Resources (FHIR) standard and IHE interoperability profiles recommended by the European Union. The implementation of interoperability mechanisms and eHealth services prioritizes holistic security enforcement and data security-by-design. The overall objective of eHealth4U is to enhance Cyprus' eHealth ecosystem by leveraging collaborative efforts among the public sector, academia, industry, and non-governmental organizations, resulting in a prototype EHR system that ensures healthcare quality, interoperability, patient-centered care, citizen ownership of health records, standardization, and data confidentiality and security.

The software architecture of the eHealth4U platform is illustrated in Figure 7. The eHealth4U ecosystem consists of two levels. The first level is the internal governmental network to which only authorized and accredited persons who are responsible for the development, maintenance and monitoring of the eHealth4U platform have access. The second level is the public network, a level where the eHealth4U portal can be accessed as well as third party systems.

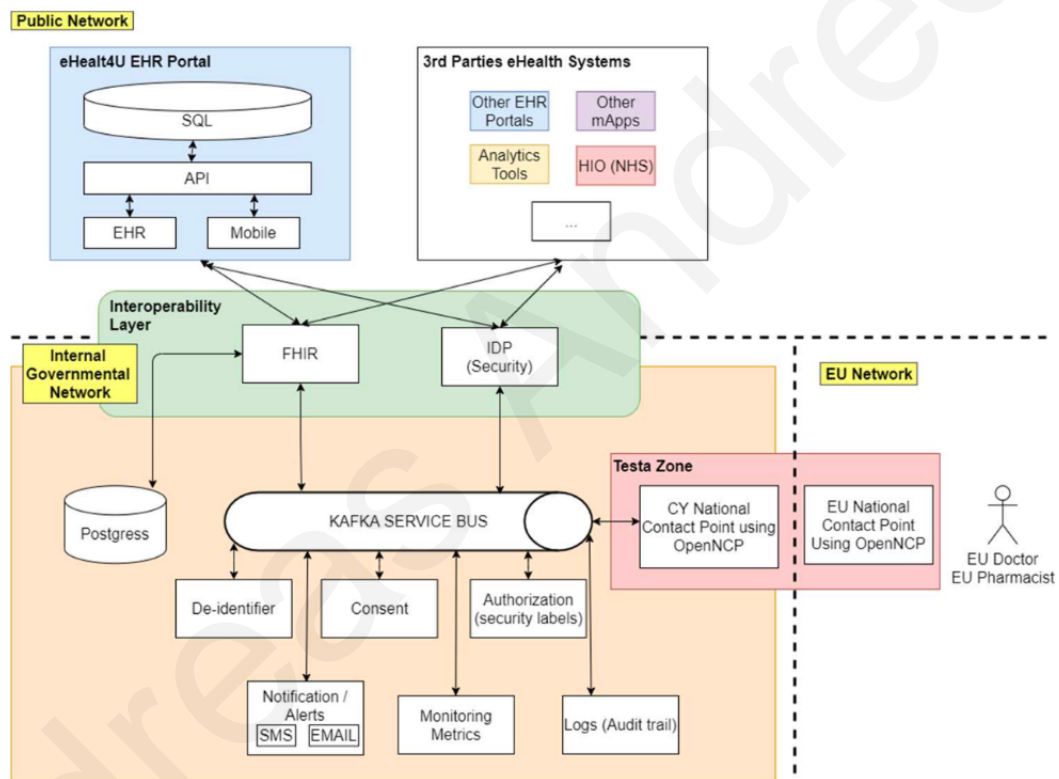


Figure 7: eHealth4U architecture [5]

4.9 Microlife SDKs

Microlife Software Development Kits (SDKs) serve an important role in enabling developers to construct apps that connect with Microlife devices and services. SDKs are collections of tools, libraries, and documentation that make working with certain hardware or software components easier. Microlife's SDKs are intended to enable smooth connection between mobile applications and their line of health-related devices, which includes blood pressure monitors, thermometers and scales, among others. Developers can harness the capabilities of these devices, obtain health data, and incorporate them into their applications to improve user experiences and allow health monitoring functionality by leveraging Microlife SDKs.

Despite the numerous advantages of Microlife SDKs for traditional mobile app development, they have several restrictions when used with React Native. React Native operates in a different context than native mobile app development, which is the primary emphasis of Microlife SDKs. React Native apps do not interface directly with native device functionality, instead relying on a bridge to communicate with native modules. As a result, SDKs designed for native mobile app development sometimes lack the compatibility and support required for React Native's unique architecture. As a result of this mismatch, smooth integration between Microlife SDKs and React Native projects is not possible, mandating other ways and workarounds for developers wishing to combine the capabilities of Microlife devices with React Native applications.

5 Requirements

5.1 Gathering and Analyzing Requirements

The requirements for the extension of MYeHealthAppCY were gathered and analyzed through a collaborative process involving my research supervisor, Dr. Constantinos Patichis, and Dr. Marios Neofytou from the eHealthLab of the University of Cyprus.

An initial conversation with these experts provided an understanding of the primary purpose of the app: to empower patients by allowing them to take control of their health monitoring. It was made clear that the application's objective is to facilitate users in taking measurements using their Bluetooth-enabled medical devices, view these measurements in the app, and have the data automatically uploaded to their user profiles.

Post the initial conversation, a comprehensive understanding of the existing application was developed. The application, constructed in React Native, was thoroughly examined to gain insight into its architecture, functionality, and user interface. This step was critical in understanding the constraints and possibilities inherent in the existing application.

Through this process, a comprehensive list of requirements for the extension of MYeHealthAppCY was established. These requirements, detailed in section 5.3, guide the development of the application and ensure alignment with the goals of facilitating user-led health monitoring.

5.2 Collection of information from similar applications

In order to provide context and insights for the development of MYeHealthAppCY, a detailed analysis was conducted on two applications: HealthManagerPro and Microlife Connected Health+. These applications were chosen for their similar scope of functionality and technology utilization, particularly their use of Bluetooth Low Energy (BLE) for data transmission.

HealthManagerPro was found to have a user-friendly interface and a robust system for connecting and retrieving data from various medical devices. The application also incorporated a comprehensive system for data management, allowing users to visualize and track their health over time. However, some areas for improvement were noted, particularly in terms of error handling during data transmission, which could sometimes be inconsistent.

Microlife Connected Health+ was praised for its ability to maintain a stable connection with a variety of Microlife's medical devices. It also demonstrated excellent reliability in the retrieval and storage of data. However, the user interface was found to be less intuitive than HealthManagerPro, which could potentially inhibit user adoption and regular usage.

To supplement the insights gained from analyzing these applications, the paper [9] "Remote Health Monitoring Systems Based on Bluetooth Low Energy (BLE) Communication Systems" was consulted. This paper provided valuable technical and conceptual understanding of BLE communication, including its strengths and limitations, as well as best practices for implementation in health monitoring systems.

The information gleaned from these analyses was crucial in informing the requirements and design decisions for MYeHealthAppCY. It became clear that a successful application would need to marry the user-friendly interface of HealthManagerPro with the stable and reliable BLE connection demonstrated by Microlife Connected Health+. Moreover, the lessons learned from the aforementioned paper emphasized the importance of proper BLE implementation and error handling to ensure the consistent transmission and accurate recording of health data. These findings have been taken into account in the detailed requirements presented in section 5.3.

5.3 Final Requirements

5.3.1 BLE Medical Device Connection

The BLE medical device connection feature in MYeHealthAppCY should be designed with several crucial requirements in mind to facilitate user interaction and device management.

Firstly, a dedicated screen should be created to act as a central hub for device discovery. From this screen, users should be able to initiate a scanning process for detecting supported BLE devices in the area. The scan duration should be limited to 10 seconds to effectively conserve battery life while ensuring adequate time for device detection.

The application should be designed to support a range of BLE medical devices such as thermometers, blood pressure monitors, pulse oximeters, body scales, among others. It should provide a reliable and user-friendly interface for these devices to connect and communicate with the app, enabling patients to monitor their health using a wide variety of devices.

As the scanning process is conducted, the application should dynamically display discovered devices on the screen. If a discovered device already exists in the user's registered device list, the user should be presented with an option to view the device's screen. If the discovered device is not already on the list, an option to add the device should be presented instead.

To inform users about the range of devices that the application supports, another screen should be included to display a list of all supported devices. This feature can guide users in choosing compatible BLE medical devices for use with the application.

In instances where the scanning process does not discover any devices, the application should inform the user by displaying a message indicating that no devices were found. This feature will enhance user interaction and help manage user expectations.

Finally, since both Bluetooth and location services are essential for the scanning process, the application should check if these services are enabled on the user's device before initiating the scan. If either or both are disabled, the application should prompt the user to enable them. This feature will ensure the user's device is appropriately configured for the scanning process and will prevent unnecessary power consumption.

By adhering to these requirements, the application should provide a seamless and efficient experience for users, facilitating the easy discovery, addition, and management of BLE medical devices.

5.3.2 User Devices and History

The application should provide a user-friendly interface for users to interact with their connected devices and review their historical data. This feature involves the creation of a dedicated screen with two main components: a user devices section and a data history section.

In the user devices section, located at the top of the screen, the application should display a horizontal list of the user's devices presented in a card-style layout. Each card should represent one of the user's devices, displaying relevant device information. If the user does not have any devices registered, the application should display an informative message in place of the device cards. When a user selects a device card, the application should open the corresponding device details screen, which will be elaborated further in section 5.3.3.

Beneath the user devices section, a history section should be implemented to display a list of different data categories, such as temperatures, blood pressure readings, and so on. Each category should provide a concise summary of the respective data recorded from the user's connected devices.

Upon selecting a specific data category, the application should redirect the user to a new screen. This screen should present the user's historical data for the selected category in a paginated table format. The table should be designed to clearly and effectively display the data, ensuring that users can easily comprehend and navigate their historical health information.

By integrating these features, the application should offer users an intuitive way to manage their devices and review their health data, facilitating more informed health decisions and improved self-monitoring.

5.3.3 Medical Device - Saving and Managing the Retrieved Data

The application should facilitate the effective management and display of the retrieved data from the connected devices. This feature would necessitate the design of a detailed device information screen, providing users with an accessible interface for understanding their device's data and historical readings.

At the top of this screen, the application should prominently display the current reading of the selected device, defaulting to zero when no measurement has been taken. The displayed metric should change depending on the type of the device. For example, a thermometer should show a measurement in degrees Celsius ($^{\circ}\text{C}$), while a blood pressure monitor should show measurements mmHg for both systolic and diastolic pressure.

In the header of this screen, an option should be included to remove the device from the user's registered devices. When selected, this option should trigger a dialog box, asking the user to confirm whether they indeed want to remove the device.

Furthermore, the application should be responsive to the device's connectivity status. If a device is not discovered during a previous Bluetooth scan, an alert should be displayed at the top of the screen, indicating that the device was not found and prompting the user to start a new scan.

Below the current measurement, a button should be placed to initiate a data retrieval process from the connected device. This button should be disabled when the device is not discovered and enabled when the device is successfully discovered. During the data retrieval process, the button should reflect a loading state to indicate that the process is ongoing. Once the data is retrieved, the button should revert to its active state, and the new data should be displayed.

Finally, the application should incorporate a paginated table below the current reading section to present the historical data pertaining to the type of measurement produced by the specific device. This table would enable users to track their health readings over time, promoting better understanding and management of their health status.

Andreas Andreou

6 Implementation

6.1 Introduction

The purpose of this chapter is to detail the implementation phase of the MYeHealthAppCY extension project. This includes an explanation of the methods and techniques used to bring the outlined requirements to life in the React Native application. I will delve into the specific technologies, tools, and practices employed throughout the development process and discuss the structure of the application, feature implementation, and the approach taken for testing and validation.

The implementation process is integral to the successful completion of any software project, and it is during this phase that the conceptual framework established in the design and requirement gathering stages is transformed into a tangible, working application. The focus of this chapter is on how the required functionality for BLE medical device connectivity and data management was implemented.

Each subsequent section of this chapter provides a more granular view of the various aspects of the implementation process. The objective is to provide a clear and detailed understanding of how the design and requirements were translated into the final application, how the application's various features were developed, and how they interact within the larger system.

By outlining the development environment, describing the architecture and design, discussing the feature implementation, and exploring the testing and validation techniques, this chapter aims to provide a comprehensive view of the application's implementation journey.

6.2 Development Environment

This section provides an overview of the development environment utilized in the implementation of the MYeHealthAppCY extension project. A well-structured development environment is essential for streamlined and effective software development.

The project was developed using JavaScript (JS) and TypeScript (TS) within the React Native framework. Visual Studio Code (VS Code) was chosen as the primary text editor due to its robust support for JS and TS and its powerful features and extensions, including excellent version control support and IntelliSense. Further discussions about JS/TS and React/React Native can be found in chapters 4.2 and 4.4 respectively.

For the mobile device emulation needed during the development process, Android Studio was utilized. It offered a variety of tools to design, test, and debug applications intended for the Android platform.

For version control, Git was utilized, enabling efficient management and tracking of code changes over the course of the development process. Git offers powerful branching and merging features, which is critical in maintaining the project's codebase. The project repository is hosted on Azure DevOps, offering a centralized location for code storage and collaboration.

The project relies on the eHealth4U API for back-end services, including storing and retrieving user health data, managing user devices, and user account management.

Several key libraries were utilized in the project. The React Native Paper library was used to facilitate UI development. It offers a wide variety of pre-built components following Material Design guidelines, making it an excellent choice for a cohesive, user-friendly interface. The library's details have been discussed in chapter 4.5.

The React Native BLE Manager was used for managing Bluetooth Low Energy (BLE) connections, which is a key component of the app given its role in connecting to medical devices.

For data fetching, synchronization and state management, the @tanstack/react-query library was used. This provided reliable and fast synchronization between the client and the server.

Due to the project's scope and resources, manual testing was preferred over using specific testing tools. This involved visual inspections of the application to confirm the correctness of implemented features and functionalities. While this method may not cover all potential edge cases, it provides a sufficient level of assurance for the project's current stage and scale. More on chapter 6.5

The blend of these tools and technologies formed a robust development environment that facilitated the implementation of this project's requirements.

6.3 Architecture and Design

The architecture and design of MYeHealthAppCY have been predetermined, as this project extends existing work. Two previous student projects laid the [19] foundational architecture and [20] for this application. This chapter briefly discusses the architecture and design aspects. For more intricate details, one can refer to the respective diploma theses.

These projects outline the general architecture and mobile application architecture of the project. The primary focus was on designing a [21] teleconsultation module for an eHealth application in Cyprus. The application was developed using React Native with the backend developed in C# and hosted on a server provided by the eHealth Laboratory at the University of Cyprus. A distinctive feature of the app includes [22] prescription management and patient summary views, which aim to streamline healthcare delivery and enhance patient engagement. This application is compatible with both Android and iOS operating systems. The healthcare industry's FHIR standard was followed for interoperability.

The mobile application architecture was designed with simplicity, maintainability, and functionality in mind. It was structured into three main layers: the presentation layer, the business logic layer, and the data access layer. The presentation layer, built using React Native, handles user input and displays information. The business logic layer, implemented in C#, manages data processing and communication with the backend API via the FHIR protocol. Lastly, the data access layer is responsible for accessing and storing data in the database using RESTful API calls.

During the design phase, the focus was on creating a user-friendly interface for healthcare professionals and patients alike. Detailed wireframes and user flows were created to outline the various screens and interactions within the application. The data model and API endpoints were defined for data retrieval and storage from the backend. Aesthetic design elements (Figure 8) such as colors, fonts, and the logo were chosen to convey values of accessibility and reliability.

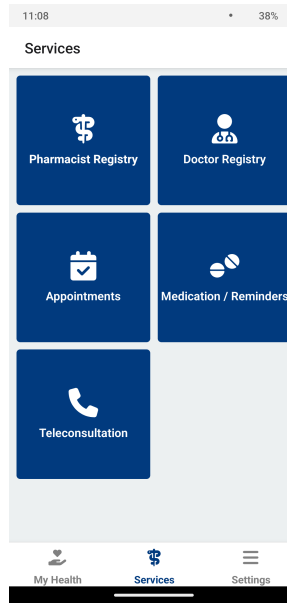


Figure 8: MYeHealthAppCY app

This project extends these foundational architectural and design considerations to add BLE medical device connectivity and data management functionalities. The extension harmonizes with the existing architecture, maintaining the separation of concerns into the presentation, business logic, and data access layers. With this architecture as a baseline, our extension introduces additional components to manage the new functionalities without disrupting the existing architecture. Further discussion of how these new features were implemented within the existing architecture will be covered in the subsequent sections.

6.4 Feature Implementation

Before delving into the specifics of each feature implementation, it is important to establish a broader understanding of the application's general implementation approach. As this project extends an existing application, namely MYeHealthAppCY, a core principle has been to ensure consistency in design and functionality with the current state of the application. This guarantees a seamless user experience across different modules and features, thereby promoting user familiarity and ease of use.

Another significant aspect of this implementation is the incorporation of multilingual support. Recognizing the diverse demographics of potential users, the application has been designed to support both Greek and English languages. This capability enhances the app's accessibility and its potential reach, offering a user-friendly interface to a broader user base, which is of utmost importance in a healthcare setting where clear and understandable information is paramount.

With these general principles in mind, the ensuing subsections will explore the technical details of the implementation of the primary features: BLE medical device connection, user devices and history, and the saving and managing of the retrieved data. For each feature, I will examine the implementation strategies, utilized libraries and encountered challenges.

6.4.1 Discover Medical Devices

The core of the BLE Medical Device Connection feature revolves around the application's capacity to efficiently discover and connect with compatible BLE medical devices. The discovery process is initiated upon opening the screen dedicated to this feature, as shown in Figure 9, utilizing the capabilities of the "react-native-ble-manager" library.

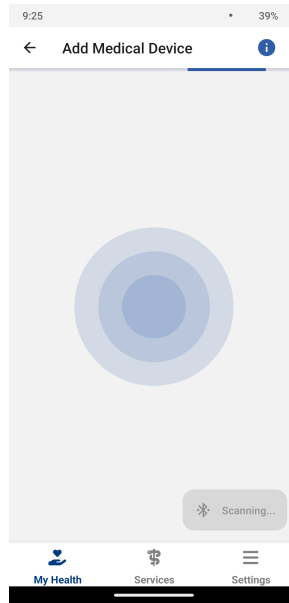


Figure 9: Discovering supported devices

During the discovery process, the application ensures that both Bluetooth and location services are enabled on the user's device. If found disabled, it immediately prompts the user to enable them, as shown in Figure 10, which is crucial for the successful initiation of the discovery process. The scan for discovering devices is set to last 10 seconds, a duration carefully selected to balance between a comprehensive device search and prudent battery usage.

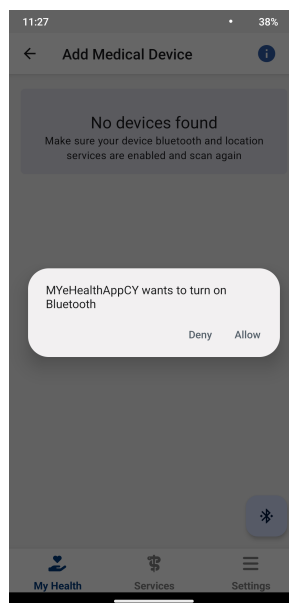


Figure 10: Enabled Bluetooth prompt

To keep the user informed, an appropriate message is displayed in case no devices are found during a scan (see Figure 11). Moreover, the user is always provided with an option to initiate a new scan anytime after a previous scan is completed. This is accomplished by pressing the floating action button that appears at the bottom right of the screen.

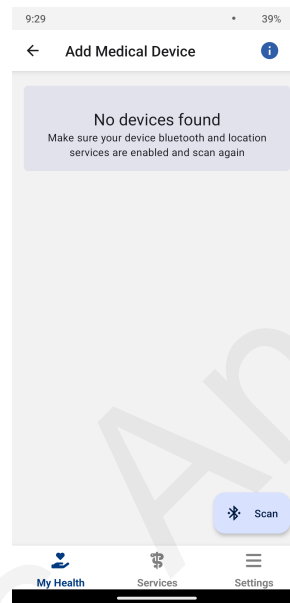


Figure 11: No devices found

As devices are found during the scan, the application collects essential information about each device including its ID, name, RSSI, and certain advertising parameters (isConnectable, serviceUUIDs, manufacturerData, serviceData, txPowerLevel). To validate if a discovered device is supported by the application, the device's name is checked against the list of supported devices.

Each discovered device is then presented on the screen in the form of a card, showcasing an image of the device, its name, and its type. If the device has already been added to the user's device list, a button appears on the card that navigates the user to view that particular device's details. Conversely, if it's a new device for the user, an 'Add' button appears on the card (example shown in Figure 12). Upon clicking 'Add', the application communicates with the API to add the device to the user's devices, subsequently redirecting the user to the main screen.

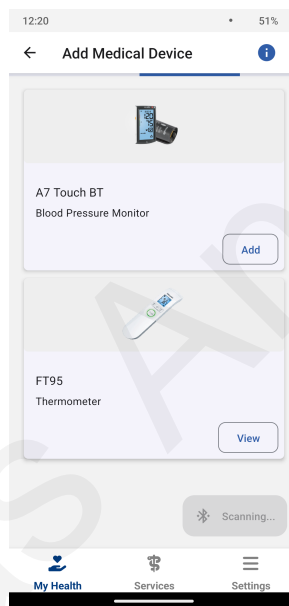


Figure 12: Add or view device

Finally, a helpful feature integrated into this screen is the availability of an information icon at the top right corner of the header area. Clicking this icon navigates the user to a new screen displaying all supported devices per category (see Figure 13), providing a comprehensive overview for the user to better understand the compatibility of their devices with the application.

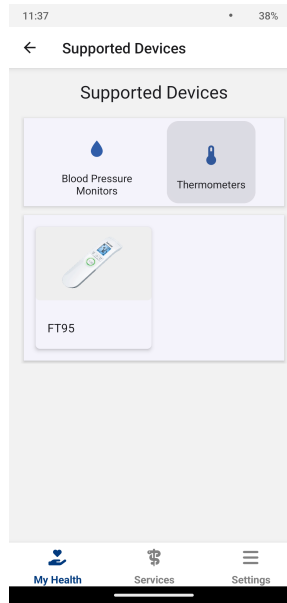


Figure 13: Supported devices screen

6.4.2 User Devices and History

This feature is the central hub within the medical devices section of the application (see Figure 14). An easily accessible plus icon, located on the top right corner of the header, enables users to navigate to the device discovery screen described in the previous subsection.

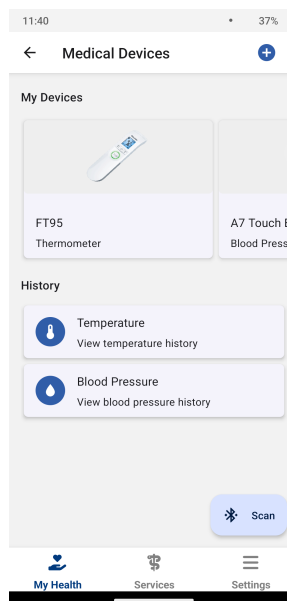


Figure 14: Medical devices main screen

The main screen is divided into two significant areas - "My Devices" and "History". The "My Devices" section is conveniently located at the top and displays the user's devices in a horizontal list of cards. Each card includes an image, the name, and the type of the corresponding device. Clicking on any of these cards navigates the user to a detailed screen for the chosen device, which will be discussed in the next subsection. If the user has no devices, an appropriate message is displayed (see Figure 15). Furthermore, if there's any issue fetching the device data from the API, an error message appears, providing the option for the user to retry fetching the data (see Figure 16).

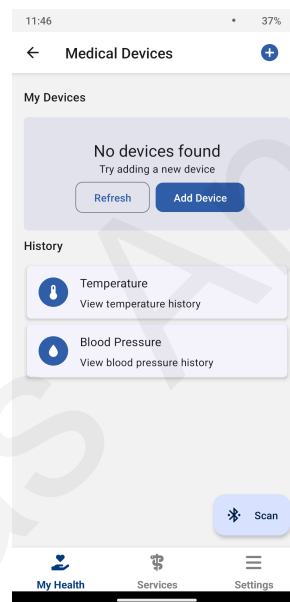


Figure 15: Medical devices main screen - no devices

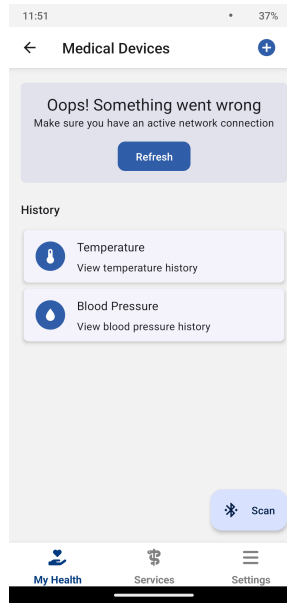


Figure 16: Medical devices main screen - error

Below the "My Devices" section is the "History" section. This area consists of a list of supported categories, each of which can be clicked to view historic data of measurements pertaining to that category (e.g Figure 17). On selection, the user is directed to a new screen that fetches and displays historic data relevant to the selected category from the API. The data is neatly organized into a table with appropriate columns for each category.

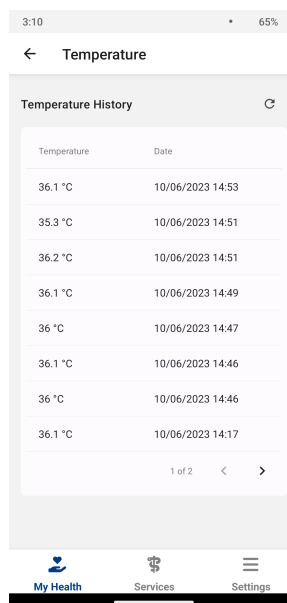


Figure 17: Temperature measurements history

To ensure that the information remains digestible and not overwhelming for the user, the data is paginated, displaying eight items per page. If multiple pages of data exist, the user can easily navigate through them using the arrow buttons located at the bottom of the table. For added convenience and data accuracy, a refresh button is placed at the top right corner of the table, allowing users to refresh the data at any point. This design carefully balances information density and user experience, facilitating easy access to the necessary data without overwhelming the user.

6.4.3 Saving and Managing the Retrieved Data

In this part of the application, the user interacts with the interface to manage and observe data retrieved from the connected BLE medical devices. The screen that serves this purpose (see Figure 18) is accessible when clicking on the device card from the "User Devices and History" screen as described in section 6.4.2 or when you opt to view or add a device as depicted in section 6.4.1.

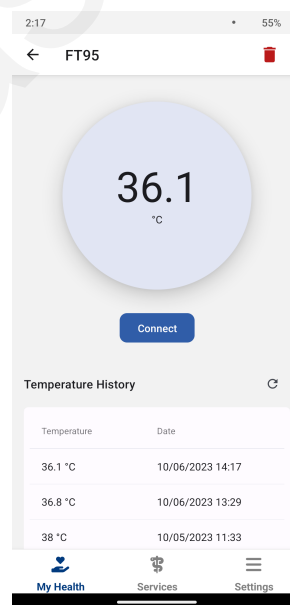


Figure 18: Device screen

Situated at the top right of the header area, a trash button is provided to remove the device from the user's device roster. When clicked, a dialog opens (see Figure 19), prompting the user to confirm whether he/she intends to remove the device.

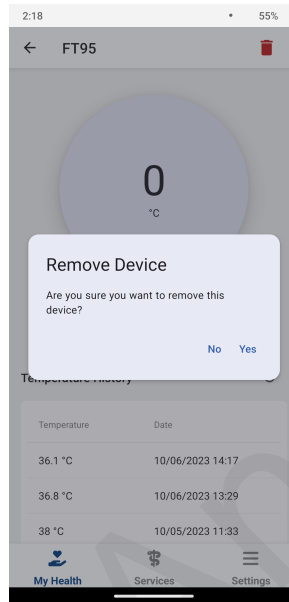


Figure 19: Removing a device

Dominating the top of the screen is a distinct, rounded area that displays the current measurement fetched from the device. It defaults to zero and is appropriately coupled with the corresponding measurement unit. Just beneath this area is a button intended to initiate connection to the device. This functionality will be detailed further along.

Located below this section is a historical data display (see Figure 20), which presents past data associated with the device based on its category. Though it resembles the display described in section 6.4.2, it presents fewer data per page. The rationale behind this design choice is to ensure that the primary focus remains on device connection and real-time measurement reading.

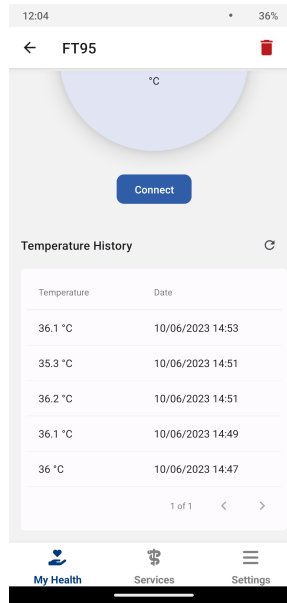


Figure 20: Device measurements category history

To connect to the device and acquire data, it is a prerequisite to have previously discovered the device. This step is necessary to ascertain the device's id. If the device remains undiscovered, a banner appears, indicating that the device has not been found and urging the user to initiate a scan for device discovery (see Figure 21). In such a circumstance, the connect button is rendered disabled.

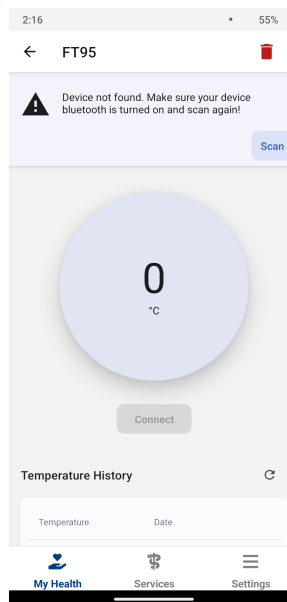


Figure 21: Device not discovered

Following device discovery, we're set to connect to the device and receive measurement data. This step, while crucial, proved to be the most challenging aspect of the project, presenting many hurdles along the way, and significantly prolonging the completion timeline.

Under normal circumstances, the process of reading data from a BLE medical device follows a defined path. First, [9] a connection is established with the device using the device's ID, which is available after the device discovery process. Following this, the device services and characteristics are retrieved. Each service and characteristic has a UUID that should correspond to an assigned number from the Bluetooth specifications, dependent on the type of the medical device and the measurements it performs. A notification listener is then set up to listen for transmitted information based on the device ID, service UUID, and characteristic UUID. When data are transmitted, they can be read and interpreted.

While the "Beurer FT95 Thermometer" adhered to the Bluetooth SIG guidelines for medical devices and presented a relatively straightforward process of data reading, the same cannot be said for all the medical devices I worked with during the project. Specifically, the devices manufactured by Microlife posed a different set of challenges.

The Microlife's devices, namely the "Microlife NC 150 BT Thermometer", "Microlife WS 200 BT Diagnostic Scale", and "Microlife BP A7 Touch BT Blood Pressure Monitor" all used custom services and characteristics, as opposed to the assigned UUIDs typical in other devices. These services and characteristics could be discovered, but the process to receive data from these devices to the mobile application was non-standard.

Specifically, it required the application to send a proprietary command back to the device through a specific characteristic. This command essentially acted as a request, asking the device to send the relevant data back to the application. However, the composition of this write command is not public and differs from one device to another.

For the "Microlife NC 150 BT Thermometer" and the "Microlife WS 200 BT Diagnostic Scale", I was not able to determine the correct command necessary to initiate data transfer. Despite considerable effort, the proprietary nature of these commands proved a barrier to reading data from these devices.

On the other hand, the "Microlife BP A7 Touch BT Blood Pressure Monitor" posed a similar problem, but in this case, I was fortunate. Thanks to the device's popularity and established presence in the community, open-source projects exist that have reverse-engineered the data reading process. By leveraging these resources, I was able to successfully discover the required command and, consequently, read data from this blood pressure monitor.

Deciphering the data received from the medical devices emerged as another significant challenge in the project. The information transmitted back from the devices arrives in the form of binary data. However, due to the varied nature of these devices, there is no standard protocol for transmitting this data. Each device may transmit different types of data, in different units, which can significantly complicate the process of deciphering the data.

To overcome this challenge, an approach based on trial and error was employed. This involved an iterative process of trying various methods and interpretations to decode the binary data. It was a time-intensive procedure that required considerable effort and experimentation. But with patience and perseverance, I was able to decrypt the binary data and extract the necessary measurements from it.

Another nuance in data decryption was the variations in the data transmitted by different devices. The "Beurer FT95 Thermometer" and the "Microlife BP A7 Touch BT Blood Pressure Monitor" differed in the type of data they sent. The thermometer transmitted the most recent stream of data, corresponding to the current measurement. In contrast, the blood pressure monitor sent a stream of a list of measurements.

Understanding and addressing these differences was critical in effectively interpreting the data received from each device and ensuring accurate measurements.

6.5 Testing

The testing phase of the application was an integral part of the development process. Given the nature and complexity of the application, manual testing was chosen as the primary method to ensure each feature was functioning as expected. Each new feature added to the application was meticulously tested to ensure it worked correctly. This involved manipulating the feature in all possible ways to observe and assess its response. Beyond individual feature testing, integration testing was also conducted. This stage involved testing the interactions between different features to verify that they were working together as intended and producing the correct output.

In addition to manual testing, user testing was introduced into the development process to verify the overall usability and user experience of the application. A set of selected users participated in testing sessions each time a new feature was implemented. These users were given access to the program and told to complete specified activities while providing feedback on their experiences. This user-centered approach yielded insightful information on how the application was perceived and used in real-world scenarios. Their opinions and recommendations were critical in identifying potential problems and improving the application's functionality.

7 Assessment

7.1 Introduction

In order to effectively evaluate and validate the application, a multi-pronged approach was employed. This included an extension to the existing user manual of the application, a user questionnaire, and an examination of the resultant data.

The current app user manual, detailed in section 7.2, was expanded to include the new features and functionalities added in this project. This provided a valuable resource to guide users through the app, ensuring that they could efficiently navigate and utilize all features.

To gain deeper insights into user experience and perspectives, a questionnaire was created, as described in section 7.3. This method allowed users to assess the application, providing feedback on a variety of aspects such as usability, design, functionality, and overall experience.

The final stage of assessment revolved around examining the results from the user questionnaire and user manual feedback. This analysis, detailed in section 7.4, provided a comprehensive overview of the application's performance, highlighting areas of success as well as potential opportunities for improvement.

Together, these elements formed a robust framework for the evaluation and validation of the application. Each component provided a unique perspective on the application, combining to create a comprehensive and well-rounded assessment.

7.2 User Manual

The user manual serves as an important tool in familiarizing users with the application and its features. Recognizing this, I have extended the existing user manual to include detailed instructions pertaining to the new functionalities introduced in this project.

The extension covers the practical use of the application, specifically the incorporation and interaction with the BLE medical devices. It provides detailed guidance on how to connect a device, view and manage user devices, and how to interpret the measurements received from the devices. This expansion was designed to enable a seamless user experience, ensuring users can fully leverage the potential of the newly implemented features.

By offering clear, step-by-step instructions, the user manual provides a reliable point of reference for users unfamiliar with certain aspects of the application. This not only reduces the learning curve associated with the introduction of new features but also promotes efficient and effective usage of the application as a whole.

The aim was to ensure that users would understand the functionality of the application and would be well equipped to navigate through it independently. Furthermore, the user manual provides a go-to resource for users if they are unsure about any aspect of the application, offering assistance and guidance when needed.

The User Manual is available in Appendix B.

7.3 Questionnaire

To gather user feedback and assess the effectiveness of the implemented features, a structured questionnaire was developed and disseminated to the users. Utilizing the platform of Google Forms, the questionnaire was designed to collect both demographic information and specific feedback related to the app's new features.

The questionnaire commences with a series of demographic questions to gain insights into the diversity of the users. This assists in understanding the range of user profiles interacting with the app and allows for the tailoring of future enhancements to cater to a broader audience.

Subsequently, the survey proceeds to focus on the newly implemented features of the app. The questions here are formulated to gather users' perceptions and experiences regarding the functionalities, usability, and overall utility of the app.

The questionnaire is available in Appendix A.

7.4 Results

The results of the user questionnaire were insightful and provided a valuable understanding of user perspectives regarding the newly implemented features of the app. In total, 21 responses were received.

In terms of gender distribution, 13 respondents identified as male, while 8 identified as female (see Figure 22). The age demographics were reasonably diverse as shown in Figure 23.

What is your gender?
21 responses

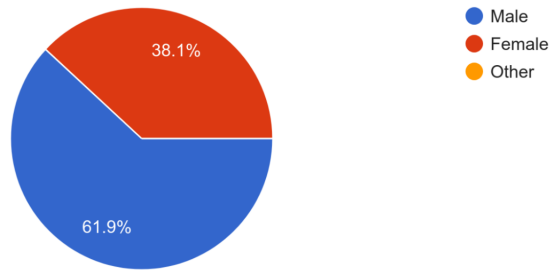


Figure 22: Gender demographics

What is your age?
21 responses

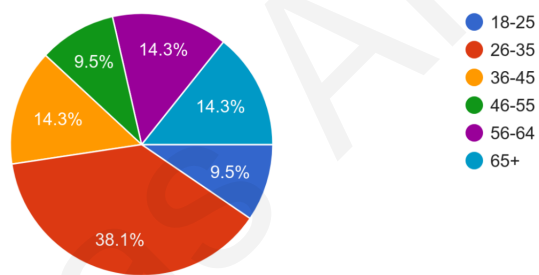


Figure 23: Age demographics

All the participants tested the application on an Android device. When asked to rate their familiarity with using Android applications, on a scale of 1 (never used an Android app before) to 5 (use Android apps every day), the results were mixed since some participants had never use an android app before or they were iOS users (see Figure 24).

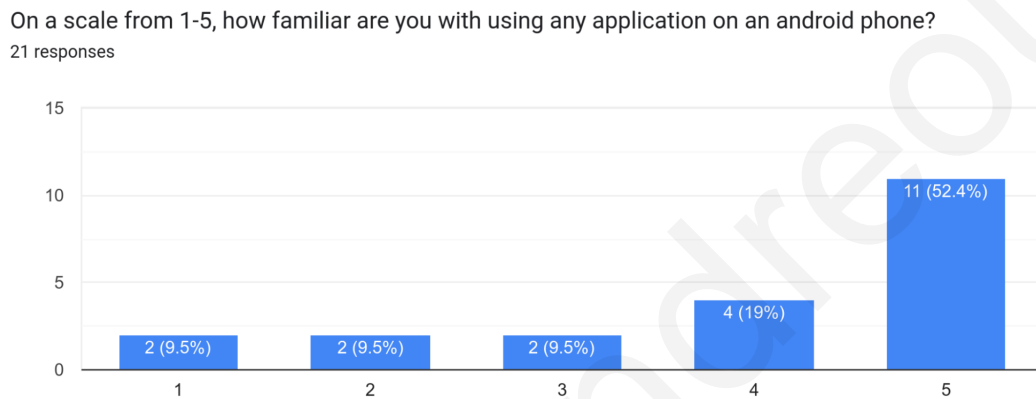


Figure 24: Android familiarity

The participants were then asked to assess the ease of various functions within the app, with 1 being "very hard" and 5 being "very easy". The questions and the corresponding responses were as follows:

Ease of accessing the medical devices section (Figure 25):

- 1 person responded with a 3
- 2 people responded with a 4
- 18 people found it very easy, responding with a 5

On a scale from 1-5, how easy was to access the medical devices section of the app?

21 responses

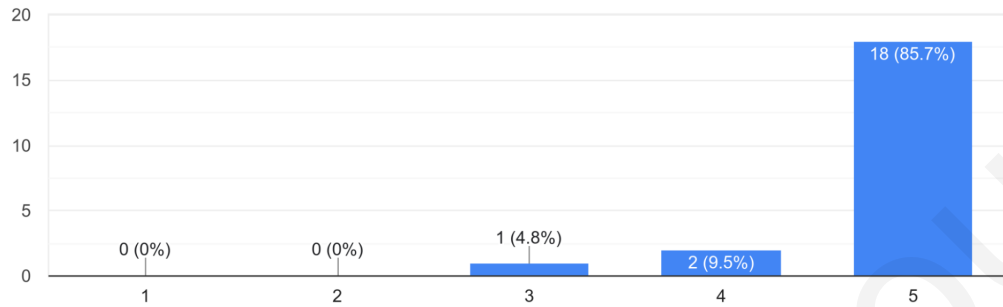


Figure 25: Ease of accessing the medical devices section

Ease of accessing the screen for adding a medical device (Figure 26):

- 1 person responded with a 1
- 1 person responded with a 2
- 1 person responded with a 3
- 7 people responded with a 4
- 11 people found it very easy, responding with a 5

On a scale from 1-5, how easy was to access the screen for adding a medical device?

21 responses

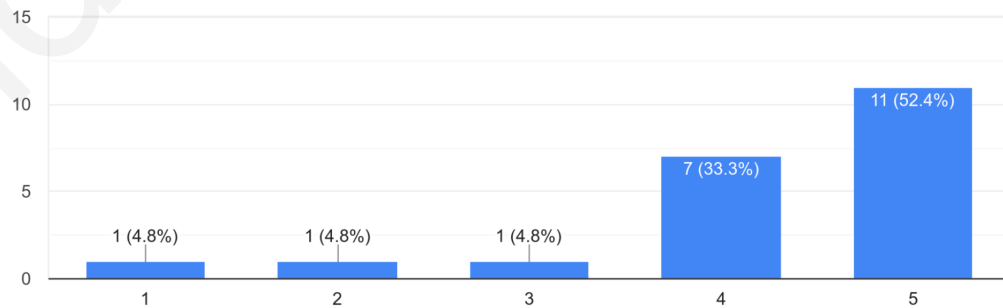


Figure 26: Ease of accessing the screen for adding a medical device

Ease of adding a medical device (Figure 27):

- 2 people responded with a 2
- 1 person responded with a 3
- 4 people responded with a 4
- 9 people found it very easy, responding with a 5

On a scale from 1-5, how easy was to add a medical device?
21 responses

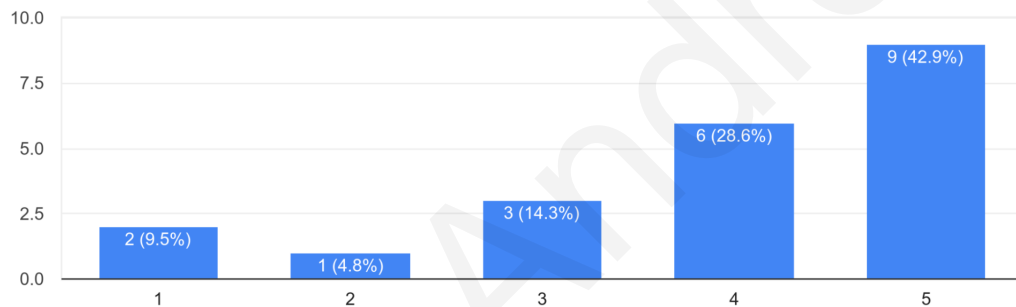


Figure 27: Ease of adding a medical device

Ease of accessing the screen for viewing a medical device (Figure 28):

- 2 people responded with a 2
- 3 people responded with a 4
- 15 people found it very easy, responding with a 5

On a scale from 1-5, how easy was to access the screen for viewing a medical device?

20 responses

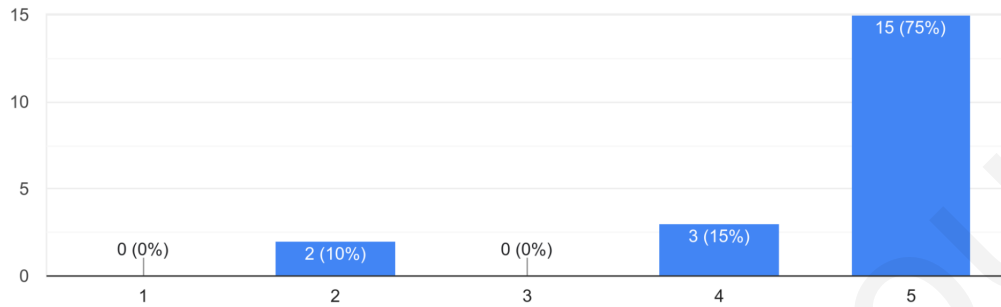


Figure 28: Ease of accessing the screen for viewing a medical device

Ease of obtaining a measurement (Figure 29):

- 2 people responded with a 1
- 2 people responded with a 3
- 7 people responded with a 4
- 10 people found it very easy, responding with a 5

On a scale from 1-5, how easy was to get a measurement?

21 responses

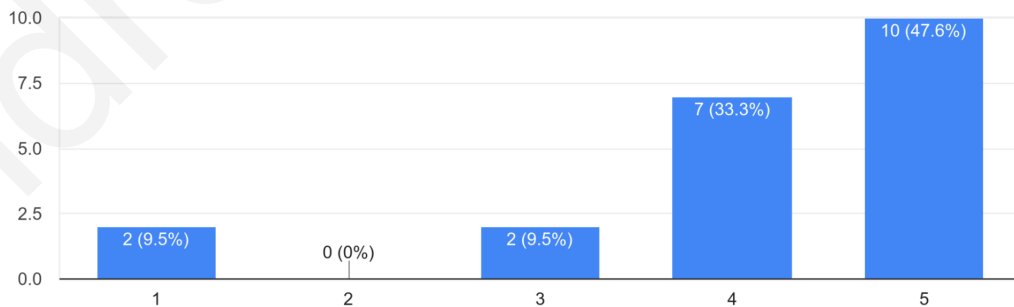


Figure 29: Ease of obtaining a measurement

Ease of understanding the data displayed on the app (Figure 30):

- 1 person responded with a 3
- 3 people responded with a 4
- 16 people found it very easy, responding with a 5

On a scale from 1-5, how easy was to understand the data displayed on the app?
20 responses

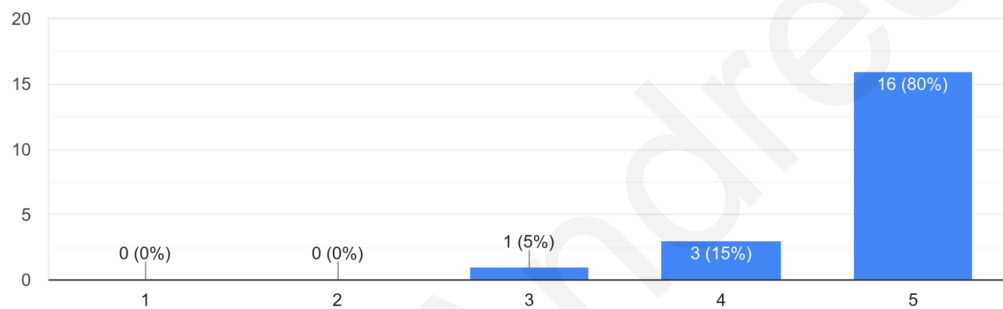


Figure 30: Ease of understanding the data displayed on the app

Ease of accessing the screen for reading historic measurement data per category
(Figure 31):

- 2 people responded with a 3
- 3 people responded with a 4
- 15 people found it very easy, responding with a 5

On a scale from 1-5, how easy was to access the screen for reading historic measurement data per category?

20 responses

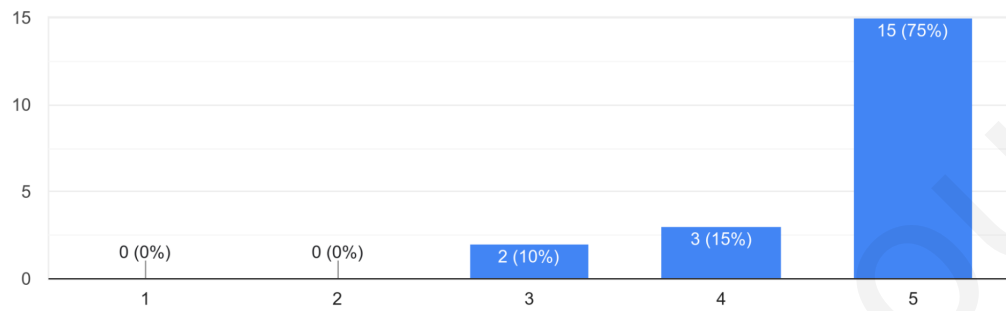


Figure 31: Ease of accessing the screen for reading historic measurement data per category

Ease of reading the data from historic measurements (Figure 32):

- 1 person responded with a 3
- 4 people responded with a 4
- 16 people found it very easy, responding with a 5

On a scale from 1-5, how easy was to read the data from historic measurements?

21 responses

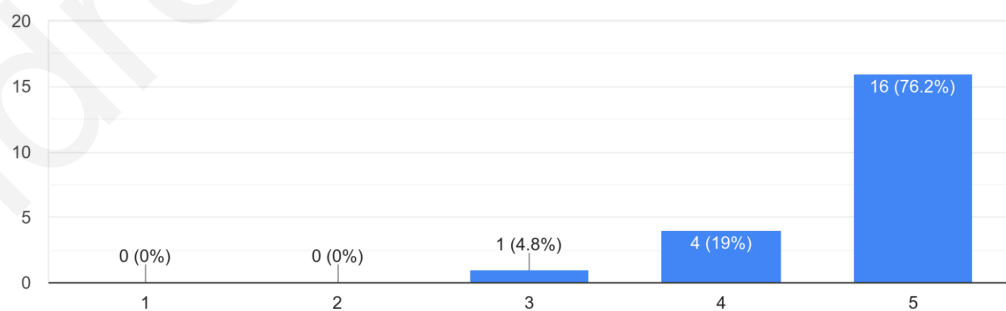


Figure 32: Ease of reading the data from historic measurements

Rating of the user manual for the medical devices (Figure 33):

- 2 people responded with a 3
- 4 people responded with a 4
- 14 people found it very easy, responding with a 5

On a scale from 1-5, how would you grade the user manual for the medical devices?
20 responses

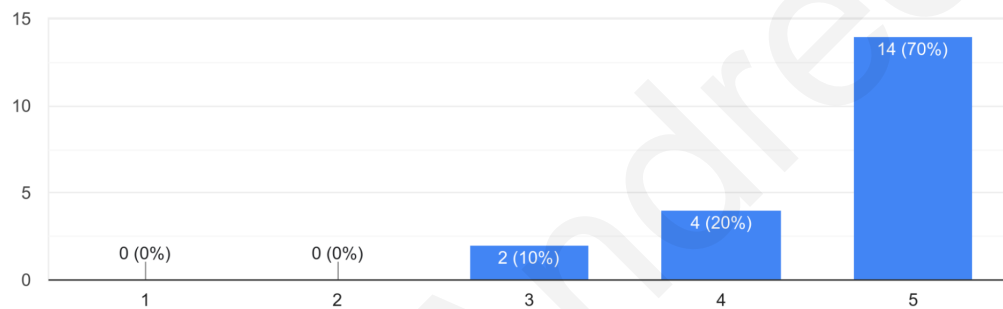


Figure 33: Rating of the user manual for the medical devices

On the question about the clarity of data presentation, 20 persons found the presentation of data helpful and clear, responding with a "Yes". Only 1 person found the data presentation unclear, responding with a "No" (Figure 34).

Did you find the presentation of data helpful and clear?
21 responses

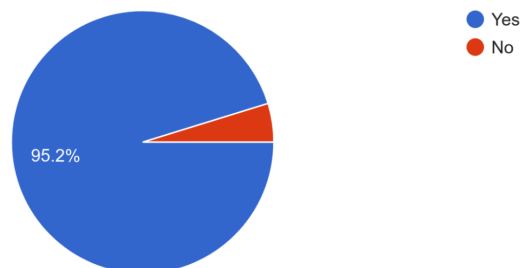


Figure 34: Rating clarity of data presentation

Finally, participants were asked to rate their overall experience with the app and the likelihood of them recommending it to others. Here's how they responded:

Overall app experience (Figure 35):

- 3 people responded with a 2
- 6 people responded with a 3
- 7 people responded with a 4
- 5 people had an excellent experience, responding with a 5

On a scale from 1-5, how would you grade the overall app experience?
21 responses

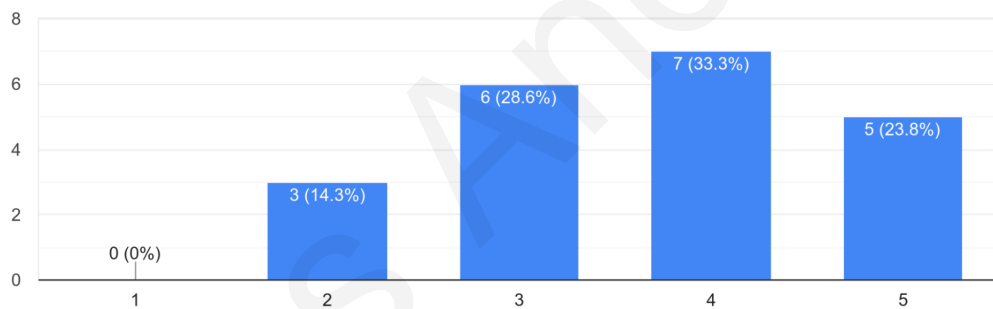


Figure 35: Overall app experience

Likelihood of recommending the app to another person (Figure 36):

- 1 person found it very unlikely, responding with a 1
- 6 people responded with a 2
- 4 people responded with a 3
- 3 people responded with a 4
- 8 people found it very likely, responding with a 5

On scale from 1-5, how possible is for you to recommend the app to another person?

21 responses

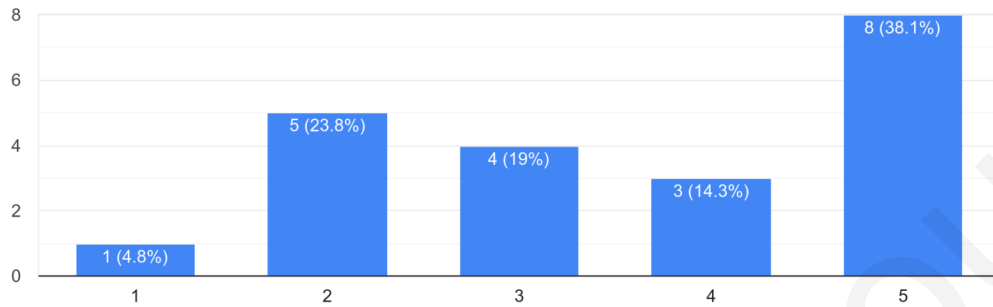


Figure 36: Likelihood of recommending the app

For the open-ended question soliciting any additional comments about the app, some respondents noted that the app would cease to function after a few minutes of usage. Others pointed out that the app's design is not optimized for devices using a dark theme, with white letters appearing on a white background, thus making it unreadable.

It's important to note that the reported issues are inherent to the base app and are not a result of the new features implemented in this project. These issues predated the current work, and the users' feedback will be a valuable resource in driving future updates and improvements to the core app. It is crucial to separate these pre-existing issues from the new implementation when evaluating the success and functionality of the added features.

8 Conclusions

8.1 Summary

This research project successfully extended the functionality of the existing MYeHealthAppCY by incorporating the integration of BLE medical devices, thereby enhancing the user's ability to monitor and manage their health data.

In the initial stages, a thorough examination of the MYeHealthAppCY application and an exploration of BLE technology were conducted. Understanding the underlying protocols, structure, and functionality of BLE technology was critical to the successful implementation of the extended features.

The development process presented a considerable challenge due to the variations in data communication techniques employed by different medical devices. The application needed to be flexible enough to handle these variations. The final implementation was successful, allowing users to connect their medical devices, retrieve measurements, and view these measurements directly within the MYeHealthAppCY.

The management of the retrieved data involved discussions about the format and structure of the data, as well as how it was presented to the user within the application.

The methods used to ensure the functionality of the new feature and its compliance with user expectations were detailed in the testing and validation stage. This involved a validation process with various users through a questionnaire, gathering valuable feedback about their experiences with the new features.

Finally, the user questionnaire results were analyzed, giving valuable insights into user experiences and interaction with the app. These insights will be highly useful for future improvements.

Overall, the project achieved its aim of successfully integrating BLE medical devices into the MYeHealthAppCY, enhancing its functionality for users in monitoring their health metrics. This integration also serves as a stepping stone for further enhancements and additions to the app's functionality.

8.2 Limitations and Challenges

Throughout the course of this project, there were several challenges and limitations faced, many of which stemmed from the inherent variability in BLE medical devices.

One of the primary challenges encountered was the lack of uniformity in the usage of services and characteristic UUIDs across different medical devices. Certain devices adhered to the assigned numbers in the Bluetooth specifications, while others used custom services and characteristics. This irregularity necessitated a flexible approach to accommodate these differences in the application design.

A similar challenge was faced in decrypting the data received from the devices. Given that there is no standard format for transmitted data, the interpretation of the binary data required a significant amount of trial and error, demanding a considerable amount of time and effort.

Some of the medical devices employed proprietary and unknown commands that needed to be sent back to the device before data could be received. This added another layer of complexity to the data acquisition process. Some of these commands were discovered with the assistance of open-source projects, however, for other devices, the data reading process remains unknown.

Feedback from the user questionnaire highlighted a couple of limitations unrelated to the newly implemented functionality but are worth noting. These included app crashes during prolonged use and visual issues when using a dark theme. These issues hint at potential improvements needed in the core application to improve the overall user experience.

Lastly, while the project was successful in integrating a number of medical devices, it is important to note that there are countless other devices available in the market. This project's scope only allowed for a selection of these devices to be integrated, leaving room for further expansion in the future.

8.3 Future Work

This research has laid the foundation for future exploration and advancements in the field of eHealth and MYeHealthAppCY. There are several potential directions for future work that could amplify the impact of this project.

The project was successful in integrating a select number of BLE medical devices with the MYeHealthAppCY. However, the medical devices market is diverse and expansive, thus further integrations would certainly enhance the scope and utility of the app, catering to a broader spectrum of patients and healthcare professionals.

While user feedback indicated some issues with the core app such as sporadic crashes and display issues in dark mode, these were not directly related to the implemented extension. Nevertheless, addressing these concerns could significantly improve the overall user experience, thus presenting an area for future work.

In terms of data interpretation, the project faced challenges in decrypting the binary data sent by the medical devices. Future work could be centered around developing more efficient and reliable methodologies for interpreting this data, reducing the dependency on time-consuming trial and error processes.

The focus of this project was primarily on data collection and display. However, future extensions could explore more sophisticated analysis of the health data collected. This might encompass the deployment of machine learning algorithms for predicting health risks, or interactive visualizations that provide users with a more comprehensive understanding of their health trends.

The project was generally well received by users, yet there are opportunities for enhancing the user interface. This might involve designing a more intuitive layout, or incorporating more comprehensive help and tutorial features. Making the app more user-friendly and accessible to a wider audience, including those less familiar with technology, could be another avenue for future work.

Lastly, as the app handles sensitive medical data, an important focus area for future work could be the enhancement of security measures and assurance of privacy. This could involve the implementation of advanced encryption methods, or the establishment of robust protocols for data access and sharing.

In addressing these potential areas of future work, it is anticipated that the MYe-HealthAppCY will continue to evolve, becoming an invaluable tool for both patients and healthcare providers.

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Andreas Andreou

A Questionnaire

Andreas Andreou

MYeHealthAppCY - Medical Devices assessment

Demographic Questions

What is your gender?

- Male
- Female
- Other

What is your age?

- 18-25
- 26-35
- 36-45
- 46-55
- 56-64
- 65+

On a scale from 1-5, how familiar are you with using any application on an android phone?

1 2 3 4 5

I have never use an android
app

I use android apps every day

Back

Next

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MYeHealthAppCY - Medical Devices assessment

Questions regarding Medical Devices

On a scale from 1-5, how easy was to access the medical devices section of the app?

	1	2	3	4	5	
Very hard	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very easy

On a scale from 1-5, how easy was to access the screen for adding a medical device?

	1	2	3	4	5	
Very hard	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very easy

On a scale from 1-5, how easy was to add a medical device?

	1	2	3	4	5	
Very hard	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very easy

On a scale from 1-5, how easy was to access the screen for viewing a medical device?

	1	2	3	4	5	
Very hard	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very easy



On a scale from 1-5, how easy was to get a measurement?

	1	2	3	4	5	
Very hard	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very easy

On a scale from 1-5, how easy was to understand the data displayed on the app?

	1	2	3	4	5	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

On a scale from 1-5, how easy was to access the screen for reading historic measurement data per category?

	1	2	3	4	5	
Very hard	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very easy

On a scale from 1-5, how easy was to read the data from historic measurements?

	1	2	3	4	5	
Very hard	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very easy

On a scale from 1-5, how would you grade the user manual for the medical devices?

	1	2	3	4	5	
Very bad	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very good



Did you find the presentation of data helpful and clear?

Yes

No

Back

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MYeHealthAppCY - Medical Devices assessment

General Questions about the app

On a scale from 1-5, how would you grade the overall app experience?

	1	2	3	4	5	
Very bad	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very good

On scale from 1-5, how possible is for you to recommend the app to another person?

	1	2	3	4	5	
Very unlikely	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very likely

Add any comments you want about the app

Your answer

Back

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Google Forms



B User Manual

Andreas Andreou

2023



USER'S GUIDE MYEHEALTHAPPCY FOR MOBILE DEVICES

For Citizens

CONTENTS

Contents.....	2
Index of Pictures	5
General.....	7
About the MYeHealthAppCY application	7
System requirement	9
Navigation.....	9
Glossary	10
Privacy and security.....	11
Legal information.....	14
User's Guide	15
Where to download.....	15
Feature 1: View prescriptions.....	16
Feature 2: View dispensings	16
Feature 3: View referrals	16
Feature 4: View patient summary	16
Feature 5: Store and view COVID certificates	16
Feature 6: Make a teleconsultation	16
Section A: User login	18
User login.....	18
Forgot password	19
Section B: User registration	20
Section C: My Health Screen.....	22
Prescriptions.....	23
Available prescriptions	23
Previous prescriptions.....	23
Dispensing.....	24
Available dispensings	24
Previous dispensings	25
Referrals.....	25
Available referrals	25

Previous referrals	25
Patient Summary	26
Patient administrative data	27
Patient clinical data	32
Covid Certificates	42
Scan QR code	43
Medical Devices	44
Adding a medical device	45
Supported Devices	46
Taking a measurement	48
Device Specific Instructions	49
Viewing history	51
Section D: Services Screen	52
Pharmacist Registry	53
Doctor Registry	54
Appointments	55
Medications / Reminders	56
Teleconsultation	57
Go to meeting	58
Teleconsultation features	59
Section E: Settings Screen	60
My Profile	61
Language	62
Terms and conditions	63
Privacy policy	64
About the app	65
Logout	66
Troubleshooting	68
Login or authentication issues	68
App crashes or freezes	68
App not responding	68

Performance issues.....	68
Error messages	68
Contact information.....	69
Instructions not included/not applicable	70

Andreas Andreou

INDEX OF PICTURES

Picture 1: Illustration showing the application integrated features.	8
Picture 2: (a) Icon of the MYeHealthAppCY application, (b) Upon activation of the application enter user credentials, (c) Initial home screen of the MYeHealthAppCY application after inserting correct login credentials.	17
Picture 3: (a) Initial login screen of the MYeHealthAppCY application, (b) Error showing that the username and password are required for login, (c) Alert indicating that an invalid username and password combination was used.....	18
Picture 4: (a) Selection for “Forgot your password?”, (b) Reset your password screen with field for email.....	19
Picture 5: (a) User registration screen, (b) User registration screen with required fields, (c) Post registration screen with confirmation code sent to email.	21
Picture 6: “My Health” screen of the MYeHealthAppCY application.	22
Picture 7: (a) Screen with “Available” prescription shown as list, (b) Screen with “Previous” prescription shown as list, (c) Details of the prescription.....	23
Picture 8: (a) Screen with “Available” dispensings shown as list, (b) Screen with “Previous” dispensings shown as list, (c) Details of the dispensing.	24
Picture 9: (a) Screen with “Available” referrals shown as list, (b) Screen with “Previous” referrals shown as list, (c) Details of the referral.	25
Picture 10: (a) Administrative Data section of the Patient Summary, (b) Patient Clinical Data section of the Patient Summary.....	26
Picture 11: Patient’s identification details in the “Administrative Data” category of “Patient Summary”	28
Picture 12: Patient’s personal information details in the “Administrative Data” category of “Patient Summary”	29
Picture 13: Patient’s contact information details in the “Administrative Data” category of “Patient Summary”	30
Picture 14: Patient’s insurance details in the “Administrative Data” category of “Patient Summary”	31
Picture 15: Patient’s alerts details in the “Clinical Data” category of “Patient Summary”	33
Picture 16: Patient’s medical history details in the “Clinical Data” category of “Patient Summary”	34
Picture 17: Patient’s medical problems details in the “Clinical Data” category of “Patient Summary”	35

Picture 18: Patient’s medication summary details in the “Clinical Data” category of “Patient Summary”	36
Picture 19: Patient’s social history details in the “Clinical Data” category of “Patient Summary”	37
Picture 20: Patient’s pregnancy history details in the “Clinical Data” category of “Patient Summary”	38
Picture 21: Patient’s provided data details in the “Clinical Data” category of “Patient Summary”	39
Picture 22: Patient’s results details in the “Clinical Data” category of “Patient Summary”	40
Picture 23: Patient’s plan of care details in the “Clinical Data” category of “Patient Summary”	41
Picture 24: Covid Certificates screen of the MYeHealthAppCY application.	42
Picture 25: (a) Scanning the QR code of the Covid certificate, (b) Insert TAN code when requested, (c) Error message in case the TAN code is incorrect.	43
Picture 26: Medical Devices screen of the MYeHealthAppCY application.	44
Picture 27: (a) Scanning for Bluetooth devices, (b) View or add a device, (c) Message in case no devices were found.....	45
Picture 28: Adding Beurer FT95	46
Picture 29: Adding Microlife BP A7 Touch BT	47
Picture 30: (a) View Medical Device, (b) Device not found banner, (c) Remove device dialog.....	48
Picture 31: Beurer FT95 measurement.....	49
Picture 32: Microlife BP A7 Touch BT measurement.....	50
Picture 33: Temperature measurements history	51
Picture 34: Services screen of the MYeHealthAppCY application.	52
Picture 35: Pharmacist registry screen of the MYeHealthAppCY application.	53
Picture 36: Doctor registry screen of the MYeHealthAppCY application.	54
Picture 37: Appointments screen of the MYeHealthAppCY application.	55
Picture 38: Medication / Reminders screen of the MYeHealthAppCY application.	56
Picture 39: Teleconsultation screen of the MYeHealthAppCY application.	57
Picture 40: (a) Teleconsultation password requirement before the teleconsultation starts, (b) View from within the teleconsultation, (c) Duration of the last meeting shown in the centre of the screen.....	58

Picture 41: Settings screen of the MYeHealthAppCY application.	60
Picture 42: My profile screen of the MYeHealthAppCY application.....	61
Picture 43: Language screen of the MYeHealthAppCY application.	62
Picture 44: Terms and conditions screen of the MYeHealthAppCY application.	63
Picture 45: Privacy policy screen of the MYeHealthAppCY application.	64
Picture 46: About the app screen of the MYeHealthAppCY application.	65
Picture 47: (a) Logout functionality under the settings screen, (b) After logging out from the application, users will be redirected to the login screen.	66
Picture 48: Illustration of work in progress of the MYeHealthAppCY application.	70

GENERAL

ABOUT THE MYEHEALTHAPPCY APPLICATION

The MYeHealthAppCY is an electronic health solution designed to improve access to quality healthcare for patients and providers in Cyprus. The app includes features such as **integrated prescription management, patient summary views**, and the ability to **connect with healthcare providers through video conferencing/teleconsultation**, enabling consultations from the comfort of their own homes. It also includes the ability to **save and access European Digital COVID certificates**, enabling users to easily access and share their health information as needed. Developed under the thesis project of Ionut – Cristian Canciu and master's project of Louiza Agroti of the University of Cyprus, the MYeHealthAppCY is available for download on the App Store for iOS devices and Google Play for Android devices. This user manual provides instructions on how to install, set up, navigate, and use the MYeHealthAppCY application, as well as troubleshooting advice for common issues and problems.

Please note that the MYeHealthAppCY application is still under development and some features may not be enabled yet. In the future, the application will use a templating method to provide specific user groups with access to specific views based on their needs/privileges and consents. For example, patients may have access to different screens than healthcare providers, and each group may have access to different information and functionality. We appreciate your understanding and patience as we continue to develop and improve the app. Thank you for your support and we look forward to your feedback as we work to bring the best possible experience to our users. [Check last page of this manual]

We hope that the MYeHealthAppCY application will be a useful and convenient tool for both patients and healthcare providers in Cyprus. The app is available in both **Greek** and **English**.



Picture 1: Illustration showing the application integrated features.

SYSTEM REQUIREMENT

The System Requirements section lists the minimum hardware and software requirements that must be met to use the app. It is important to ensure that users' device meets these requirements to ensure optimal performance and usability. Please review the system requirements carefully to ensure that the device is compatible with the app.

To ensure optimal performance and functionality, it is necessary that the device on which the app is installed meets the minimum system requirements of **iOS 13 or newer** or **Android 10.0 (API 29) or newer**. In addition, the app requires access to the device's **camera**, **microphone**, and **internet connection** to function properly.¹

Please make sure that the device meets these requirements and has the necessary permissions before installing and using the app.

NAVIGATION

The Navigation section provides an overview of how to move around within the app and access its various features and functions. Whether users are new to the app or simply need a refresher, this section will help users navigate through the app with ease. Please carefully review the navigation instructions provided below to ensure that users can fully utilize the app's capabilities.

- The app features a tab navigation bar located at the bottom of the screen, which allows users to easily access the different sections of the app.
- To navigate to a different section, simply tap on the corresponding tab.
- Within each section, users can use the app's various features and functions by pressing on the corresponding buttons or links.
- Some sections may also include a back button or breadcrumb trail that allows users to return to a previous screen or section. Users can also return to the previous section or screen by clicking the back button.

A description of the main features/functions and how to navigate is available in each section of the app, including any specific actions that users can take.

¹ It is important to note that the camera and microphone are used only for specific functions within the app, namely teleconsultation and scanning COVID certificates. These features are essential to the app's core functionality and are not used for any other purposes. Rest assured that the app does not include any spyware or malware, and we take the privacy and security of the users very seriously.

GLOSSARY

Account: This refers to the user's personal profile and account within the MYeHealthAppCY app.

Alien Resident Card (ARC): The Alien Resident Card (ARC) is a document issued by the Cyprus Department of Immigration to non-EU citizens who are legally residing in Cyprus.

Appointments: This refers to the process of scheduling and attending appointments with healthcare providers through the app.

Clinical Data: This refers to medical information about a patient, including their medical history, diagnoses, treatments, and other relevant details.

COVID Certificate: This refers to the digital certificate issued by the government or other authorized body to certify that an individual has been vaccinated, recovered, or tested negative for COVID-19.

Dashboard/Home Screen: This refers to the main screen or home page of the app, which displays a selection of actions the user can make.

Dispensing: This refers to the process of a pharmacy providing a patient with the medication that has been prescribed by their healthcare provider.

Electronic Health Record (EHR): This is a digital record of a patient's health information that is stored and shared electronically, allowing healthcare providers to access and update the information as needed.

General Health System (GHS): This refers to the General Health System of Cyprus and the term is used under the identifications section.

Health Information Exchange (HIE): This refers to the electronic exchange of healthcare information between different healthcare organizations, allowing for more efficient communication and data sharing.

Health Record: This refers to the collection of medical information about an individual, including their medical history, diagnoses, treatments, and test results.

Medication: This refers to the drugs or other substances that are prescribed by a healthcare provider to treat or prevent a medical condition.

Medication Adherence: This refers to a patient's ability to follow their prescribed treatment plan, including taking their medications as directed and following any other recommendations from their healthcare provider.

Patient Summary: This refers to a summary of a patient's medical information, including their current medications, allergies, diagnoses, and other relevant data.

Personal Health Record (PHR): This is a digital record of a patient's health information that is maintained and controlled by the patient themselves, rather than a healthcare provider.

Prescription: This refers to a written order from a healthcare provider for a specific medication or treatment.

Referrals: This refers to the process of a healthcare provider recommending that a patient see a specialist or receive treatment from another healthcare provider. This may be necessary if the patient's condition requires a higher level of care or specialized treatment that the primary healthcare provider is not equipped to provide.

Teleconsultation: This refers to the process of consulting with a healthcare provider remotely through video conferencing or other electronic means.

Transaction Authentication Number (TAN): This is a security code that is used to authenticate and authorize a transaction. It is typically sent to the user via email or SMS and must be entered to complete the transaction. In the context of the MYeHealthAppCY app, a TAN may be required for certain actions, such as verifying a COVID certificate.

User Interface (UI): This refers to the way that the app is designed and laid out, including the layout, colours, and fonts used.

PRIVACY AND SECURITY

To ensure the security and privacy of the users' data, the MYeHealthAppCY app employs several measures to protect user data. These measures include:

- **Encryption:** All data transmitted to and from the app is encrypted using secure protocols to prevent unauthorized access.
- **Secure servers:** The app uses secure servers to store user data, which are protected by firewalls and other security measures.
- **Other security measures:** In addition to encryption and secure servers, the app employs other security measures to protect user data, such as regular security updates and assessments to identify and address any vulnerabilities.

In addition to the measures described above, the MYeHealthAppCY app also includes a feature that **wipes all data saved on the device or in the memory cache when the user logs out**. This means that no data is maintained between sessions, and all data is

deleted when the user logs out. This feature is designed to protect the privacy of users by ensuring that **no data is left behind on the device after the user logs out.**

Please note that this feature does not apply to data stored on the app's servers, authentication and consent service and the cloud database.

If users have more questions about how their data is stored, encrypted, and protected on the cloud, they shall contact the support team for more information.

By employing these and other security measures, the MYeHealthAppCY app aims to ensure the security and privacy of user data and provide users with a secure and reliable experience.

As a user of the MYeHealthAppCY app, user have certain rights regarding their personal data. These rights include:

- **The right to access:** Users have the right to request a copy of the personal data that the app holds about them, as well as information about how that data is used and shared.
- **The right to correct:** If users believe that any of the personal data that the app holds about them is incorrect, users have the right to request that it be corrected.
- **The right to delete:** In certain circumstances, users have the right to request that the app delete any personal data it holds about them.

To exercise any of these rights, please contact the support team. They will be happy to assist users in understanding and exercising their rights regarding their personal data.

The MYeHealthAppCY app takes the privacy and security of user data very seriously and has policies in place to ensure that user data is only shared with third parties in accordance with relevant laws and regulations.

In general, the app will only share user data with third parties in the following circumstances:

- **For research purposes:** The app may share anonymized user data with research institutions or other organizations for the purpose of conducting research or analysis. **This data will be stripped of any identifying information and used solely for research purposes.**
- **For server performance and user activity at peaks:** The app may share anonymized user data with service providers or other third parties for the purpose of monitoring and improving server performance or analysing user activity at peak times. **This data will be stripped of any identifying information and used solely for these purposes.**

In all cases, the app will only share user data with third parties in accordance with relevant laws and regulations and will take steps to ensure that the data is handled securely and in accordance with the app's privacy policies.

If users have any questions about the app's policies on sharing user data with third parties, they shall contact the support team for more information.

The MYeHealthAppCY app includes a feature that **automatically captures and reports crash data** if the app crashes or experiences an error. This crash data includes information about the **device, operating system, and app state at the time of the crash**, as well as **a log of the events leading up to the crash**.

Crash reports are used to help the app developers identify and fix issues that may be causing the app to crash. They are also used to improve the overall stability and performance of the app.

Crash data is collected and processed in accordance with the app's privacy policies and relevant laws and regulations.

User data is retained by the MYeHealthAppCY app for **as long as the user's account is active**. If a user decides to delete their account, their data will be deleted as well. In cases where a user has not accessed their account **for an extended period**, their login may be blocked as a measure to protect their data. If a user wishes to regain access to their account, they can request activation of their login by following the instructions provided in the app. Once their login has been activated, they will be required to create a new password to access their account. This helps to ensure that user data is protected and that users have control over their data.

The MYeHealthAppCY app **is not intended for children under the age of 13**, and we do not knowingly collect or process personal data from children under the age of 13. If we become aware that we have collected personal data from a child under the age of 13, we will take steps to delete that data in accordance with applicable laws and regulations.

If user is a parent or guardian and they believe that their child under the age of 13 has provided personal data to us through the app, they shall contact the support team so that the needed steps are taken to delete the data and deactivate the child's account.

We encourage parents and guardians to monitor their children's online activity and to educate them about safe and responsible online behaviour.

If users have any questions or concerns about children's privacy in connection with the MYeHealthAppCY app, please contact the support team for more information.

LEGAL INFORMATION

The MYeHealthAppCY app is provided "as is" and the developers make no representations or warranties of any kind, express or implied, as to the operation of the app or the information, content, materials, or products included on the app. The developers are not responsible for any errors or omissions in the app or for any damages of any kind that may result from the use of the app, including but not limited to direct, indirect, incidental, punitive, and consequential damages. The user assumes full responsibility for using the app and any reliance on the information and materials contained within it. The developers reserve the right to change or modify the app or its content at any time without notice. *[Check last page of this manual]*

Additionally, the app handles user health related data and personal information according to the laws and regulations of Cyprus. Please refer to the Cyprus electronic health system (eHealth) framework and the General Data Protection Regulation (GDPR) for more information on the protection and use of personal data in the healthcare sector. The app developers are committed to ensuring the privacy and security of user data and will take appropriate measures to protect user data in accordance with these laws and regulations.

The MYeHealthAppCY app and its content are protected by copyright and may not be reproduced or distributed without permission. Unauthorized reproduction or distribution of the app or its content is strictly prohibited and may result in legal action.

The MYeHealthAppCY application is governed by the laws of the Republic of Cyprus. Any disputes arising in relation to the use of the app, or its content will be resolved in accordance with the laws of the **Republic of Cyprus**.

USER'S GUIDE

The User's Guide section of the app offers instructions and information about the various features and functions available within the app. This includes details about specific actions that users can take, such as logging in to their account, accessing and managing their personal health record, making teleconsultations with healthcare providers, and more. Each section of the guide provides step-by-step instructions and explanations to help users navigate and utilize the app's capabilities effectively.

WHERE TO DOWNLOAD

Users with **mobile** devices can download and install the **MYeHealthAppCY** application from Google Play for Android devices and from App Store for iOS devices.

DISCLAIMER: At the current stage of development the access can be only granted using a firebase account upon beta testing request. The default username and password are patient/patient. Some features like "Reset your password" or "Registration" are disabled.

(Android: <https://appdistribution.firebase.dev/i/23ca9dd7936d6525>).²

(iOS: <https://appdistribution.firebase.dev/i/xxxxxxxxxx>).³

The MYeHealthAppCY app is a comprehensive **Electronic Health Record (EHR)** solution designed to improve access to quality healthcare for patients and providers in Cyprus. Currently, the app provides users with the ability to access and manage their personal health record, connect with healthcare providers through teleconsultation or video conferencing, and scan and save COVID certificates for easy access and verification. In the future, the app will also include features such as the ability to schedule appointments, view and track medication usage, access educational resources and information about various health topics and conditions; and use a symptom checker and self-assessment tool to help identify potential health concerns and determine whether medical attention is needed.

² Android invitation link to install the app from Google Firebase. User will need to download and install **App Tester** on their Android device and allow installation from unknown sources. On most Android devices the App Tester is installed by default when trying to install a Firebase distribution application.

³ iOS invitation link to install the app from Google Firebase. Users will need to download and install **Test Flight** on their iOS device. On most iOS devices the **Test Flight** is installed by default when trying to install a Firebase distribution application.

Following successful installation of the MYeHealthAppCY application on their smart device, users can view/use one of the following features:

FEATURE 1: VIEW PRESCRIPTIONS

1	2	3
View personal prescriptions.	View current or previous prescriptions.	View medications and details about the medications.

FEATURE 2: VIEW DISPENSINGS

1	2	3
View personal dispensing.	View current or previous dispensing.	View medications and details about the medications.

FEATURE 3: VIEW REFERRALS

1	2	3
View personal referrals.	View current or previous referrals.	View details about the examination plan/results.

FEATURE 4: VIEW PATIENT SUMMARY

1	2	3	4
View personal patient summary.	View administrative data.	View patient specific clinical data.	Track medical history and events.

FEATURE 5: STORE AND VIEW COVID CERTIFICATES

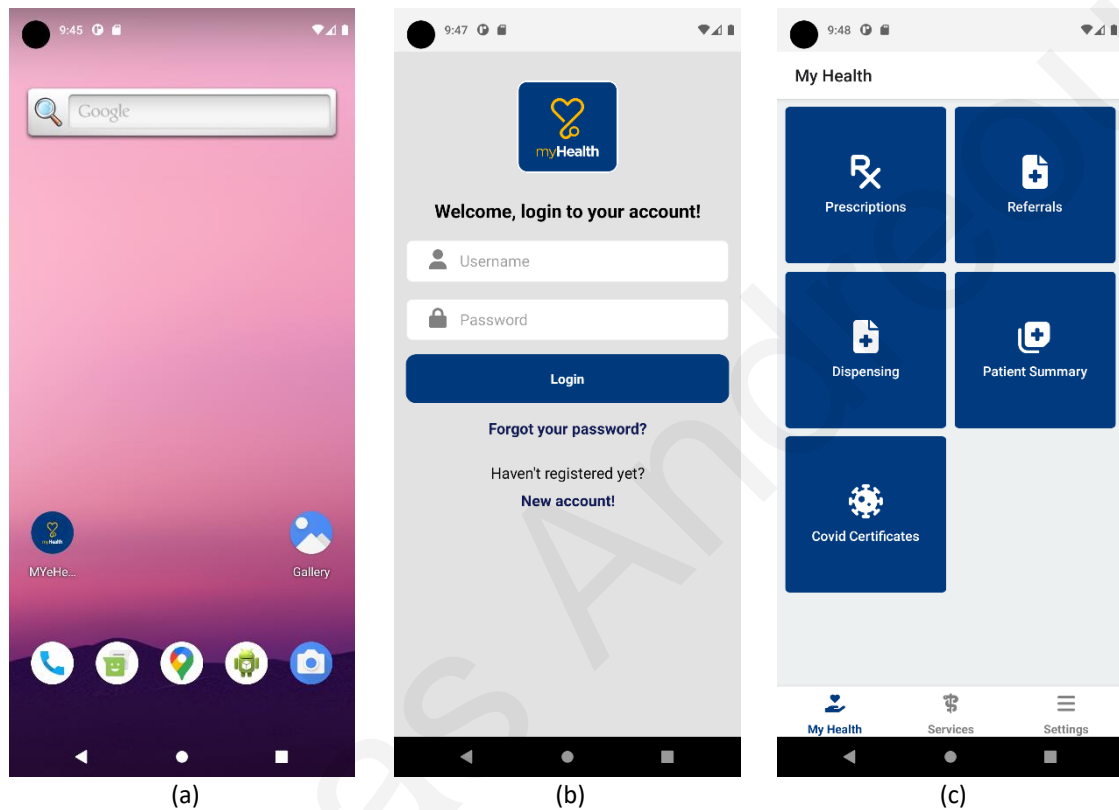
1	2	3	4
Scan the QR code with the MYeHealthAppCY application.	Insert the TAN code found under the QR code.	Check if the certificate details are correct.	Save the certificate for future use.

FEATURE 6: MAKE A TELECONSULTATION

1	2	3	4
Upon request, join the teleconsultation	A provider will be ready to pick up the call.	Once connected, insert the passcode received.	The consultation is ready from the comfort of the user's home.

Make sure that entry to the smart device is protected by some security setting (personal code, fingerprint, or other method of users' choice) and which is necessary to enter the MYeHealthAppCY application.

Important security information: If users' device is not protected by any security setting, they will not be able to use the MYeHealthAppCY.



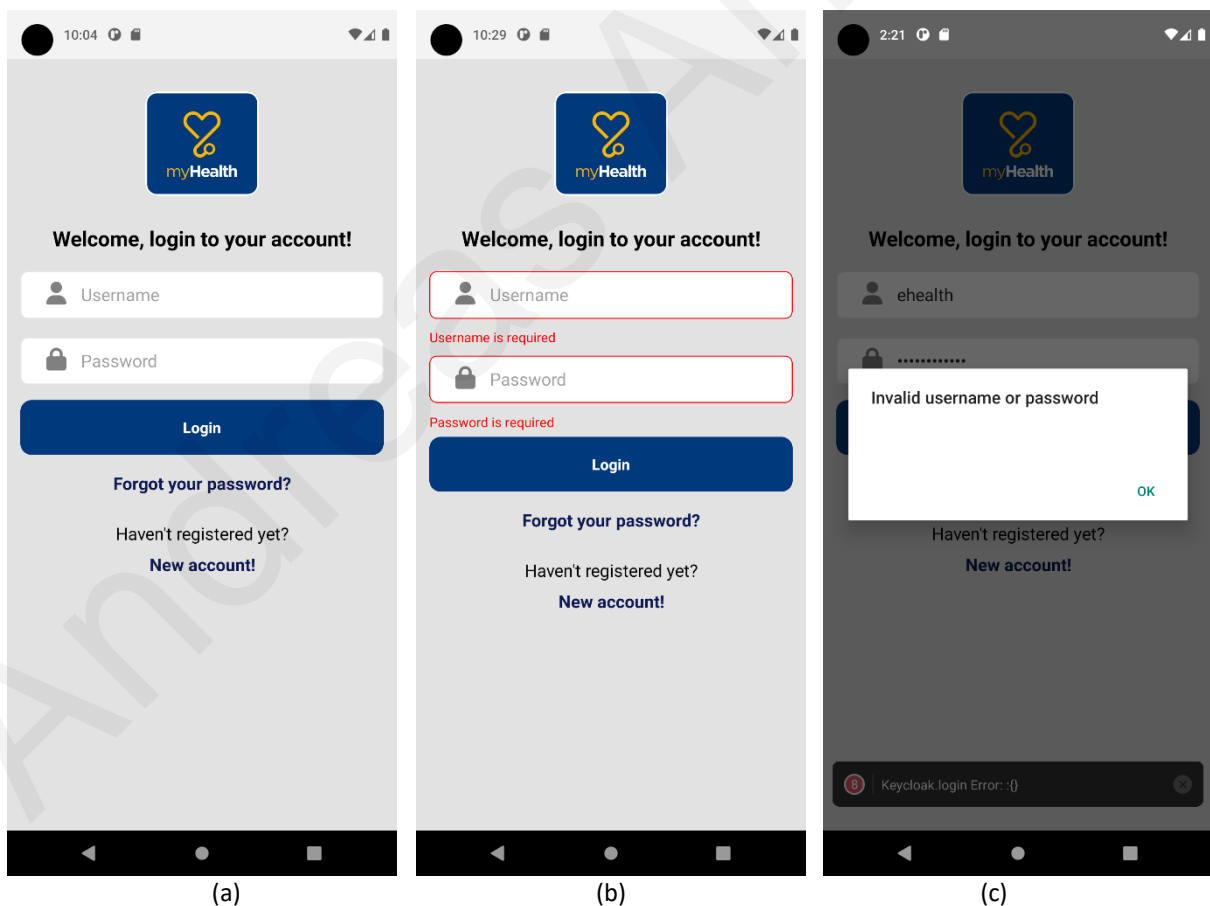
Picture 2: (a) Icon of the MYeHealthAppCY application, (b) Upon activation of the application enter user credentials, (c) Initial home screen of the MYeHealthAppCY application after inserting correct login credentials.

SECTION A: USER LOGIN

The “**User Login**” section of the MYeHealthAppCY app is designed to help users access their personal health record and other important features and functions within the app. Users can log in to the app using their unique username and password, and if they forget their password, they can follow the instructions on how to reset it. It is essential for users to log in *into* the app to access their personal health record and other features.

USER LOGIN

To log in to the MYeHealthAppCY app, users will need to enter their **username** and **password** and press “**Login**”. If the username or password is not provided, users will see a red error message saying “Username/Password is required.” If the credentials provided are incorrect, users will see a pop-up alert saying, “Invalid username or password.” To try again, simply press “**OK**” and re-enter the login credentials. If the credentials provided are correct, users will be redirected to the home screen of the application, as shown in Picture 2 (c).”



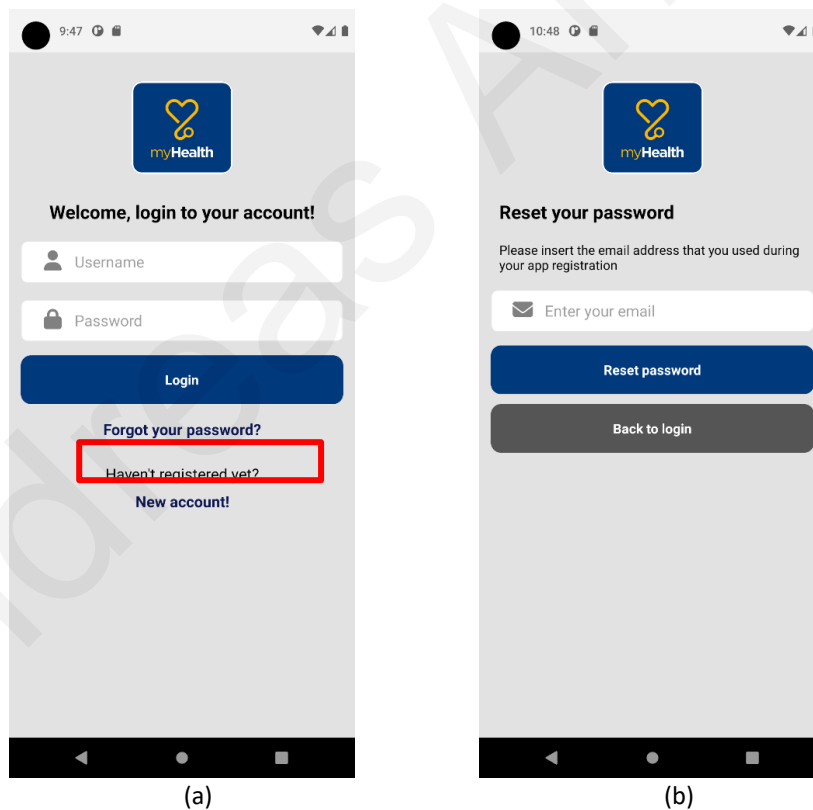
Picture 3: (a) Initial login screen of the MYeHealthAppCY application, (b) Error showing that the username and password are required for login, (c) Alert indicating that an invalid username and password combination was used.

FORGOT PASSWORD

To reset their password in the MYeHealthAppCY app, users will need to follow this step:

- Click on the **"Forgot your password?"** link in the login screen of the app.
- Enter the email address in the designated field and press **"Reset password."**
- Check the email for a message from MYeHealthAppCY with a **password reset code**.
- If the password reset code is not received, check the spam or junk email folder.
- Follow the **instructions in the email** to enter the password reset code and create a new password.
- Once the new password is entered, press **"Continue"** to complete the password reset process.

By following these steps, users will be able to reset their password and regain access to their account. **It is important for users to keep their password secure and to choose a strong and unique password to protect their personal information.**



Picture 4: (a) Selection for "Forgot your password?", (b) Reset your password screen with field for email

If users have any trouble resetting their password, they shall check the troubleshooting section or contact the support team for assistance.

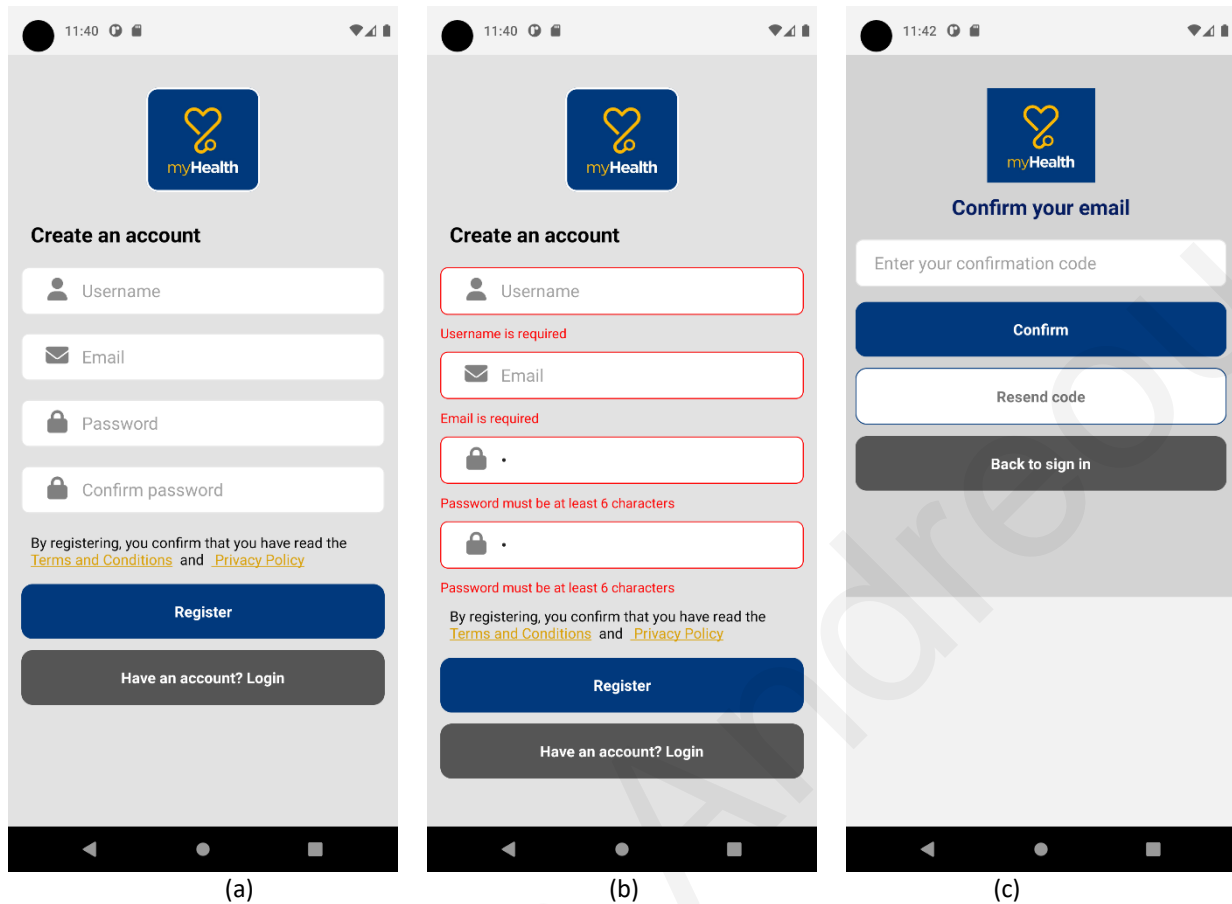
SECTION B: USER REGISTRATION

The registration section of the MYeHealthAppCY app is designed to help users create a new account and access their personal health record and other features and functions of the app. In this section, users will find instructions on **how to create a new account** and provide the **necessary information to set up their profile**. It is important for users to complete the registration process to access their personal health record and other features and functions of the app. *Please carefully follow the instructions provided in this section to create your account and begin using the app.*

To register for a new account in the MYeHealthAppCY app, follow these steps:

- Press the **“New Account!”** link at the bottom of the login screen.
- In the registration screen enter the desired **username** in the designated field.
- Enter the **email address** in the designated field and **create a password** in the designated field.
- **Re-enter the password** in the designated **"Confirm Password"** field to confirm that it is correct.
- Press the **"Register"** button to submit the registration information.
- **Check the email** for a message from MYeHealthAppCY with a confirmation code.
- Follow the instructions in the email to enter the **confirmation code** and complete the registration process.

By following these steps, users will be able to create a new account and access the features and functions of the MYeHealthAppCY app. **It is important for users to choose a strong and unique password to protect their personal information and to keep their email address up to date to receive important notifications and updates from the app.**

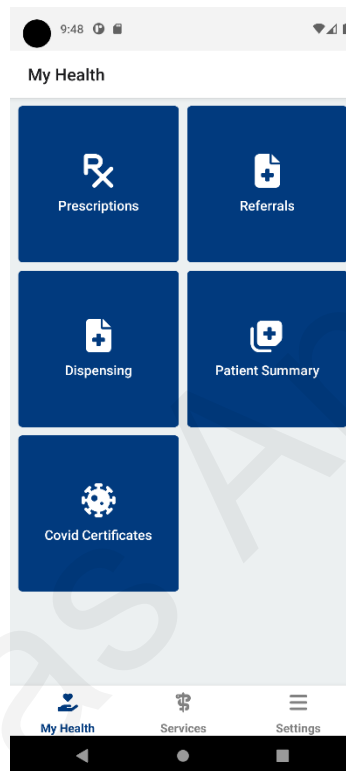


Picture 5: (a) User registration screen, (b) User registration screen with required fields, (c) Post registration screen with confirmation code sent to email.

If users have any trouble with the registration process, they shall check the troubleshooting section or contact the support team for assistance.

SECTION C: MY HEALTH SCREEN

The "**My Health**" screen is the main hub for accessing and managing users' personal health information within the MYeHealthAppCY app. From this screen, patients can view and manage their prescriptions and dispensings, view their referrals, access their patient summary, and view and scan their COVID certificates. The app's intuitive design and user-friendly interface make it easy for patients to quickly access and manage their health information, helping them to stay organized and on top of their health needs.



Picture 6: "My Health" screen of the MYeHealthAppCY application.

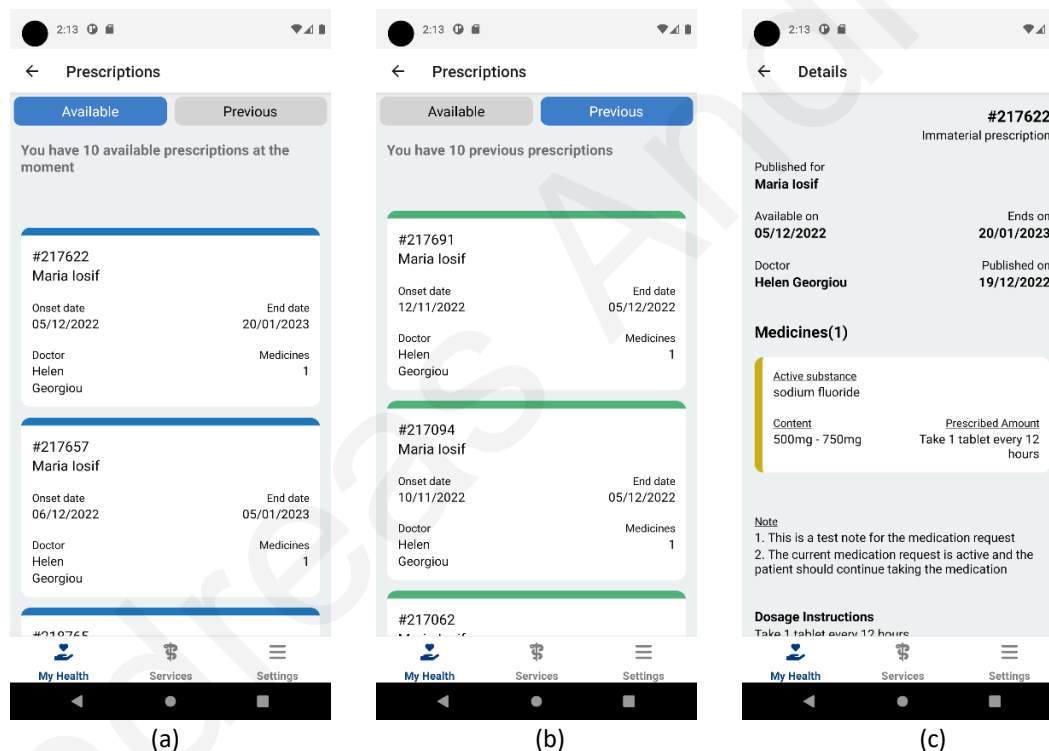
The "**My Health**" screen in the MYeHealthAppCY app provides users with access to several important features and functions:

- **Prescriptions:** Users can view their current and past prescriptions, as well as request refills or renewals as needed.
- **Dispensings:** Users can view their dispensed medications, including details about the prescribed dosage and frequency.
- **Referrals:** Users can view and manage their referrals to specialists or other healthcare providers.
- **Patient Summary:** Users can view a summary of their administrative data and medical history, current health status, including any diagnoses, allergies, or other important health information.
- **COVID Certificates:** Users can scan and save COVID certificates for easy access and verification.

PRESCRIPTIONS

The screen includes a list of the patient's available prescriptions. The user has the possibility to select one of the preceding prescriptions. From the list, the user can see **the number of the prescription, the patient's name, the patient's name for whom the prescription has been written, the start and end dates of the prescription, the doctor who wrote the prescription and the number of drugs listed in the prescription.**

By clicking on a prescription and scrolling down, the user can see more details about the prescription chosen. In particular, the same information that was on the previous screen is displayed, together with **information about the medication, doctor's notes, dosage instructions, instructions for the patient, the time when the medication will be taken, the dose and analogy and the time when it will be taken.**



Picture 7: (a) Screen with "Available" prescription shown as list, (b) Screen with "Previous" prescription shown as list, (c) Details of the prescription.

AVAILABLE PRESCRIPTIONS

The "Available Prescriptions" category displays any prescriptions that are currently available for the user to refill or renew.

PREVIOUS PRESCRIPTIONS

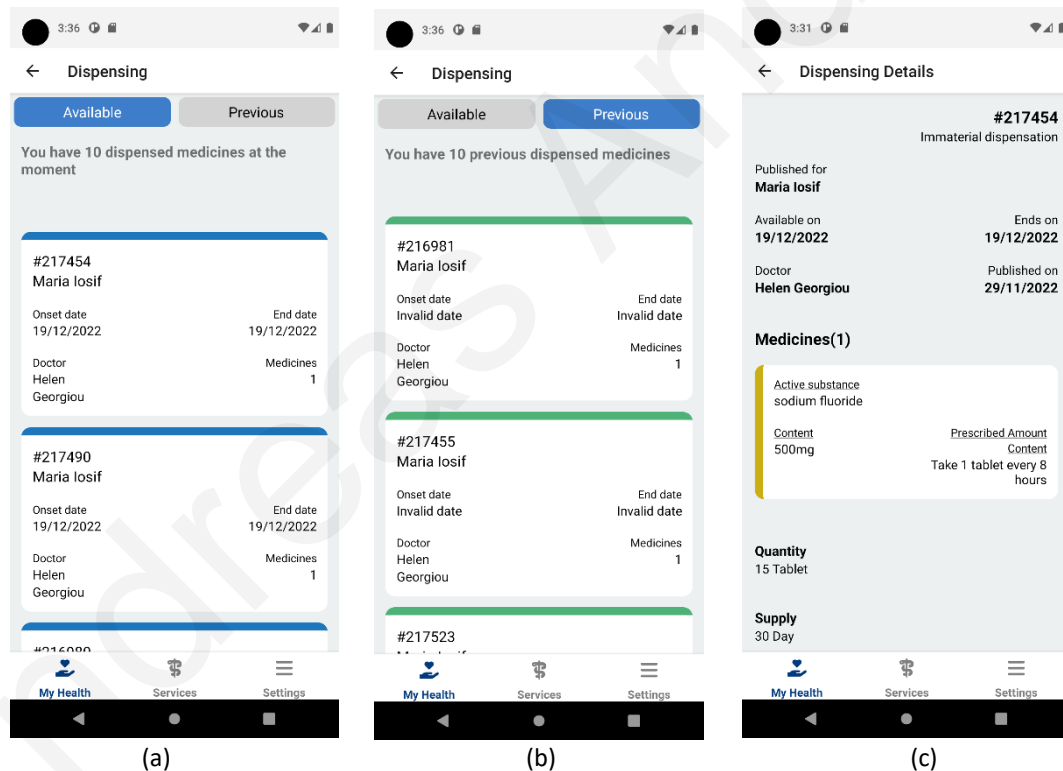
The "Previous Prescriptions" category displays a history of prescriptions that have been fulfilled or expired.

DISPENSING

This screen contains a list of available dispensing for the patient. The user has the possibility to choose from among the previously dispensed medicines.

By looking at the list of medicines, the user can see **the number of the dispensed medicine, the patient's name, the patient for whom the medicine has been dispensed, the start and expiry dates and the doctor who prescribed it.**

By clicking on a medicine and scrolling down, the user can see more details about the medicine chosen. In particular, the same information that was on the previous screen is displayed, together with information **about the drug, its quantity, its supply, the doctor's notes, dosage instructions, the time taken to take the drugs, the period of time during which the medicine is taken, dose and analogy, information on which medicine has been replaced, and information on the source from which the patient received the medicine administered.**



Picture 8: (a) Screen with "Available" dispensings shown as list, (b) Screen with "Previous" dispensings shown as list, (c) Details of the dispensing.

AVAILABLE DISPENSINGS

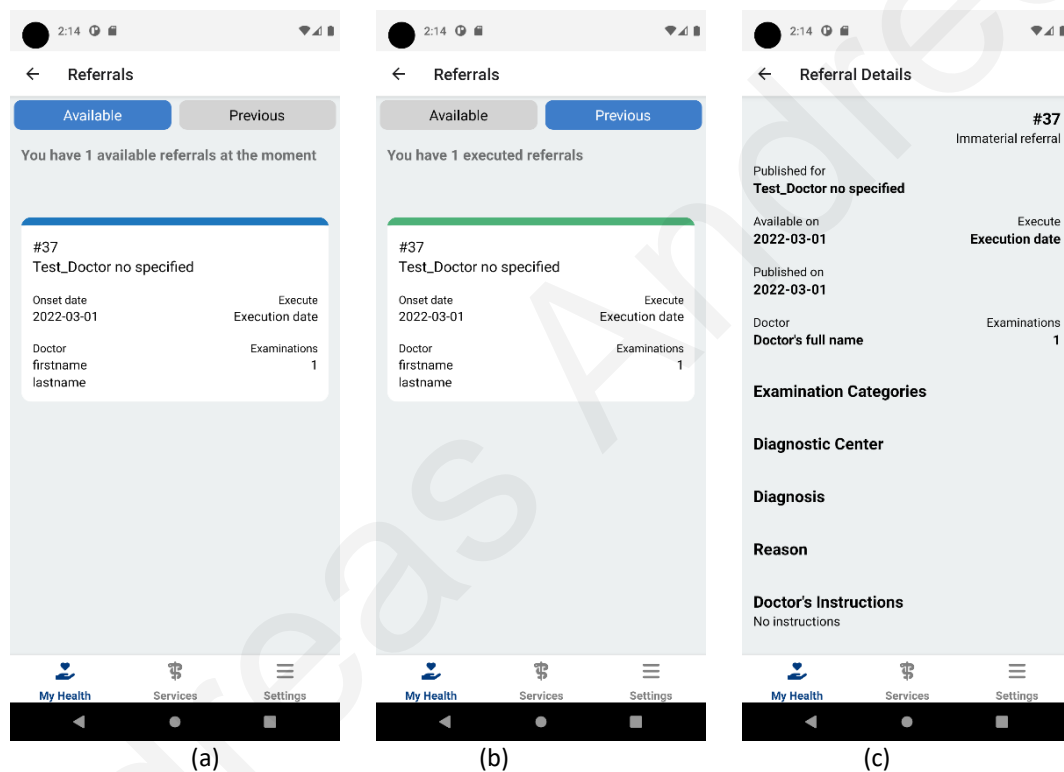
The "Available Dispensings" category displays any dispensings that are currently available for the user to pick up or request a delivery.

PREVIOUS DISPENSINGS

The "**Previous Dispensings**" category displays a history of dispensings that have been picked up or delivered.

REFERRALS

The screen includes a list of the patient's referrals. The user has the possibility to view and review their previous referrals as well as any current referrals that are still active. From the list, the user can see the details of each referral, including **the referral date, the referring healthcare provider, the specialist, or facility being referred to, and any notes or details provided about the referral.**



Picture 9: (a) Screen with "Available" referrals shown as list, (b) Screen with "Previous" referrals shown as list, (c) Details of the referral.

AVAILABLE REFERRALS

The "**Available Referrals**" category displays any referrals that are currently available for the user to follow up on.

PREVIOUS REFERRALS

The "**Previous Referrals**" category displays a history of referrals that have been completed or expired.

PATIENT SUMMARY

The **"Patient Summary"** screen displays a summary of the patient's medical information, including their personal details, medical history, and current health status. The screen is divided into two categories: **"Patient Administrative Data"** and **"Patient Clinical Data"**.

The first category, **"Patient Administrative Data"**, refers to the patient's administrative data and includes screens with information related to the patient's identification, personal information, contact details and information related to the patient's insurance.

The second category, **"Patient Clinical Data"**, refers to the patient's clinical data and includes screens relating to alerts, medical history, any medical problems, summary of medications, social history, pregnancy history, data provided by the patient, results, and care plans.

Each button is shown based on what applies to the user, so if a button is missing, it may be because the user does not have any information in that category, or it might not apply to the specific patient. For example, the "Pregnancy History" clinical data button will not be shown for male patients.



Picture 10: (a) Administrative Data section of the Patient Summary, (b) Patient Clinical Data section of the Patient Summary

PATIENT ADMINISTRATIVE DATA

The "**Patient Administrative Data**" section of the "**Patient Summary**" screen allows users to view and manage their personal and administrative information.

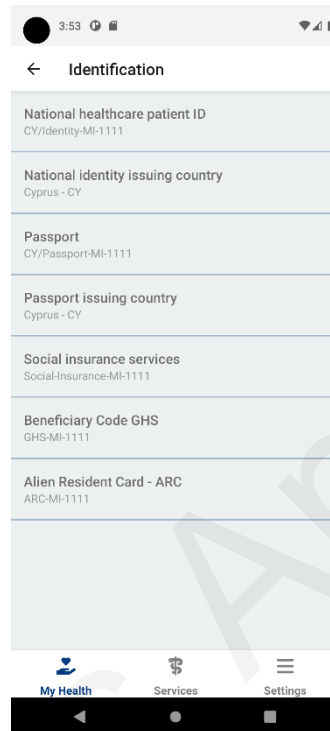
This includes the following options:

- **Identification:** This section displays the user's identification details, such as their name, gender, date of birth, and identification number.
- **Personal Information:** This section displays the user's personal details, such as their nationality, marital status, and occupation.
- **Contact Information:** This section displays the user's contact details, such as their address, phone number, and email address.
- **Insurance Information:** This section displays the user's insurance details, such as their policy number, insurer, and coverage limits.

If any of this information is incorrect or needs to be updated, users can contact the support team for assistance.

IDENTIFICATION

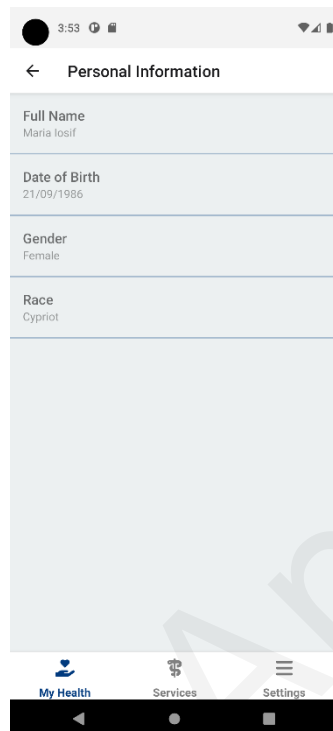
This screen includes data relating to the patient's identification. It displays information concerning **the national identity of the patient, patient's passport, social security number, general health system (GHS) beneficiary code** and the **alien resident card (ARC) number** in case the patient is a foreigner.



Picture 11: Patient's identification details in the "Administrative Data" category of "Patient Summary"

PERSONAL INFORMATION

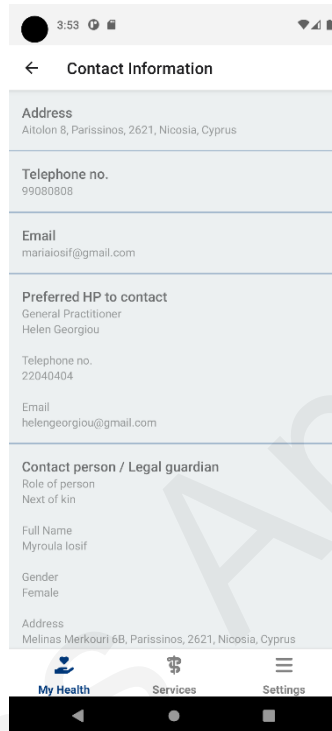
It includes data related to the patient's personal information, such as the **patient's full name, date of birth, sex, and race.**



Picture 12: Patient's personal information details in the "Administrative Data" category of "Patient Summary"

CONTACT INFORMATION

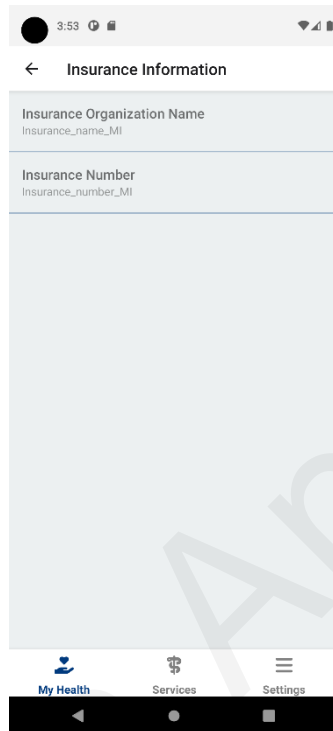
It includes data related to the patient's contact details. Those are the **telephone number of the patient, the address of the patient, and the personal e-mail address.** Also shown is information relating to the **healthcare provider that the patient prefers to contact in case of an incident.** Apart from this, there is information about the **patient's legal guardian or a close emergency contact.**



Picture 13: Patient's contact information details in the "Administrative Data" category of "Patient Summary"

INSURANCE INFORMATION

Includes data related to the patient's insurance, such as the **insurance organisation's name** and the **insurance number of the patient** and **coverage limits of the patient's insurance**.⁴



Picture 14: Patient's insurance details in the "Administrative Data" category of "Patient Summary"

⁴ In the above screen there is no coverage limits since this data is not provided yet.

PATIENT CLINICAL DATA

The "**Patient Clinical Data**" section of the "**Patient Summary**" screen allows users to view and manage their personal clinical data.

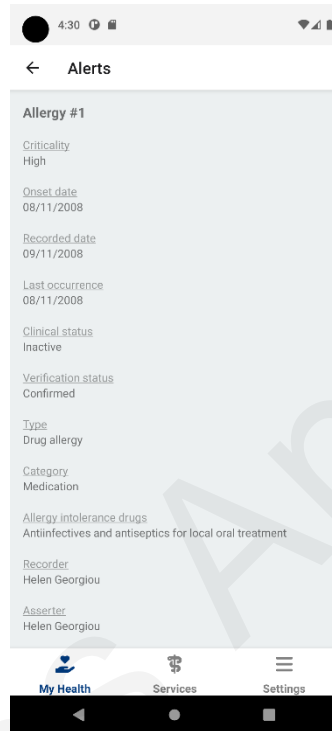
This includes the following options:

- **Alerts:** This section displays any important medical alerts or warnings that apply to the user, such as allergies or sensitivities to certain medications.
- **Medical History:** This section displays the user's past medical history, including any previous surgeries, hospitalizations, or medical conditions.
- **Medical Problems:** This section displays any current or ongoing medical problems or conditions that the user is experiencing.
- **Medication Summary:** This section displays a summary of the user's current and past medications, including the medication name, dosage, and prescribing healthcare provider.
- **Social History:** This section displays information about the user's social life, including their exercise habits, sleeping habits, tobacco use, drug use, alcohol consumption, and diet.
- **Pregnancy History:** This section displays the user's pregnancy history, including any past pregnancies and childbirths.
- **Patient Provided Data:** This section displays any additional information or data that the user has provided, such as travel history to other countries and the period spent in each country.
- **Results:** This section displays the results of any laboratory or imaging tests that the user has undergone, including any abnormal or notable findings.
- **Plan of Care:** This section displays the user's current care plan, including any treatment recommendations or follow-up appointments.

If any of this information is incorrect or needs to be updated, users can contact the support team for assistance.

ALERTS

This screen refers to any allergies the patient may have. More specifically, it includes information such as the **severity of the allergy**, the **date of recording**, **when it last occurred**, the **patient's clinical case**, the **type of allergy**, **intolerance medications** and which **physician recorded** the allergy. Also, **the reaction the patient had along with the severity of the reaction** is mentioned.



Picture 15: Patient's alerts details in the "Clinical Data" category of "Patient Summary"

MEDICAL HISTORY

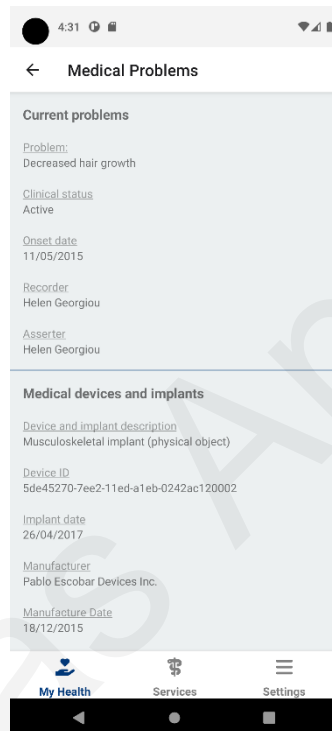
This screen contains data concerning the patient's **medical history of past vaccinations** with information such as the **disease or target agent for which the vaccination was given**, the **vaccine code**, the **pharmaceutical product**, the **marketing authorization holder**, and the **date of vaccination**. Also, on the same screen we find information about the patient's **resolved or inactive medical problems**, **current clinical status**, **date of onset and date of remission of the problem**. At the end of the screen, **information is given on diagnoses** related to the patient, the **period of diagnosis**, **clinical condition**, **severity**, **body site**, **evidence**, and the **various stages of diagnosis**.



Picture 16: Patient's medical history details in the "Clinical Data" category of "Patient Summary"

MEDICAL PROBLEMS

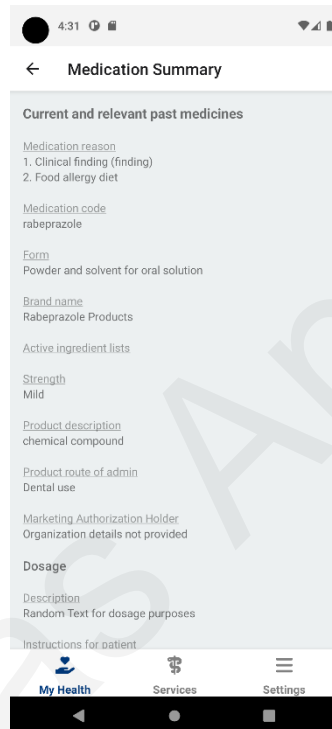
On this screen, the patient's **current medical problems** are listed along with their **clinical status** and the **date of onset**. The next information displayed is a list of any **medical devices or implants** that the patient has, including the **device identifier**, **implantation date**, **manufacturer**, and **production date**. This is followed by information on **any procedures the patient has undergone**, including the **date of the procedure**, the **performing physician**, and any **relevant details about the device or implant**. Finally, the screen includes information about the patient's **functional status**.



Picture 17: Patient’s medical problems details in the “Clinical Data” category of “Patient Summary”

MEDICATION SUMMARY

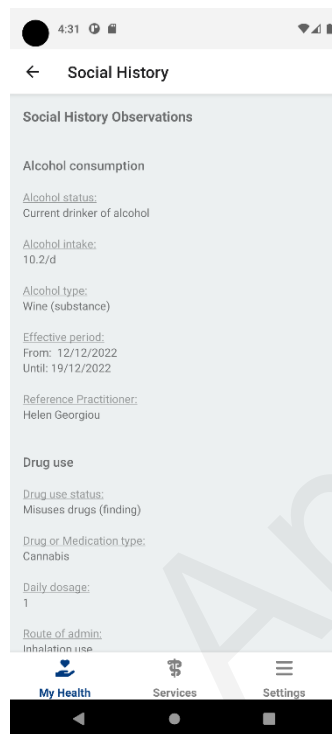
This screen displays a list of the patient's **current and past medications**. It includes **details about each medication**, such as the **reason for taking it**, the **medication code**, the **form**, the **brand**, the **strength**, the **route of administration**, and the **marketing authorization holder**. It also includes information about the **dosage**, **instructions for the patient**, the **duration of treatment**, and the **healthcare provider who prescribed the medication**. More details about those medications can also be found under the **“Prescriptions”** or **“Dispensings”** section.



Picture 18: Patient’s medication summary details in the “Clinical Data” category of “Patient Summary”

SOCIAL HISTORY

This screen displays information about the patient's social history, including their **tobacco and alcohol use, drug use, exercise habits, sleeping habits, and diet**. It may also include information about their **exposure to infectious diseases**.

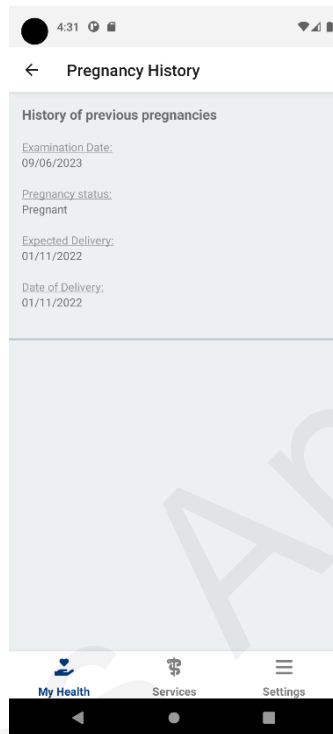


Picture 19: Patient's social history details in the "Clinical Data" category of "Patient Summary"

PREGNANCY HISTORY

This screen displays information about the patient's **pregnancy history**, including details about **past and current pregnancies** such as **dates of tests** and **expected delivery**, as well as the **outcome of each pregnancy**.

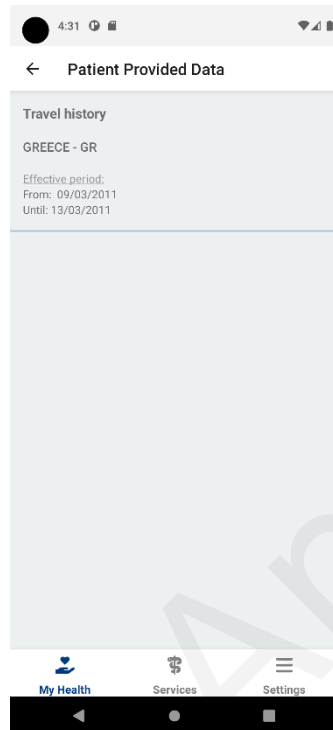
This information is only applicable to female patients.



Picture 20: Patient's pregnancy history details in the "Clinical Data" category of "Patient Summary"

PATIENT PROVIDED DATA

This screen includes data provided by the patient themselves, such as **travel history**, including **countries visited** and **the duration of time spent in each country**.

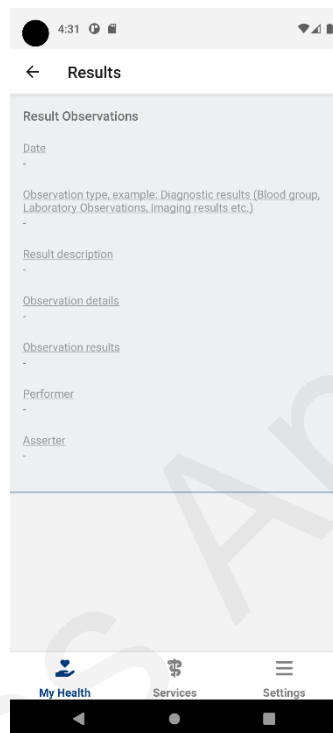


Picture 21: Patient's provided data details in the "Clinical Data" category of "Patient Summary"

RESULTS

On this screen, there is a list of the patient's **laboratory results**, **imaging results**, or **other observations results**. The results are **organized by date**, with the most recent results displayed first. Each result includes information about the **type of test**, the **date the test was performed**, and the **result of the test**.

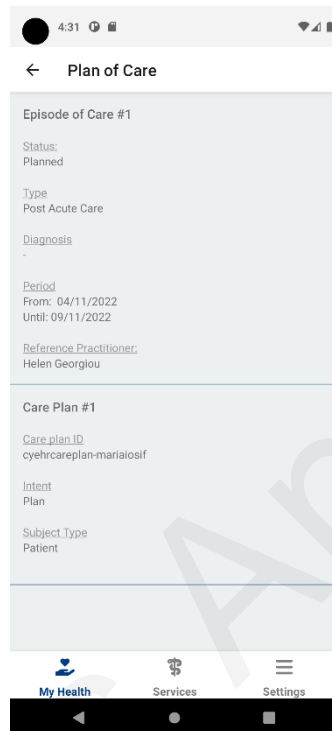
Please note that at this time, this information is not provided.



Picture 22: Patient's results details in the "Clinical Data" category of "Patient Summary"

PLAN OF CARE

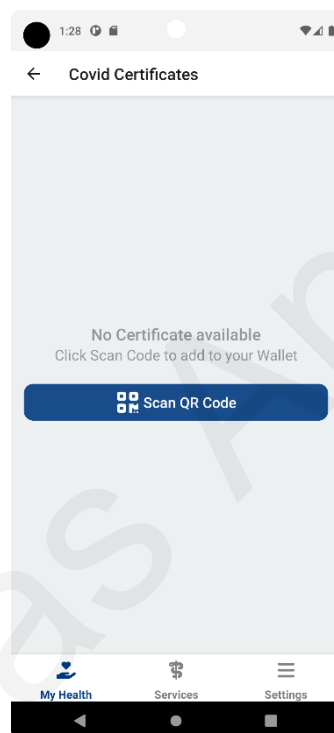
This screen displays information about the patient's **episodes of care**, including the **condition, type**, and **duration of the episode**, as well as the **referring physician**. It also includes information about the **patient's overall plan of care**.



Picture 23: Patient's plan of care details in the "Clinical Data" category of "Patient Summary"

COVID CERTIFICATES

The "**COVID Certificates**" section of the "**My Health**" screen allows users to view and manage their COVID-related certificates and documents, such as **vaccination and recovery records** and **test results**. Users can scan and save their certificates for easy access and verification and can also share them with healthcare providers or other authorized parties as needed. This feature helps users to keep track of their COVID-related information and ensure that they have the necessary documents for travel, work, or other activities. To begin the process of scanning and saving a Covid Certificates, press the "**Scan QR Code**" button.



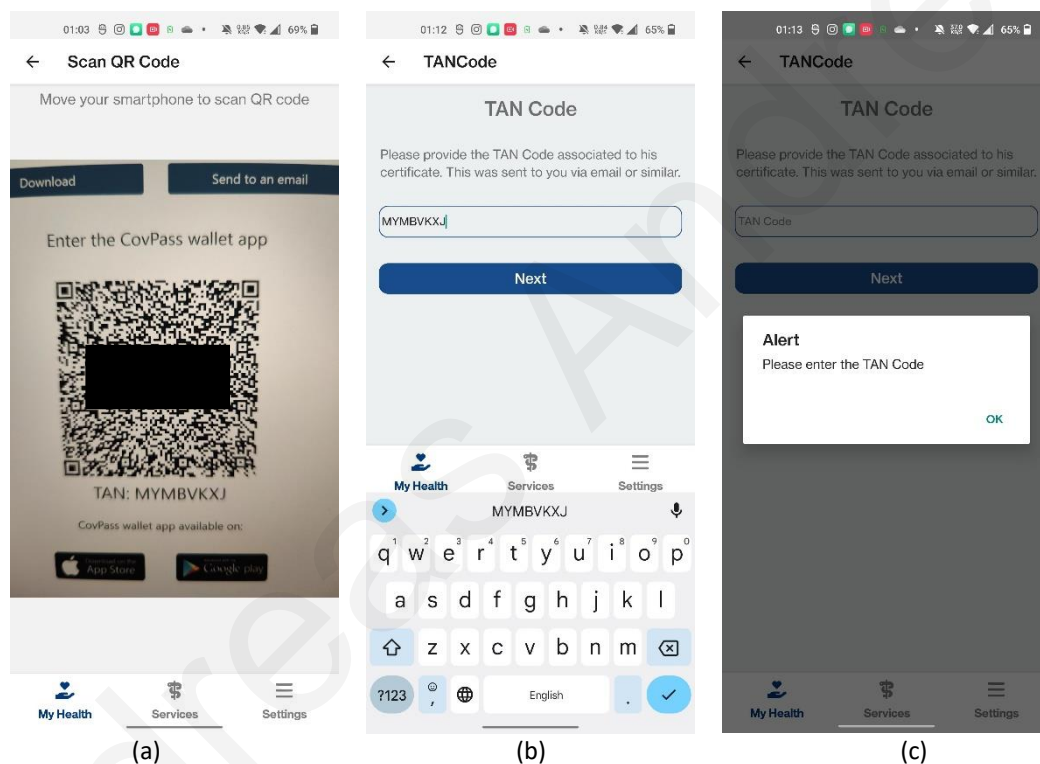
Picture 24: Covid Certificates screen of the MYeHealthAppCY application.

Please note that if this is the first time using the camera within the app, users may be prompted to grant permission for the app to access the device camera. This is necessary for scanning the QR code on their COVID certificate. If used do not grant permission, they will not be able to use this feature.

SCAN QR CODE

The **"Scan QR Code"** section of the Covid Certificates screen allows users to scan the QR code of their Covid certificate using their device's camera. Once the QR code is scanned, the user may be prompted to enter a **TAN (Transaction Authentication Number)** code for verification. If the TAN code is incorrect, an error message will be displayed, and the user will need to try again. Once the TAN code is successfully entered, the user's Covid certificate will be displayed on the screen.

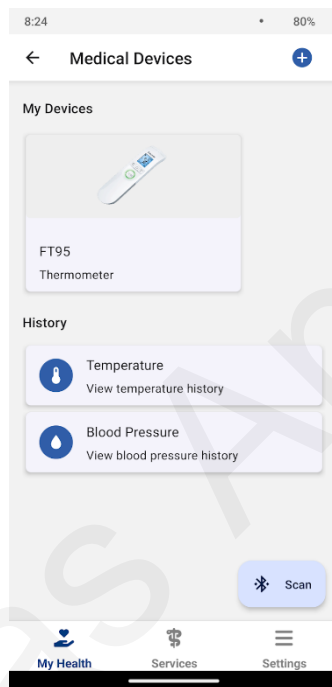
Once the certificate has been verified and saved, the user can access it at any time from within the **"Covid Certificates"** screen. The user also has the option to remove any saved certificates as needed.



Picture 25: (a) Scanning the QR code of the Covid certificate, (b) Insert TAN code when requested, (c) Error message in case the TAN code is incorrect.

MEDICAL DEVICES

The "**Medical Devices**" section of the "**My Health**" screen allows users to view their medical devices, such as **thermometers and blood pressure monitors**. Users can view the medical device connection screen by clicking the device card. Users can also view their history of measurements for each category by clicking on one of the categories under "History" section. If you want to begin the process of adding a medical device, press the **Plus Icon** button, on the top right of the screen.

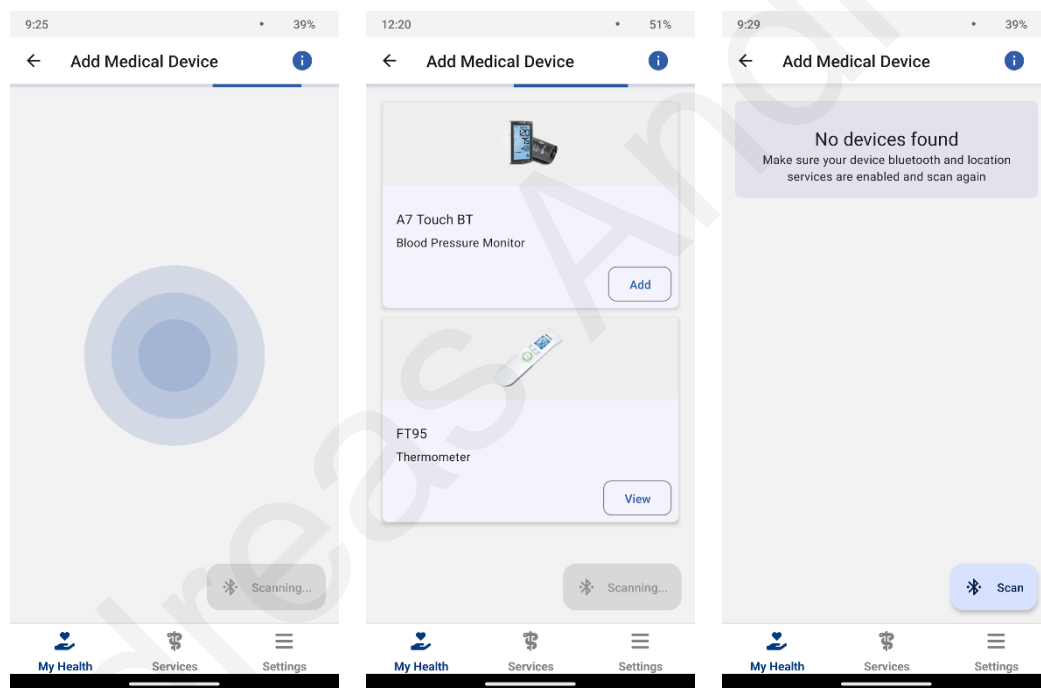


Picture 26: Medical Devices screen of the MYeHealthAppCY application.

ADDING A MEDICAL DEVICE

The **"Adding a medical device"** section of the medical devices screen allows users to initiate a Bluetooth scan to discover supported medical devices. Information on supported devices and how to enable Bluetooth for each device is in the next section. During the scan process, the discovered supported devices will be shown in cards. If the user already have added the device, a **"View"** button will be displayed in the device's card else an **"Add"** button will be displayed instead. If no devices were found an appropriate message will be displayed and the user will have to try again by clicking the **"Scan"** button.

Once the medical device has been added or by clicking view, the user will be redirected to the device's screen. The user can access the device screen at any time from within the **"Medical Devices"** screen.



(a)

(b)

(c)

Picture 27: (a) Scanning for Bluetooth devices, (b) View or add a device, (c) Message in case no devices were found.

Please note that users may be prompted to grant permission for the app to enable the device Bluetooth and Location services. This is necessary for scanning Bluetooth devices. If users do not grant permission, they will not be able to use this feature.

SUPPORTED DEVICES



MYeHealthAppCY support these devices:

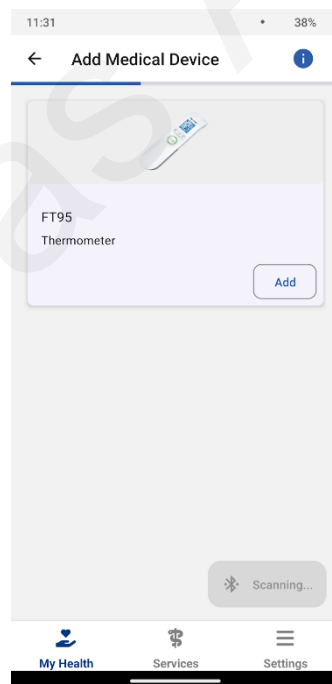
Thermometers: Beurer FT95

Blood Pressure Monitors: Microlife BP A7 Touch BT

Following are the guides for each device. Users should follow the guide for their specific device, as each device has different connection flow.

BEURER FT95

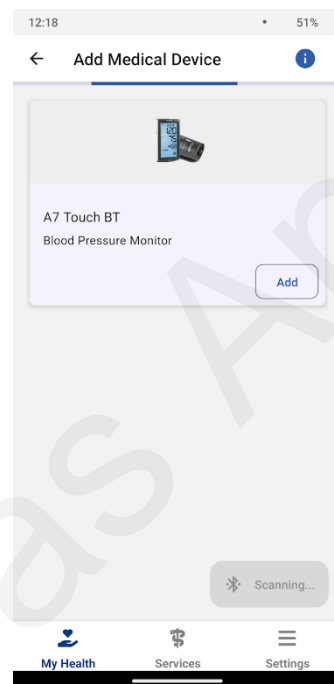
1. To switch on the thermometer, briefly press the  button. After two short beeps the device is ready for forehead temperature measurement. The device is in forehead temperature mode by default. You can tell this from the  symbol on the display.
2. Start taking a measurement with the thermometer. At the same time initiate a scan as described above.
3. The device's Bluetooth will automatically be enabled during the scanning, and the device should pop up in the app. Click the **"Add"** button to add the device to your devices.



Picture 28: Adding Beurer FT95

MICROLIFE BP A7 TOUCH BT

1. To switch on the blood pressure monitor, slide the lock switch down to the **“unlock”** position, that is located at the right side of the device.
2. For Bluetooth to work you **must** select a user on the device. To do that press and hold the **“User Indicator”** icon in the bottom right of the screen until it shows **“1”** or **“2”** inside the user icon. Also, the device should be in single measurement mode. To do that slide the switch at the left of the device to down to **“1”** position.
3. Start taking a measurement. The device’s Bluetooth will automatically be enabled **after** you take a measurement, and the device should pop up in the app. Click the **“Add”** button to add the device to your devices.

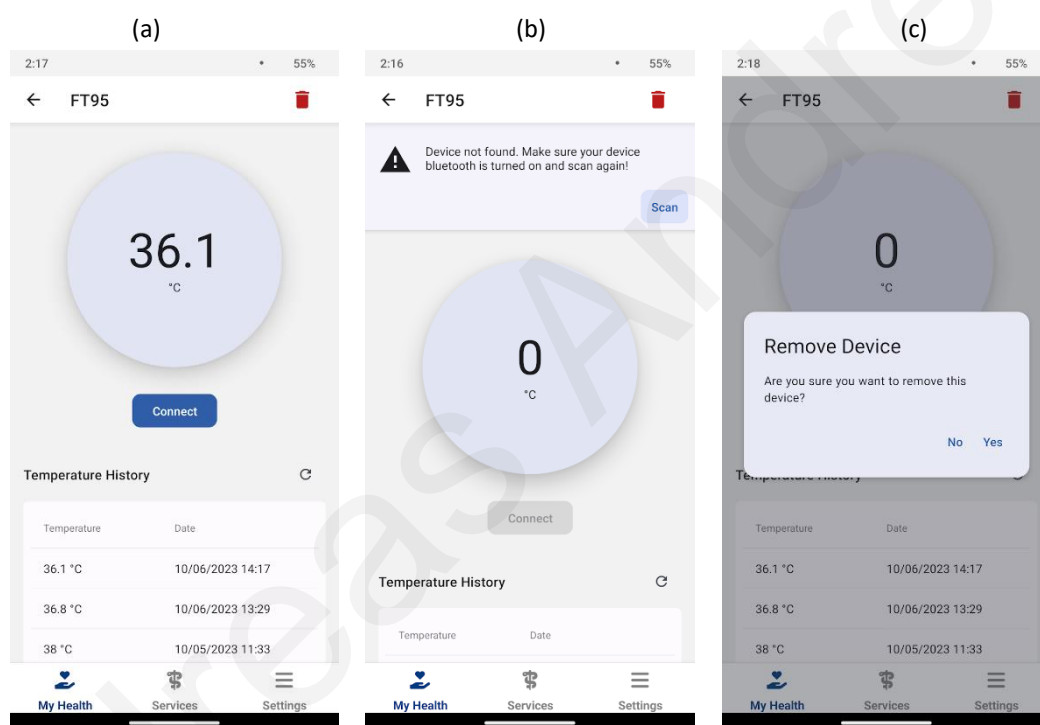


Picture 29: Adding Microlife BP A7 Touch BT

TAKING A MEASUREMENT

The **"View Device"** section of the medical devices screen allows users to initiate a Bluetooth scan to connect to the selected device and view historic measurements of the type of measurement the device takes. Information on how to take measurement for each supported device is in the next section. Before initiating a connection, the device must be discovered. If it is not, a relevant banner will be shown prompting the user to **"Scan"** first. The user can also remove the device by clicking the **"Trash Icon"** button on the top right of the screen and clicking **"Yes"** to the dialog that opens.

Once the medical device has been discovered, the user can connect to the device to read a measurement by clicking the **"Connect"** button.





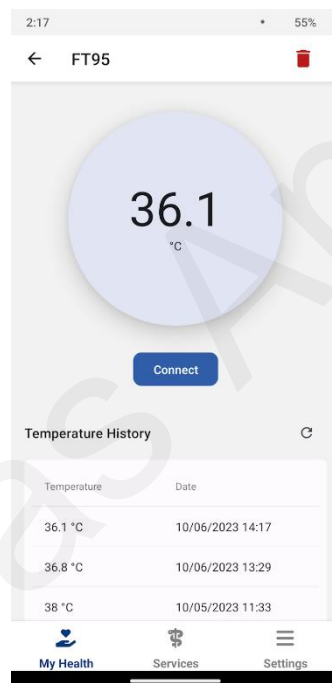
Picture 30: (a) View Medical Device, (b) Device not found banner, (c) Remove device dialog

Please note that users may be prompted to grant permission for the app to enable the device Bluetooth and Location services. This is necessary for scanning Bluetooth devices. If users do not grant permission, they will not be able to use this feature.

DEVICE SPECIFIC INSTRUCTIONS

BEURER FT95

1. To switch on the thermometer, briefly press the  button. After two short beeps the device is ready for forehead temperature measurement. The device is in forehead temperature mode by default. You can tell this from the  symbol on the display.
2. Start taking a measurement with the thermometer. At the same time initiate a connection by clicking the **“Connect”** button.
3. The measurement will automatically show up in the app and stored in measurements.

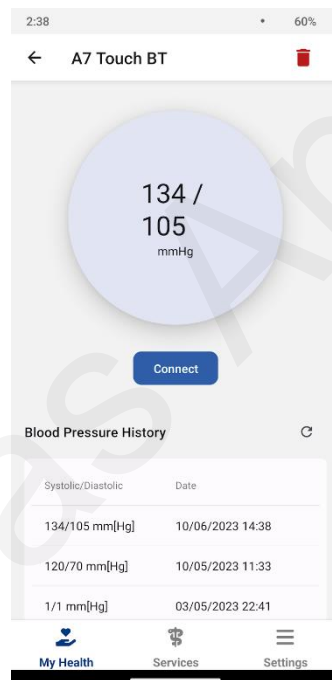


Picture 31: Beurer FT95 measurement.

Please note that if this is the first time connecting with the Beurer FT95 thermometer, users may be prompted to pair their device with the phone. This is necessary for reading the measurement from the device. If users do not grant permission, they will not be able to use this feature.

MICROLIFE BP A7 TOUCH BT

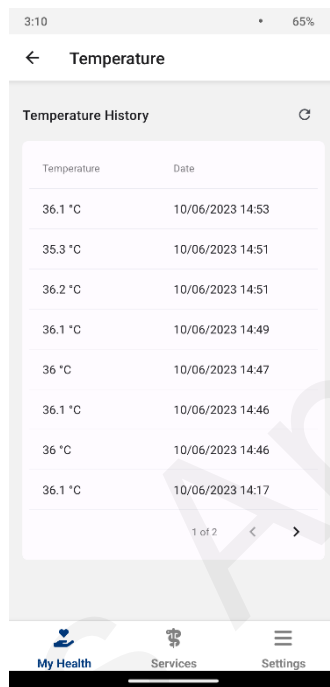
1. To switch on the blood pressure monitor, slide the lock switch down to the **“unlock”** position, that is located at the right side of the device.
2. For Bluetooth to work you **must** select a user on the device. To do that press and hold the **“User Indicator”** icon in the bottom right of the screen until it shows **“1”** or **“2”** inside the user icon. Also, the device should be in single measurement mode. To do that slide the switch at the left of the device to down to **“1”** position.
3. Start taking a measurement. After the measurement is finished click the **“Connect”** button on the app.
4. The measurement will automatically show up in the app and stored in measurements.



Picture 32: Microlife BP A7 Touch BT measurement

VIEWING HISTORY

The "**View History**" section of the medical devices screen allows users to view historic measurements of the type of measurement they selected. The measurements are shown in a table with pagination. If there are more measurements the user can navigate using the "**Arrow**" buttons at the bottom of the table. The user can also refresh the data by clicking the "**Refresh**" button next to category history name.

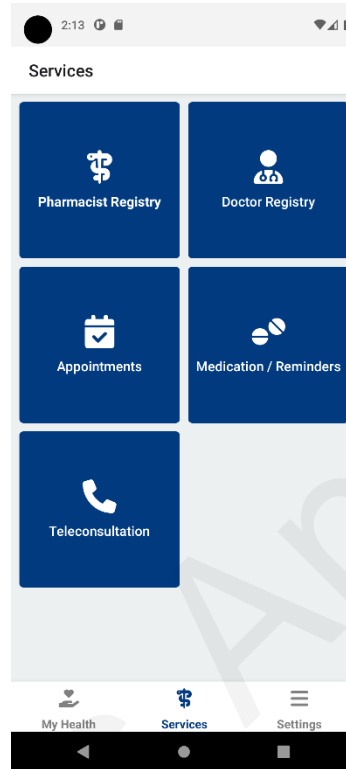


Temperature	Date
36.1 °C	10/06/2023 14:53
35.3 °C	10/06/2023 14:51
36.2 °C	10/06/2023 14:51
36.1 °C	10/06/2023 14:49
36 °C	10/06/2023 14:47
36.1 °C	10/06/2023 14:46
36 °C	10/06/2023 14:46
36.1 °C	10/06/2023 14:17

Picture 33: Temperature measurements history

SECTION D: SERVICES SCREEN

The "**Services**" section of the MYeHealthAppCY app provides users with access to a range of helpful tools and resources to manage their healthcare needs.



Picture 34: Services screen of the MYeHealthAppCY application.

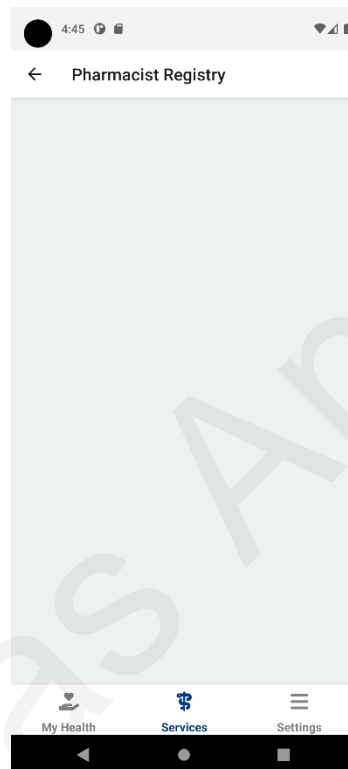
The "**Services**" section of the MYeHealthAppCY app provides users with access to several important features and functions:

- **Pharmacist Registry:** Users can search for and locate nearby pharmacies, as well as view their contact information and hours of operation.
- **Doctor Registry:** Users can search for and locate healthcare providers, including doctors, specialists, and other healthcare professionals, as well as view their contact information and specialties.
- **Appointments:** Users can schedule appointments with healthcare providers, view their upcoming appointments, and cancel or reschedule appointments as needed.
- **Medications/Reminders:** Users can view and manage their current medications, including details about dosage and frequency, and set reminders to help them stay on track with their medication regimen.
- **Teleconsultation:** Users can connect with healthcare providers through video conferencing or teleconsultation, allowing them to receive medical care remotely.

PHARMACIST REGISTRY

The "**Pharmacist Registry**" section of the MYeHealthAppCY app allows users to access information about registered pharmacists in Cyprus. This includes the **pharmacist's name, contact information, and location**. Users can **search for pharmacists by name or location** and can also view **details about the pharmacy** where the pharmacist works.

Please note that at this time, this information is not provided.

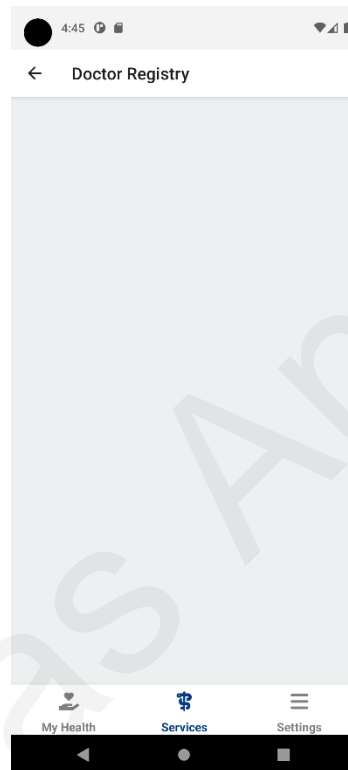


Picture 35: Pharmacist registry screen of the MYeHealthAppCY application.

DOCTOR REGISTRY

The "**Doctor Registry**" feature of the MYeHealthAppCY app allows users to **search for and view information about healthcare providers in their area**. This includes details such as the **provider's name, specialty, location, and contact information**. Users can also **view ratings and reviews** from other patients to help them choose the best provider for their needs.

Please note that at this time, this information is not provided.



Picture 36: Doctor registry screen of the MYeHealthAppCY application.

APPOINTMENTS

The "**Appointments**" section of the MYeHealthAppCY app allows users to view and manage their appointments with healthcare providers. Users can view the details of their **upcoming appointments**, such as the **date**, **time**, and **location**, and can also **request cancellations or rescheduling** as needed.

Please note that at this time, this information is not provided.

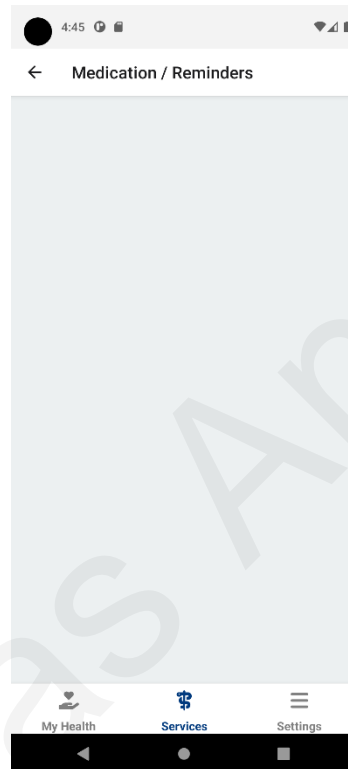


Picture 37: Appointments screen of the MYeHealthAppCY application.

MEDICATIONS / REMINDERS

The "**Medication/Reminders**" section in the MYeHealthAppCY app allows users to view and manage their medication regimen. Users can see a list of their **prescribed medications**, including details about the **dosage, frequency**, and other important instructions. The app also includes a **reminder function** to help users remember to **take their medications on time**.

Please note that at this time, this information is not provided.



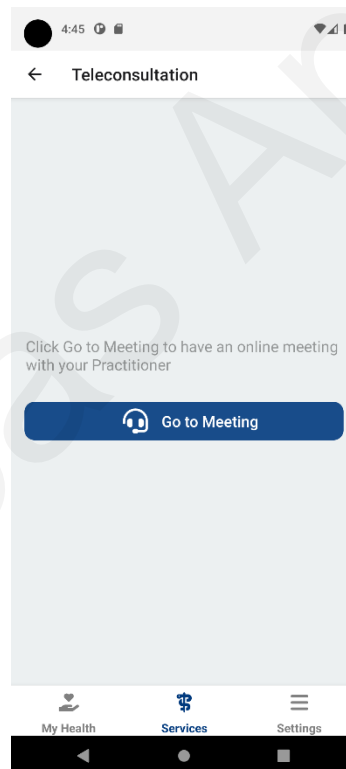
Picture 38: Medication / Reminders screen of the MYeHealthAppCY application.

TELECONSULTATION

The "**Teleconsultation**" feature in the MYeHealthAppCY app allows users to connect with healthcare providers through video conferencing or other remote communication methods. This feature is particularly useful for patients who are unable to visit a healthcare facility in person, or who prefer to avoid in-person visits due to COVID-19 or other reasons.

With the teleconsultation feature, users can schedule appointments with healthcare providers, discuss their health concerns, and receive medical advice and treatment recommendations without the need to physically visit a clinic or hospital.

To use this feature, users simply need to click the "**Go to Meeting**" button and wait for a provider to pick up the call. Once the teleconsultation is underway, users can communicate with their provider using audio and video and can also share documents or other relevant information as needed.

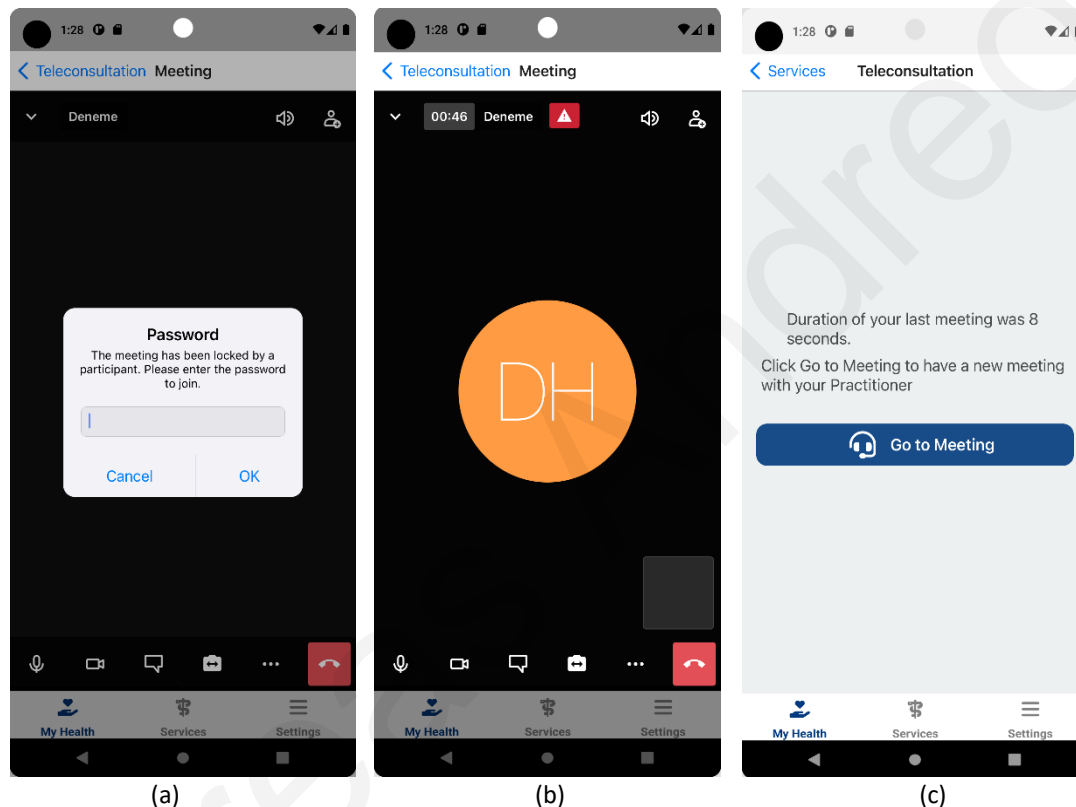


Picture 39: Teleconsultation screen of the MYeHealthAppCY application.

Please note that if this is the first time the user is accessing the camera or microphone within the app, they may be prompted to grant the app permission to use these features. The user must accept these permissions to continue using the Teleconsultation feature.

GO TO MEETING

To initiate a teleconsultation, the user simply needs to click the **"Go to Meeting"** button on the **"Teleconsultation"** screen. Once connected, the user will be asked to enter a password, which will be sent via email or SMS. During the teleconsultation, the user can end the call at any time by clicking the red button on the bottom right corner of the screen. Once the call is ended, the user will return to the **"Teleconsultation"** screen, and the duration of the meeting will be displayed in the centre of the screen.



Picture 40: (a) Teleconsultation password requirement before the teleconsultation starts, (b) View from within the teleconsultation, (c) Duration of the last meeting shown in the centre of the screen.

The teleconsultation feature allows users to connect with healthcare providers for virtual appointments. It includes options to **change audio** and **video settings**, **invite additional participants**, use the **chat function to communicate with the provider**, and **view details about the call**. Users can also end the call at any time by pressing the red button.

At the current stage, it is possible to end the call also by trying to press the back button.

TELECONSULTATION FEATURES

At the top of the screen, starting from left to right the user can find the following:

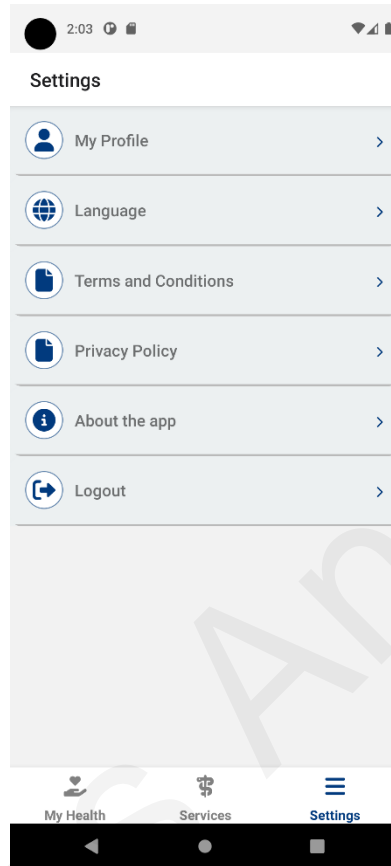
- **Duration:** The duration of the teleconsultation.
- **Audio output options:** The user can change the audio output (speaker/headphones).
- **Invite participants:** The user may invite other participants to the teleconsultation, such as other providers or a related person.

The bottom bar, starting from left to right, includes several tools for managing the call:

- **Mute microphone:** The microphone can be muted by clicking the microphone icon.
- **Turn camera on/off:** The camera can be turned on or off by clicking the camera icon.
- **Chat function:** The user can send messages or documents to the provider using the chat function.
- **Switch cameras:** The user can switch between the front and back cameras by clicking the camera switch icon.
- **View call details:** The user can view details about the call by clicking the information icon.
- **End call:** The user can end the call by clicking the red button.

SECTION E: SETTINGS SCREEN

The "**Settings**" screen in the MYeHealthAppCY app allows users to customize and manage their app experience.



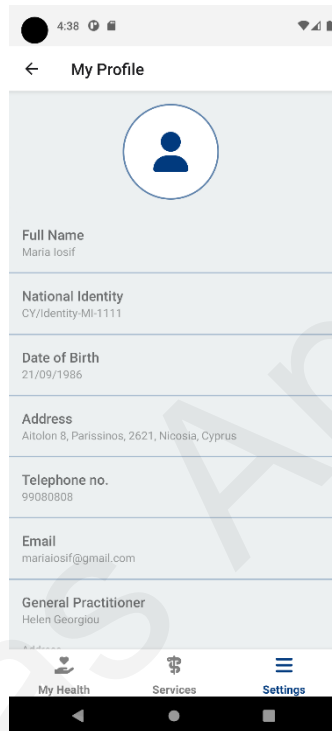
Picture 41: Settings screen of the MYeHealthAppCY application.

The "**Settings**" screen in the MYeHealthAppCY app provides users with the following options:

- **My Profile:** Users can view their personal information, such as their name, contact details, and insurance information.
- **Language:** Users can select their preferred language for the app.
- **Terms and Conditions:** Users can view the app's terms and conditions.
- **Privacy Policy:** Users can view the app's privacy policy.
- **About the App:** Users can view information about the app, including its version number and contact details for the developers.
- **Logout:** Users can log out of the app.

MY PROFILE

It includes all the most important information about the user's profile. There is a **photo of the user**, **patient's full name**, the **number of the personal National Identity document**, **date of birth**, **address of residence**, **personal identification numbers**, the **user's personal telephone number** and **user's e-mail address**. At the end, there are the **personal details of the preferred doctor** (full name, work address, telephone number and e-mail address his/her e-mail address).

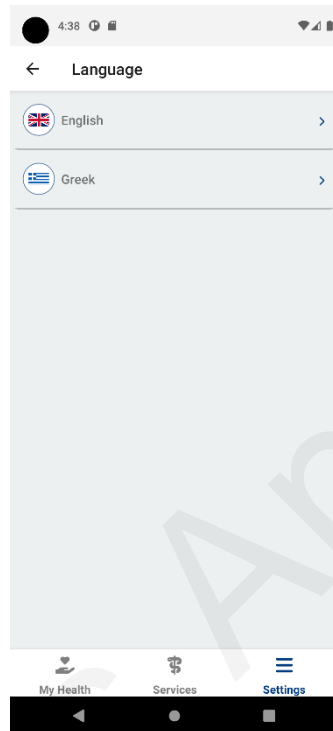


Picture 42: My profile screen of the MYeHealthAppCY application.

In the context of the development stage, it is not possible to make any changes to the data.

LANGUAGE

This screen has two options as to the language of the application the user wants, the **English** and **Greek**. **The default language is English.** If the user chooses to change the language of the application, they will be taken to the home page of the application, which is the "**My Health**" tab.



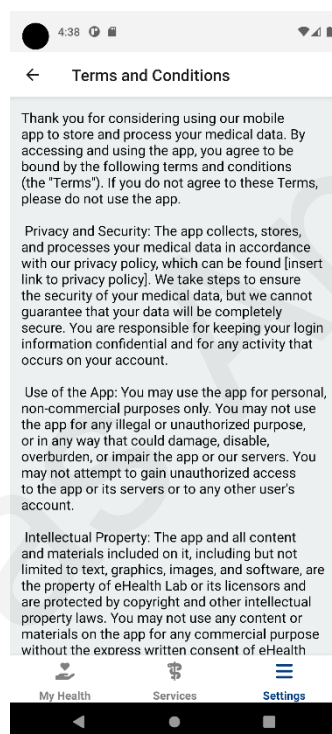
Picture 43: Language screen of the MYeHealthAppCY application.

TERMS AND CONDITIONS

The "**Terms and Conditions**" section of the MYeHealthAppCY app provides users with access to the terms and conditions governing the use of the app. These terms and conditions **outline the rights and responsibilities of users and developers**, as well as any **limitations on the use of the app**.

It is important for users to review and understand these terms and conditions before using the app.

Please note that much of the information contained in the terms and conditions can also be found in the general section of the user manual under the "Privacy and Security" and "Legal Information" sections.

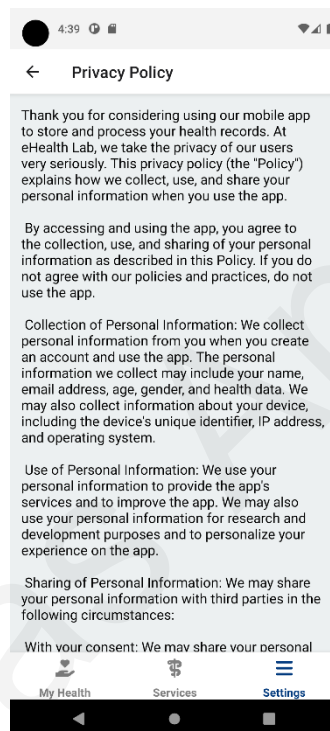


Picture 44: Terms and conditions screen of the MYeHealthAppCY application.

PRIVACY POLICY

The "**Privacy Policy**" section of the MYeHealthAppCY app provides users with information about **how their personal data is collected, used, and protected within the app**. This includes details about the **types of data that are collected**, the **purposes for which it is used**, and the **steps that are taken to ensure its security and confidentiality**.

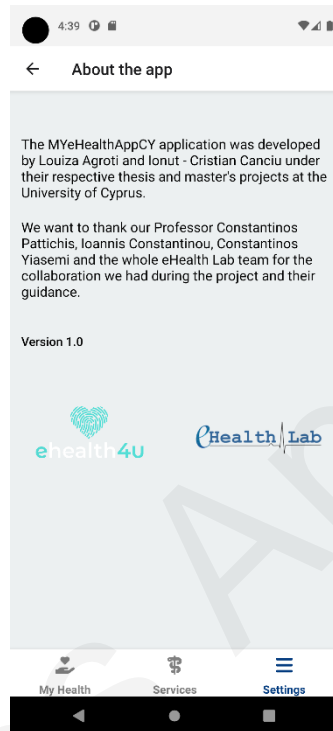
Most of this information is also present within the general section of the user manual under "Privacy Policy" and "Legal Information."



Picture 45: Privacy policy screen of the MYeHealthAppCY application.

ABOUT THE APP

This screen includes information about the developers of the application, the purpose for which the app was developed, and acknowledgments to the people who helped with their cooperation and guidance in the development and implementation stage of the application. The current version of the application is also mentioned.

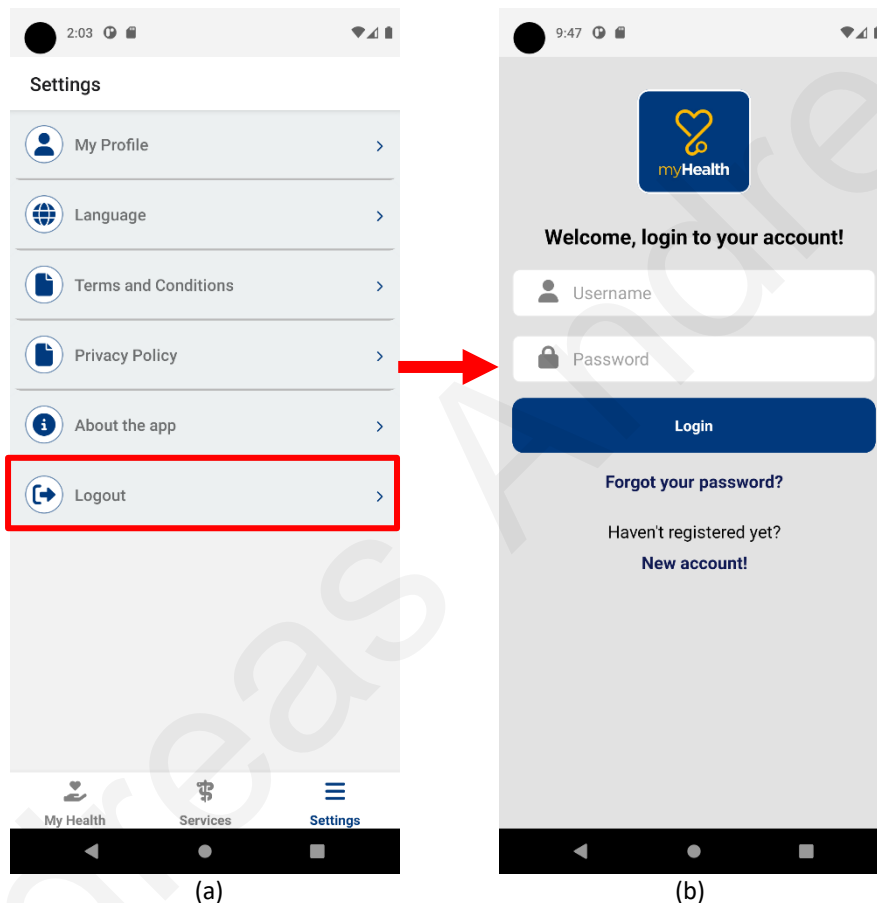


Picture 46: About the app screen of the MYeHealthAppCY application.

LOGOUT

The logout functionality allows users to sign out of their account and end their current session within the app. This is a useful feature if users need to switch accounts or if they want to log out for security reasons.

Please note that after logging out, any data saved on the device or in the memory cache will be wiped and no data will be maintained between sessions. If users want to keep their data available between sessions, they can choose to stay logged in.



Picture 47: (a) Logout functionality under the settings screen, (b) After logging out from the application, users will be redirected to the login screen.

It is important to note that COVID certificates are also deleted after logging out of the app. These certificates are not stored in the cloud or on any external servers, but rather are stored in the encrypted memory of the device. This means that they will be wiped after logging out and will need to be added again if users want to access them in a future session. Please make sure to re-enter the COVID certificates after logging back into the app to ensure that are available when needed. The app's encryption ensures that the COVID certificates always remain secure.

Frequently asked questions (FAQ)

The **"FAQ" (Frequently Asked Questions)** section of the MYeHealthAppCY User Manual is designed to provide users with answers to common questions and concerns about the app and its features.

- **Q: How do I log in to the app?**
A: To log in to the app, you will need to enter your registered email address and password. If you have forgotten your password, you can use the "Forgot Password" feature to reset it.
- **Q: How do I reset my password?**
A: To reset your password, you can use the "Forgot Password" feature on the login screen of the MYeHealthAppCY app. Enter your email address and follow the instructions provided to reset your password.
- **Q: Can I change the language of the app?**
A: Yes, you can change the language of the app by going to the "Settings" screen and selecting "Language." From there, you can choose from a list of available languages. Your selection will be applied immediately and all text within the app will be displayed in the selected language.
- **Q: How do I view my medical records in the app?**
A: To view your medical records in the app, you will need to go to the "My Health" screen and select the "Patient Summary" option. From there, you can view your administrative data and clinical data.
- **Q: How do I log out of the MYeHealthAppCY app?**
A: To log out of the MYeHealthAppCY app, go to the "Settings" screen and select the "Logout" button. This will end your current session and you will need to enter your login credentials to access the app again.

TROUBLESHOOTING

The Troubleshooting section is intended to help users resolve any issues they may encounter while using the app. If user experience a problem or error message while using the app, they can refer to this section for possible solutions. If they are unable to resolve the issue, users shall not hesitate to contact the app's support team for further assistance.

Please note that in most cases, internet connectivity issues may cause problems with the app. Make sure that the device is connected to the internet before attempting to troubleshoot any issues.

LOGIN OR AUTHENTICATION ISSUES

If users are unable to log in to the app or access certain features, check that the correct login information was used, and that the device is connected to the internet. If the issue persists, try resetting the password or contacting the app's support team for assistance.

APP CRASHES OR FREEZES

If the app crashes or freezes, try closing the app and reopening it. If the issue persists, try restarting the device or checking for updates to the app.

APP NOT RESPONDING

If the app becomes unresponsive, try closing and reopening it. If the issue persists, try restarting the device or checking for updates to the app.

PERFORMANCE ISSUES

If the app is running slowly or experiencing other performance issues, try closing other apps or restarting the device. If the issue persists, try clearing the app's cache or checking for updates to the app.

ERROR MESSAGES

If the app displays an error message, try following the steps provided in the message to resolve the issue. If the issue persists, try restarting the app or contacting the app's support team for assistance.

CONTACT INFORMATION

The "**Contact Information**" section of the MYeHealthAppCY User Manual provides information about how to get in touch with the app developers or support team for assistance. If user have any questions, feedback, or need help using the app, they can contact the team through the following channels:

- **Email:** users can send an email to the support team at:
support@mxxxxy.com
- **Phone:** users can call the support team at:
[+357 2222xxxx](tel:+3572222xxxx)
- **Live Chat:** users can use the live chat feature within the app to speak with a representative in real-time.

In addition to these options, users can also find helpful information and assistance in the FAQs and online resources provided by the app developers. If users have any concerns or issues related to privacy, they can refer to the Privacy Policy section of the user manual for more information.

INSTRUCTIONS NOT INCLUDED/NOT APPLICABLE

Thank you for using the MYeHealthAppCY app. As we are currently in the development stages of the app, some features and functions may not be available at this time. The instructions and information provided in this section pertain to features and functions that will be added to the app in the future. We appreciate your understanding and patience as we work to bring these additional features and improvements to our users. If you have any suggestions for features that you would find helpful, we encourage you to share them with us. Your feedback is always welcome and helps us to continue to develop and enhance the app. Thank you for your support and we look forward to hearing your ideas.

Instructions and features not applicable:

- Biometric authentication as an option for logging in, allowing users to use their fingerprint or facial recognition to securely access their account without the need to remember a separate login password.
- Instructions for using search or filter functions, if applicable, to help users quickly find specific information or items within the app.
- A description of the app's notification system and how users can customize their notification settings or view their notification history
- A description of any in-app help or support resources available to users, such as a FAQ section or access to customer support via email or chat.
- Instructions for accessing the app's settings or account information and making any necessary changes (e.g., updating personal information, changing password, etc.)
- Integration with wearable devices (e.g., fitness trackers, smartwatches) to track and display health data such as steps taken, heart rate, sleep patterns, etc.
- A symptom checker or self-assessment tool that helps users identify potential health concerns and determine whether they should seek medical attention.
- A health library or knowledge centre that provides users with access to educational resources and information about various health topics and conditions.



Picture 48: Illustration of work in progress of the MYeHealthAppCY application.

C Technical Manual

Andreas Andreou

Medical Devices Technical Manual

PREPARED FOR

MYeHealthAppCY

PREPARED BY

Andreas Andreou

V1.0, JUL 14, 2023

1. Dependencies

Package	Description
react-native-ble-manager	A React Native Bluetooth Low Energy library.
react-native-geolocation-service	React native geolocation service for iOS and android.
react-native-device-info	Device Information for React Native.
react-native-permissions	An unified permissions API for React Native on iOS and Android.
react-redux	Official React bindings for Redux
buffer	The buffer module from node.js, for the browser.

2. "useBLE" Custom Hook

The useBLE custom hook is a [React hook](#) that I created in order to handle the BLE logic that gets reused throughout the medical devices implementation. The hook contains functions and listeners needed to handle BLE communication and various variables that return the state.

2.1 scanForPeripherals

This function is used to scan for peripherals. The function checks if the device bluetooth and location services are enabled and then it initiates a 10 second BLE [scan](#), after resetting the discovered devices state.

2.2 connectToPeripheral

This function is used to connect to a peripheral in order to take measurement. This function checks the device's name and gets its services that are declared in the "services.ts" file, one for each device. Then the BLE Manager [connects](#) to the device using the device id and [retrieves](#) the device's services and characteristics.

After that it calls the [startNotification](#) function with the service and characteristic from "services.ts" to enable the "[BleManagerDidUpdateValueForCharacteristic](#)" listener. If the device is a Microlife device (you can state that in the "services.ts" file) a special function is called to handle the [write](#) command that is required in order to read from the device.

2.3 Listeners

2.3.1 `BleManagerDidUpdateValueForCharacteristic`

This [listener](#) is responsible for notifying us if a new value was received. After reading the value that this listener returns we need to parse the data as described in [3. Parsing Data](#).

2.3.2 `BleManagerDisconnectPeripheral`

This [listener](#) is responsible for notifying us if the peripheral was disconnected. After this listener is triggered we can safely call [stopNotification](#) to stop the “`BleManagerDidUpdateValueForCharacteristic`” listener.

2.3.3 `BleManagerDidUpdateState`

This [listener](#) is responsible for notifying us if the BLE changes state. This state is used throughout the app to show the user if a scan is in progress or not.

2.3.4 `BleManagerDiscoverPeripheral`

This [listener](#) is responsible for notifying us if the scanning process found a new peripheral. If the discovered peripheral is in the list of our supported devices we add the peripheral to the list of discovered devices.

2.3.5 `BleManagerStopScan`

This [listener](#) is responsible for notifying if the scanning of peripherals is ended. This is used to notify the user if the scan ended.

2.4 State

2.4.1 data

The “data” state returns the latest measurement after it was parsed when taking a measurement.

2.4.1 isStreamingData

The “isStreamingData” state returns true if the device is currently in the process of taking a measurement from a device.

2.4.1 measurements

The “measurements” state returns an array of the latest measurements, after being parsed, when taking a measurement.

2.4.1 peripherals

The “peripherals” state returns an array of the discovered supported medical devices after a scan is completed.

2.4.1 scanning

The “scanning” state returns true if the device is currently scanning else it returns false.

2.4.1 state

The “state” state returns the current bluetooth state. This is an enum with these options: “unknown”, “resetting”, “unsupported”, “unauthorized”, “on”, “off” or “turning_off”

3. Discovered Device Data Format

The data returned from a discovered device are presented below: E.g FT95 Thermometer.

```
{
  "advertising":{
    "serviceUUIDs":[
      "1809"
    ],
    "txPowerLevel":-2147483648,
    "isConnectable":true,
    "serviceData":{

    },
    "localName":"FT95",
    "manufacturerData":{
      "bytes":[
        3,
        2,
        9,
        24,
        ....
      ],
      "data":"AwIJGAUJRlQ5NQTEQYBBQlGVdk1AAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAA=",
      "CDVType":"ArrayBuffer"
    }
  },
  "rssi":-69,
  "id":"<device-id-here>",
  "name":"FT95"
}
```

The most important information here is the serviceUUIDs and name that is used to differentiate between devices and handle reads, as described in [4. Adding a Device](#).

4. Adding a Device

To add a new device, add the reported device name in the “devices.ts” file inside the “useBLE” custom hook folder, under the correct category. Also, using the same name, add the device service and characteristic UUID that you want to use in the “service.ts” file.

You can find the device name, service and characteristic UUID using any BLE scanning app or you can “console.log” the peripheral info inside the ‘BleManagerDiscoverPeripheral’ listener (only for services, as shown in [3. Discovered Device Data Format](#)). The list of Bluetooth assigned numbers can be found [here](#).

The assigned numbers for BLE are listed as 16 bit hex values. To construct the full UUID you have to add the number **XXXX** inside “0000XXXX-0000-1000-8000-00805f9b34fb”, in order to construct the fully 96 bits value. For example for the Health Thermometer Service has the UUID “**1809**” but in the “service.ts” file you should add it as “0000**1809**-0000-1000-8000-00805f9b34fb”

If the device is a Microlife device you can set it inside the “services.ts” file along with a writeUUID. This will trigger the “handleMicrolifeDevice” function found in the “microlife>handle.ts” file inside the “useBLE” folder.

In this function you should add the device name and write the required data (command) to read from the device. The data you need to write in order to receive information from a Microlife device are proprietary.

You can find how I built the write command for the BP A7 Touch BT Blood Pressure Monitor inside “microlife>helpers.ts” inside the “readBPM” function. Note that the data that you need to send must be in *hexadecimal* format.

5. Parsing Data

The received data are in raw binary format. Each device sends the data in a different way. Inside “helpers.ts” set the device name in the “parseData” function and handle the parsing there.

I will recommend using the “buffer” library to handle data parsing, starting with the “[Buffer.from](#)” function and later by trying different variations of readInt16LE, readUInt8 etc.

Note that we don’t have a way to know beforehand how the device sends the data so the best approach here is trial and error.