

# Carer Communication Application

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## Abstract

Professional home care can be put in place to support individuals who are struggling with independent living. Alongside professional carers, other 'non-professional' carers such as family and friends often support the individual. Non-professional carers face a lot of their own struggles by taking on this role. This can include personal, physical and mental health problems such as anxiety, depression, sleep deprivation and financial problems (such as losing a job as a result of the caring role).

Currently, care giving agencies that are providing home care packages use paper-based notes to record patient information after a visit. This means that family/friends can only get updates on the wellbeing of individual if they can go to the individual's home. If they cannot visit the individual for personal reasons, not knowing how the individual is can amplify the struggles they have with their caring role, potentially leading to further stress and difficulty maintaining a job.

This project focused on building a simple and fast application for professional carers to use after home visits in order to update family/friends on their patients' wellbeing. The app will enable professional carers to fill out short, patient orientated questionnaires and then non-professional carers view the responses instantly.

## Acknowledgements

Thank you to my supervisor Liam Turner for his constant support and encouragement throughout the project.

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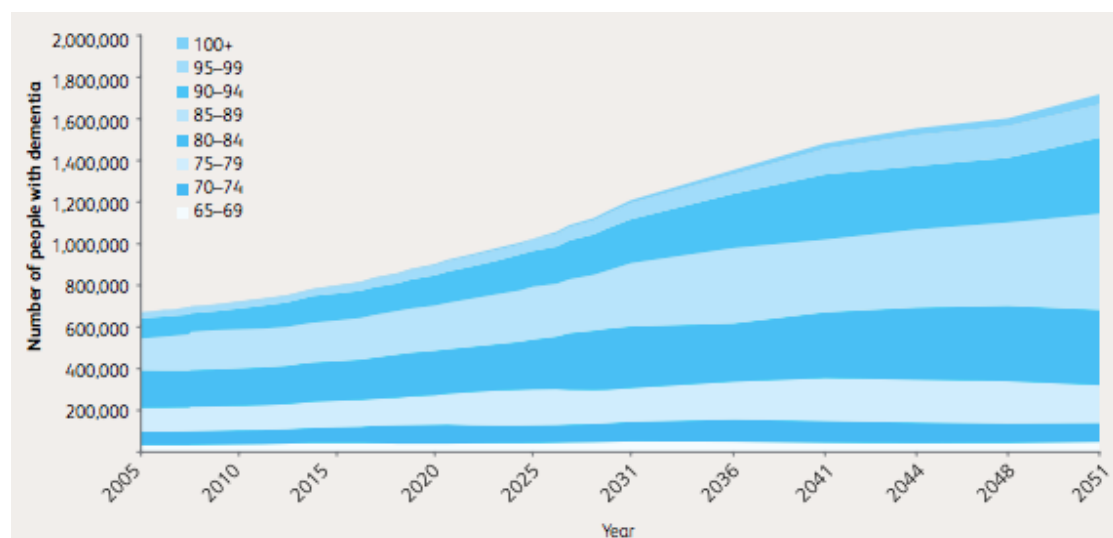
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# 1. Introduction

The following section will outline the problem and state the aims and objectives for the project.

## 1.1 Outline

In a 2017 report into health and care of elderly people in England, Age UK stated “It is now well understood that our population is ageing rapidly, and that this is now the single most significant driver for changing health and care needs in our society” [ageUK, 2017]. With this rise comes an increase in the frequency and complexity of health problems for the older generation, which is resulting in more and more people becoming incapable of managing their own care. Dementia is an important example of a disorder that is increasing in prevalence. As demonstrated in Figure 1, research by Prince, M et al (2014) predicted that the number of people living with dementia in UK would increase by 40% after 12 years and 156% after 38 years.



**Figure 1:** Prince, M et al (2014) *Dementia UK: Update Second Edition* report produced by King's College London and the London School of Economics for the Alzheimer's Society

For people struggling with independent living as a result of poor health, one option used to support maintaining a life at home is to put in place professional home care packages. These can cover personal care, washing, dressing, domestic work, nursing and healthcare [NHS Choices, 2018]. However, non-professional carers (e.g. family members and friends) often take on a care role to supplement this professional care. Therefore, the success of caring for the elderly in their own homes often relies on a partnership between professional carers and non-professional carers. Dr Doug Brown, Director of Research and Development at Alzheimer's Society, said: “In this country, unpaid dementia carers prop up our health and social care system. This silent army of husbands, wives, sons and daughters spend 1.3 billion hours a year providing care. This can take an enormous toll on their emotional health and wellbeing.” [Brown, 2016]

It is clear that the role of non-professional carers is incredibly important in supporting our care structure but currently, there is a lack of standard or easy communication methods between those responsible for providing care i.e. between multiple professional carers and the non-professional carers. Family members and friends can try to be present when the carer visits occur but this can be difficult when they are remote from the person they care for, and have other responsibilities to balance such as maintaining a full time job. The difficulty of communicating with professional carers can lead to unnecessary worry about the wellbeing of the person they care for. A UK State of Caring Report 2017 stated “only 15% of people said their contribution is well understood and valued by health and care professionals, despite these being the very people who carers rely on for support” [CarersUK, 2018]. This statistic highlights the disjointed relationship between the different carers, which could ultimately impact the overall quality of care.

In this project, the aim is to mitigate the absence of communication methods by designing and building a simple-to-use application for carer interaction, resulting in a more consistent and effective care system. Professional carers will use the application to fill in short, pre-defined, patient-orientated questionnaires after home visits that are then stored by the application for later review. Family members will then have instant, clear and easy access to view this information via a personal device. The information captured could include objective observations such as whether the care receiver had eaten, washed, been changed or taken their medication. Alongside these indicators of care, the carer could also capture subjective measures such as the patient's mood or whether they'd advise a family member to visit. Updates from professional carers will help to provide reassurance of the wellbeing of the care receiver when away from family members. For the professional care providers, better communication would help provide continuity as care responsibilities shift between professional and non-professional. Importantly for the care receiver, the application would help to provide a balance between professional care, family/friend involvement and independent living.



## 1.2 Aims and Objectives

In order to build a full functioning application that will provide professional carers with an easy method of updating non-professional carers on a home care visit, the following aim and objectives are crucial:

1. Aim: Understand the requirements of the targeted users and how other applications meet similar requirements.

### Objectives:

- Circulate a survey to professional and non-professional carers in order to establish
  - o What the constraints on professional carers are
  - o What families want to be updated on
  - o The types of questions that should be available on the applications questionnaire
  - o How users want to interact with the application
- Research existing applications in order to understand key feature gaps or successful techniques that could be replicated.

2. Aim: Identify the most appropriate technology stack and implementation approach.

### Objectives:

- Decide what technology choices are most appropriate.
- Choose a development language to be adopted
- Establish how data can be stored securely.
- Investigated the platform that the application should be deployed on e.g. iOS, Android, Web

3. Aim: Design and develop an application to meet the functional and non-functional requirements.

### Objectives:

- Design and implement the database, client and server structure.
- Design and implement how data will flow through the system.
- Design user flows
- Think aloud usability testing for prototyped design

4. Aim: Ensure that the application successfully meets the requirements

### Objectives:

- Perform functional testing based on user flows
- Perform non-functional testing, for example to validate error handling

5. Aim: Evaluate the final solution.

### Objectives:

- Evaluate solution against initial objectives
- Gather lessons learnt to improve future development

## 2. Background

This section will focus on the wider context of the problem that the project aims to tackle and research existing applications in similar care subject areas.

### 2.1. Carer communication issues and associated risks

A professional carer is someone whose profession is to provide care services to others. There are many different types of carers but for the purpose of this discussion, professional carers will be defined as those who are paid to provide care and support to individuals living at home. A non-professional carer is anyone who is not paid to do so, but cares for someone who cannot cope without their ongoing support as a result of factors such as illness, disability, mental health problems or an addiction. Around 7 million people in the UK are non-professional carers and predictions show that by 2030, this will increase by around 60% [CarersTrust (1)]. Therefore, for many elderly, disabled or ill people in the UK, both professional and non-professional carers support their life at home.

There are multiple different agencies that can provide professional home care. Typically, once a home carer has visited a patient, they will record their visit on paper-based charts. If making use of technology, the system will focus on the needs of the care agency and will not aim to share information with the family or friends of those being cared for. Care will usually be provided by a team of care workers assigned to that persons care and so the same carer will not visit every time [NHS (1), 2018]. As a result, the non-professional carers have no easy or regular way of being updated on this care unless they are physically present at the time of every visit. This creates a risk of there being a lack of consistency of care between both parties, ultimately having a negative impact on the person in need of help. Importantly, it also creates additional stress and work for non-professional carers who struggle to balance caring for someone and maintaining a healthy life. Being a non-professional carer can have a great impact on both mental and physical wellbeing; many people have money struggles as they've had to give up or reduce their paid work; they can be isolated from their friends as they rarely leave the person they care for alone in the home; and they can be physically exhausted from struggles such as being up during the night [CarersTrust (2)]. Statistics show that family carers are more than 50% likely to have bad health when compared to non-carers. As many as 72% of people felt more anxious since becoming carers and nearly 50% suffered from depression [CarersUK (1)]. Better communication methods between the stakeholders involved in an individuals care could help to mitigate these issues. The use of technology is an obvious option to tackle this requirement.

## 2.2 Technology in the healthcare industry

Worldwide, people have become obsessed with tracking every aspect of their lives; this includes what they have eaten that day, their sleep cycles and even monitoring their pets when they are not present. Many industries have revolutionised their business model using technology. An example of this is Royal Mail who has undertaken one of the largest IT transformation programmes across the UK and Europe to incorporate technology into their core business function [Royal Mail Group]. In the Healthcare section there is still significant room for improvement. At this point in time, it's likely that we would be able to get a faster update on the location of our online shopping than we would a health update on a loved one under supervision of professional care. From a medical perspective, technology is completely changing the way we care for people, "in the coming years, 5G will enable surgeons to perform robotic operations from other continents. Augmented reality will change our understanding of the human body. AI will help us fight illnesses that have defeated even the best care givers" [The telegraph, 2018]. However, there is still massive room for growth when focusing on the administration of healthcare in UK.

NHS Digital [NHS Digital, 2017] is a national information and technology partner to the health and care social system. Their vision is to "harness the power of information and technology to improve health and care". The service is trying to improve all aspects of health and social care using technology. Figure 2 shows their current aims for 2017 - 18, it is clear from the diagram that there are a number of areas that could benefit from technology. One of their focuses is 'Paper Free at point of care' which they have invested £10.3 million (revenue) and £100,000 (capital) in. The digitalisation of currently paper-based care methodology could be adopted and applied to care agencies working outside of the NHS.



**Figure 2:** NHS Digital 2017-18 plan

In terms of setting up new technologies for care provides, whilst there is an upfront cost, the result of using more efficient and advanced systems could result in improved care for a person. As a result of enabling an easier care system, it could also improve the health of non-professional carers who are using other health services to cope with their own mental and physical health problems as a knock on effect of caring. The outcome would therefore decrease the number of people requiring healthcare support and result in the government having more money to invest in other areas.

## 2.3 Existing Product Research

Research was conducted on two applications: Care.ly and Medici:

### 2.3.1 Care.ly

As a result of personally caring for a family member and participating in a residence programme living in a care home for a week, Micheal Eidsaune was inspired to support families with a loved one in care by leveraging technology to enable sharing of care-giving information [Care.ly]. He developed the application 'Care.ly' which aims to simplify communication for caregivers. There are two core functions of the app:

- the first is creating a care network of family members caring for an individual. Within this care network, families are able to provide updates on details such as, calendar appointments; patient mood, whether they have visited and they can also post pictures and general comments.
- the second feature is the partnership with care providers to create 'Care Provider Pages'. Information regarding general care or provider facilities that are typically distributed on paper leaflets or booklets, are digitally accessible from within the app. Family members who use the app can share these pages with each other without the need to make copies of, or re-explain, the information.

This application is an excellent example of the use of technology to digitalise typically paper-form care information, making it more easily accessible to a group of carers and also enabling instant updates on patient wellbeing. However, the sharing of information regarding a specific care receiver is isolated to family networks. Care providers have access to the system but the data they share is limited to generic organisation details and services. Therefore, this application does not resolve the problem of professional care providers being able to update non-professional care providers on the wellbeing of their loved one. The non-professional carers still need to be present to get updates. This is the issue that the proposed Carer Communication app aims to tackle.

The structure of the Care.ly application is similar to that of a 'FaceBook' feed where updates are shared between family members via a newsfeed. The Carer Communication App will adopt a different approach, as it will focus on a repeatable, standard method of sharing information, in the format of a pre-defined questionnaire. The driver for this is that the person inputting the information will be the professional carer, who is likely to be working in a time pressured environment. The application aims to provide a simple, instantaneous method of communicating updates to non-professional carers that can be easily incorporated into professional carers daily routines.

### 2.3.2 Medici

Medici [*Medici*] is a mobile application that has been designed to allow direct communication between healthcare providers such as Doctors, Vets and Therapists. The key features of the application are: direct communication with a doctor; the ability to directly pay per consultation; and the ability to order prescriptions straight from the pharmacy. Importantly, Medici stores a history of all messages. Founder and CEO Clinton Phillips said the app “focuses on reinventing the doctor-patient relationship and reforming how healthcare is practiced and delivered by offering patients and medical professionals a more streamlined and compliant system of communication and record-keeping” [*Business Wire*, 2017].

This application is a great example of the use of technology to improve sharing of healthcare related information but is limited to communication between an individual and their healthcare providers. The proposed Care Communication app also aims to streamline correspondence, provide better record keeping and enable fast communication but instead focuses on the communication between multiple carers, taking care of a person at home. In addition, the method of communication in the Medici app is bilateral communication via text. Whilst this is a feature that the Care Communication app could look to offer, the initial focus will be on providing a method for the professional caregiver to give a quick, simple and repeatable update on a home care visit that can be instantly viewed by multiple non-professional carers i.e. multilateral communication.

## 2.4 Statement

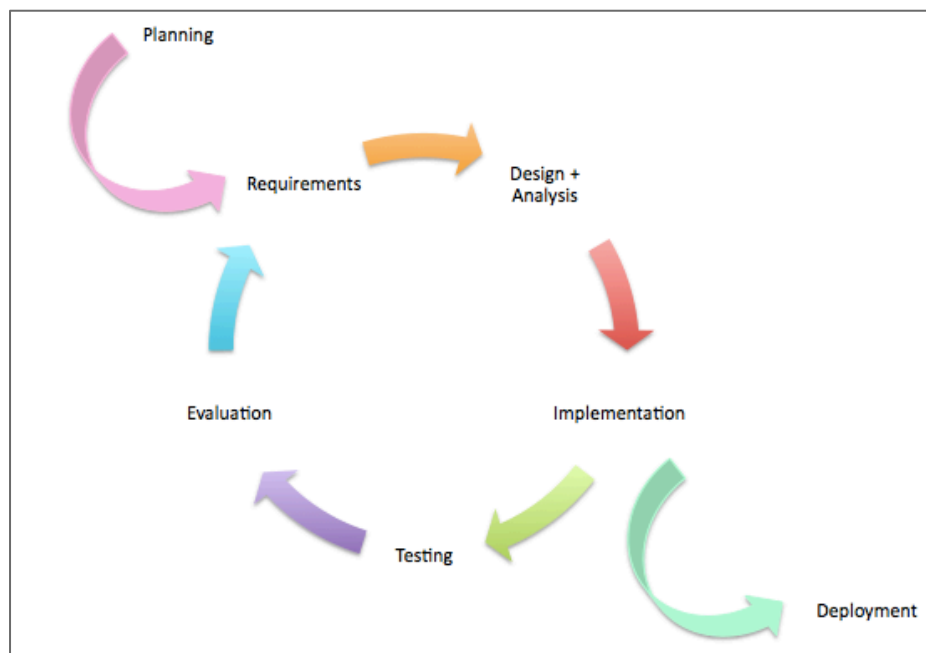
The aim of this project is to develop a functional application that will provide professional carers with an easy method of updating non-professional carers on a home care visit in order to help reduce stress, anxiety and mental health problems for friends/family and ensure they are more informed on overall patient care.

### 3. Project Approach

The chosen development approach for the project was iterative, as shown in figure 3. This approach was chosen in preference to a waterfall approach for multiple reasons. Firstly, if a waterfall approach had been adopted, then the planning phase would have to be done before any implementation could take place [Kienitz, 2017]. Due to the timescale of this project, this doesn't leave a great deal of flexibility e.g. if the early preparation phases took longer than expected, it could leave no time to implement. In waterfall development, it can also be hard to make changes along the way due to the fixed sequence of steps required. This can result in important phases such as testing being left until the end of the project, with increased risk of impact due to design or development errors found late in the project [Lucidchart Content Team, 2017].

Another approach that could have been used is Agile; this focuses on incremental delivery, team collaboration, continual planning, and continual learning [Bjork, 2017]. The main reason for not adopting this approach is that this is a one-person project. Agile is excellent for delivering projects with multiple stakeholders and teams involved as it has a variety of techniques to combat communications issues between groups working on the same project e.g. stand ups, planning poker, demos. It also focuses on 'working' software, over documentation; in this project documentation cannot be compromised.

An iterative approach allowed for core functionality to be developed early in the software development cycle and refined in later cycles. It was easier to adapt the project to changes in requirements discovered throughout the process. [Professionalqa, 2018]. The feedback from successive testing and product demonstrations produces improved design and implementation quality throughout the cycles.



**Figure 3:** Iterative development methodology

## 4. Requirements Gathering

To gather requirements for the application, the following activities took place:

### 4.1 Initial Requirements

After background research, an initial set of requirements was drawn up (Appendix A). These requirements covered all core functionalities to be performed by the application. To improve these requirements and the understanding of the problem, two surveys were created and distributed to professional and non-professional carers.

### 4.2 Survey Distribution and Analysis

The surveys were created to help gain insight on the two groups of carers the project is aiming to help. The first survey was distributed to the non-professional carers and aimed to find: what their current situation is; if they feel there is a need for better communications from the professional carers; and if so, what questions they would like to see on the application. The second survey was designed for professional carers. The main focus of this was to find out what current systems are in place and investigate whether carers would feel happy using an application like this in their day-to-day work. It was also intended to find out whether they would be allowed by their agencies to use an application like this and what information they feel they would/would not be allowed to share.

#### 4.2.1 Methodology

After ethical approval had been granted (Approval ID: COMSC/Ethics/2018/002), surveys were created using 'Google Forms' (Appendix C). Using this software ensured that all of the survey answers were stored securely and provided anonymity. The surveys were then distributed to current professional carers and non-professional carers.



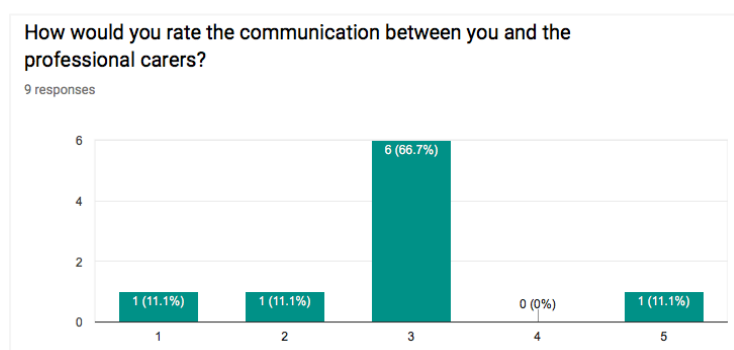
### 4.2.2 Analysis of results

Results from the two surveys are shown below:

#### Non-professional carers

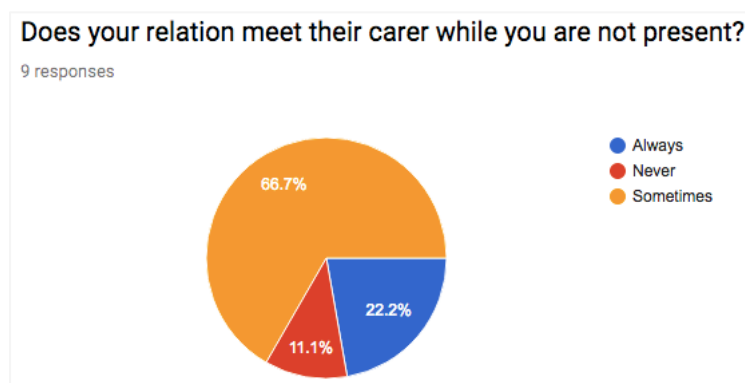
Nine non-professional carers participated in the survey. The following findings were gathered:

Figure 4 shows that majority of non-professional carers rate the communication between themselves and professional carers at 3 or less, out of 5. Initially, these figures support evidence that communication with professional carers is not effective.



**Figure 4:** Rating of communication by non-professional carers.

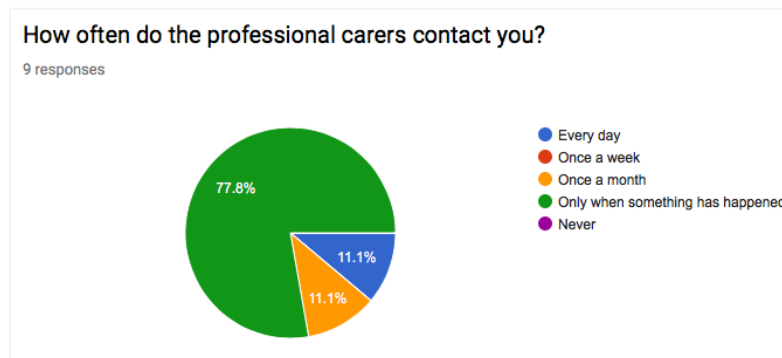
Figure 5 demonstrates whether non-professional carers tend to be present when the professional carer visits. If non-professional carers were always present then communications via an application would be unnecessary. It is clear from the results that only one participant is always present when a professional carer visits. In all other cases, the person is sometimes or never present when the professional carer visits.



**Figure 5:** Non-professional carer presence when care visits take place

Figure 6 highlights how often professional carers currently contact non-professional carers. From the results, it can be seen that in most situations, a care provider will only contact the non-professional carers if an incident has occurred. Only 1 out of 9 participants received daily updates and it is likely that

this was the one person that confirmed that were always present for carer visits (figure 5). This finding highlights that currently non-professional carers are not receiving daily communications from professional carers.



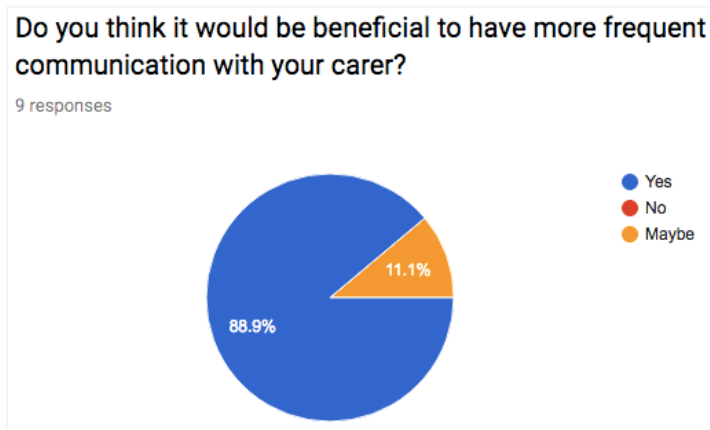
**Figure 6:** Frequency of professional carer contact

The next question aimed to find out how the non-professional carers currently contact the professional carers. From figure 7, it can be seen that the main method of communication is via the non-professional carer getting in contact with the care agency. This demonstrates that there is no defined method of the professional carers keeping family/friends updated without additional work on their behalf.



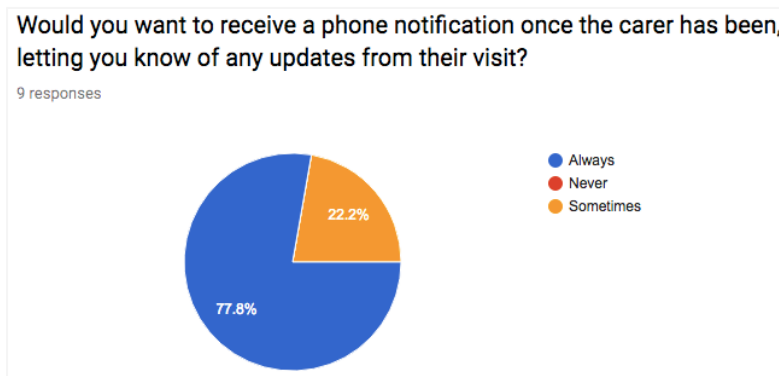
**Figure 7:** Method of carer communication

One of the most important investigations within the survey was to understand if non-professional carers would actually appreciate frequent communication with the professional carers. Figure 8 shows that 8 out of 9 participants said that 'yes' they think it would be beneficial to have more frequent updates. This validates the need for a 'carer communications app'.



**Figure 8:** Frequency of professional carer contact




Figure 9 shows that 7 out of 9 of participants would be happy to receive mobile notifications from professional carers after they've visited to provide updates. The 'Carer Communications App' will look to provide this functionality and these results again validate the app requirements.



**Figure 9:** Phone notification updates

Survey participants were given a list of ten possible questions that the professional carers would answer after a home care visit and graded these questions according to whether they were 'always very important', 'could be generally useful' or 'not important'. The results of this are displayed in Figure 10. 63 out of 72 votes against all questions were 'always very important', no one marked any questions as 'could be generally useful' and only 9 out of 72 votes against all questions were 'not important'. This demonstrates that non-professional carers would find it very important to be informed about a range of objective and subject questions. The most sought after objective question was whether the patient had taken their medication and in terms of a subjective question it was whether the professional carer would advise a family member or friend to visit. The least desired question was whether patients needed any items picking up for them which was the only question is unrelated to the person's wellbeing. Taking these results into consideration, the first 7 questions were added to the application.

Questions	Number of Participants								
	1	2	3	4	5	6	7	8	9
If the care provider is responsible for feeding, how well did they eat?									
If the care provider is responsible for personal care such as washing/bathing, were they able to provide this service?									
If the care provider is responsible for changing the client, were they able to provide this service?									
If the care provider is responsible for giving medicine, was the person you care for cooperative?									
As a relative measure, how was their mood e.g. normal, happy, down, in pain, lonely									
In the carers opinion, would they advise an additional family visit									
If the carer had any specific problems that you would like to inform the family of									
Do they need any essential items picking up for them e.g. milk, loo rolls...									

Always very important   
 Could be generally useful   
 Not important 

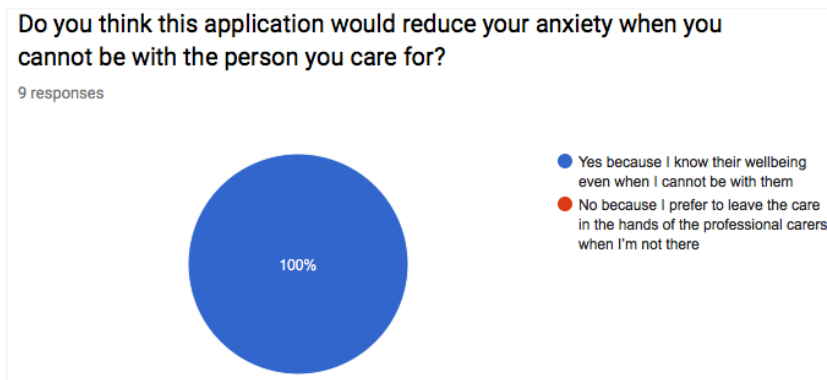
**Figure 10:** Possible questions for the ‘Carer Communication App’ questionnaire and how non-professional carers would value that information

Participants were asked if they would like to add any additional questions to the application. The only response received was ‘General state of house and living conditions’ (Figure 11). Due to the question not being linked to the wellbeing of the patient, it was decided not add this to the requirement list but it could be added in future and is an example where flexibility to customise the questions could be a useful extension.

General state of the house and living conditions

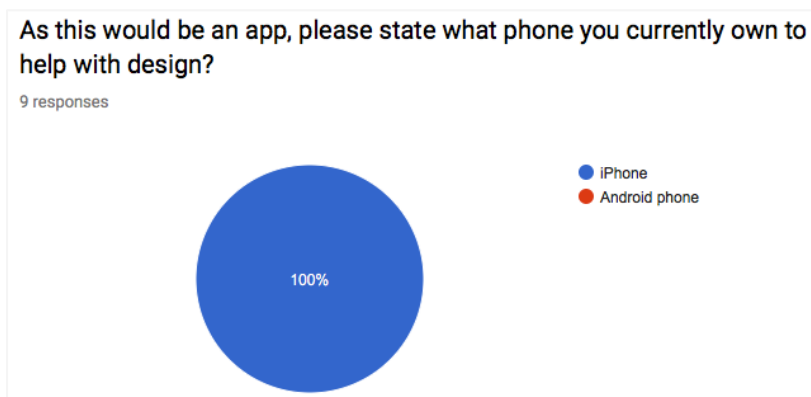
**Figure 11:** Additional questions response.

Analysis earlier in this report (section 2.1) showed that non-professional carers can have high levels of stress and anxiety. One key intention of this project is to tackle this. When participants were asked if they felt this application would reduce their levels of anxiety, all 9 participants said ‘yes it would reduce their anxiety as they would know the patient wellbeing even when not present’ (figure 12). This highlights that the application concept will hopefully reduce stress and possible health problems in non-professional carers.



**Figure 12:** Reduce anxiety in non-professional carers response

Figure 13 was aimed to identify which platform the app should be developed for; all participants currently have iPhones so this will be considered during app design.

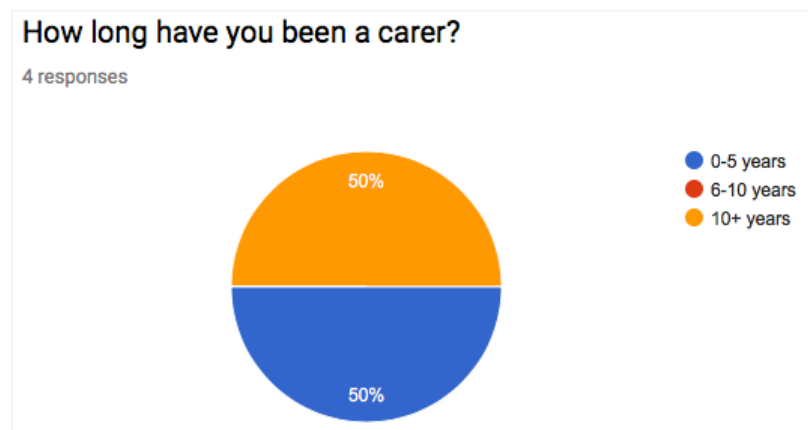


**Figure 13:** Current mobile device used by non-professional carers

## Professional Carers

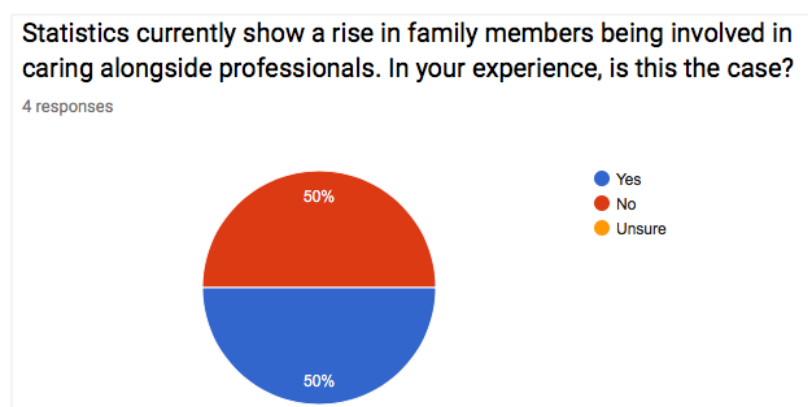
4 professional carers participated in the survey. The following findings were gathered:

Figure 14 shows that out of the 4 participants that took part, 2 have been professional carers for between 0-5 years and 2 have been carers for +10 years. The diversity of career length was helpful in validating results, especially when questions are asked about previous experience.



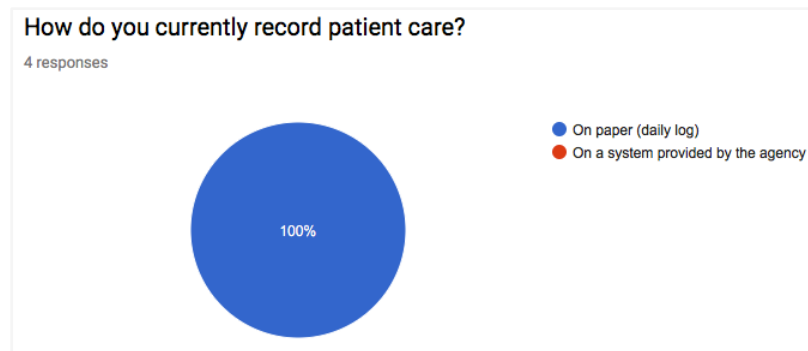
**Figure 14:** Carer career length

Interestingly, statistics show that the number of non-professional carers involved in caring for individuals has increased and is still increasing. However, only 2 out of 4 professional carers who were asked if they had experience this said yes (figure 15). One hypothesis to describe this result is that two of the participants career length was shorter and therefore they may not have been in the career long enough to see a change. Another factor could be that non-professional carers said they don't always stay with the patients during a visit and therefore the professional carer won't notice their involvement (figure 5).



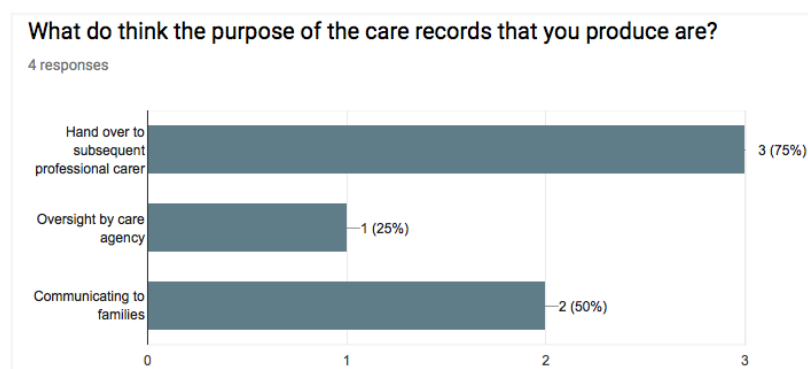
**Figure 15:** change in professional carers involvement in patient care

Figure 16 shows the results of professional carer's current method to recording patient care. All four carers said they still use paper daily logs to record visits. This supports the evidence that there is a lack of technology used by the industry and confirm that non-professionals do not receive visit updates through any current system.



**Figure 16:** Current method to recording patient cares

When carers were asked what they thought the patient records were used for, there were several results as shown in figure 17 (participants could select more than one answer). The most common response was that care records are produced to hand over to the subsequent professional carers and for communicating with families. This shows that non-professional carers are expected to access the records but again assumes they will visit the patient house. Only one participant felt the purpose of records were for oversight by agencies. This supports the proposed Carer Communication app as this aims to give families easy access to the patient notes and allow the professional carers to view previous visits.

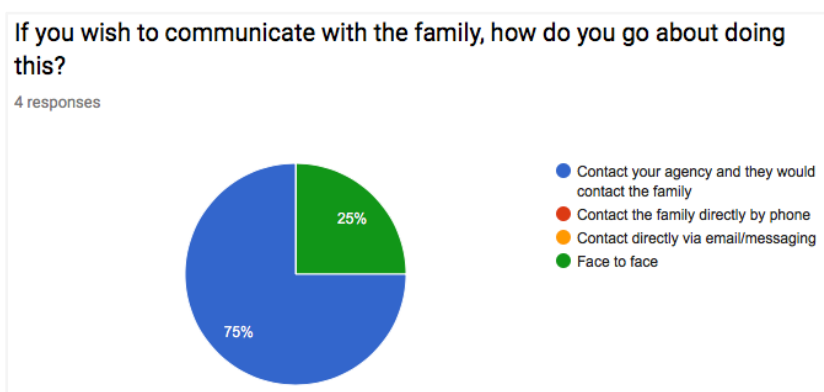


**Figure 17:** Current method to recording patient cares

When participants were asked how they communicate with the families and if they know who the main point of contact is for a patient, the results showed that 3 out of 4 always had a specified point of contact (figure 18) and that the majority of carers would not directly contact family members but contact their agencies that would then ring the family (figure 19). This is consistent with the result of the non-professional survey, where participants said they are normally contacted by the agencies (figure 7). One participant said that if they want to speak to a family member, they would do it face to face. This was likely to be a case where the family member is always present at the time of the visit, which is not often the case according to the non-professional survey answers (figure 5).

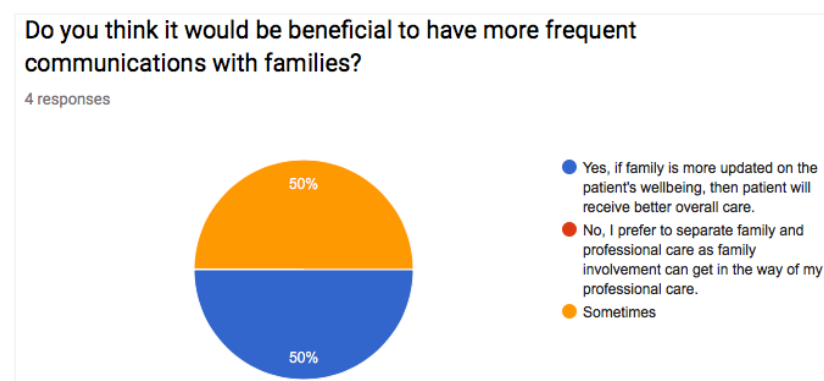


**Figure 18:** Professional carers main point of contact



**Figure 19:** Current method of communicating with non-professional carers

Figure 20 shows the answers when professional carers were asked if they thought it would be beneficial to have more communications with the families: half said 'Yes because the patient will receive better overall care'; and half said 'Sometimes'. These responses are overall positive and show that carers think more frequent communication would be beneficial or at least beneficial in some cases.

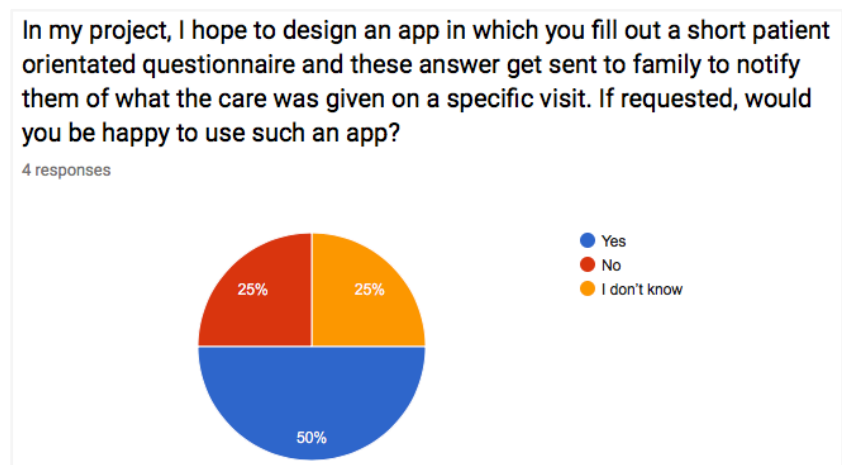


**Figure 20:** Current method of communicating with non-professional carers

The carers were given an explanation of what the 'Carer Communication App' aims to achieve. They were then asked whether they would use this application if a family member asked them to. The responses to this question were mixed with

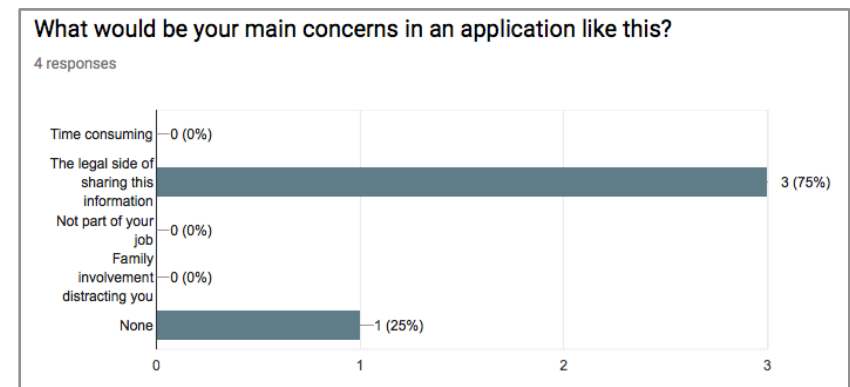


2 of 4 stating that they would be happy to use the app, 1 participant stating that they wouldn't be happy and 1 participant unsure (figure 21).



**Figure 21:** would professional carers use carer communication app

When participants were asked what the main concern of an application like this would be, the results showed that it was the legal side of sharing this kind of information that was a big concern to them (figure 22). It could be assumed that this led to 2 people answering more negatively on the previous question (figure 21). For this application, it may be best practise for the professional carers to talk to their agencies before using the application with families, and ensure that the information they are answering is in line with data sharing guidelines.



**Figure 22:** main concerns for a mobile application

The following table is a representation of questions proposed for the application. It focuses on two key aspects:

- a) Whether the carer would be able to provide the information
- b) How valuable they think these answers would be to families

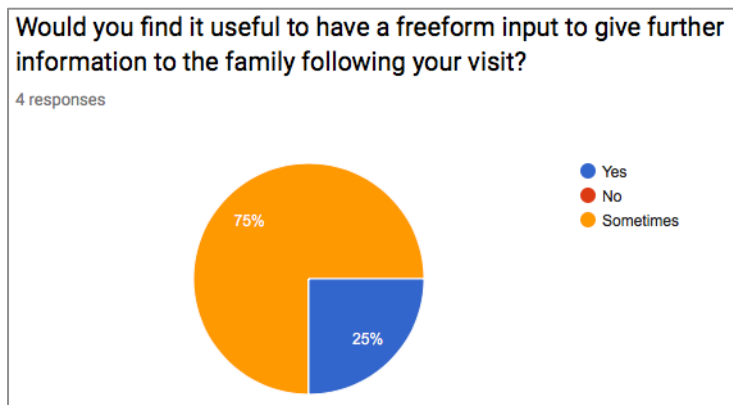


**Figure 23: proposed questions**

As shown in figure 23, in almost all cases the carers can provide the information (question a's). However, the majority of the time only half of the carers felt the question answers would be important to families (question b's). When non-professional carers were asked the same question the overwhelming majority said the answers were very important to them (figure 10). This provides further evidence of the disjointed relationship between the two types of carers.

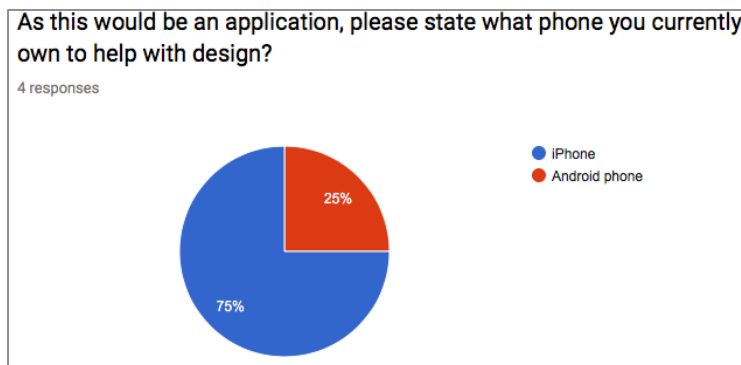
2 out of 4 professional carers said that they would not be able to provide information on items being picked up for carers. Non-professional carers felt this was also the least important question for them to answer, therefore will not be put as a question requirement.

Figure 24 shows that most carers would sometimes find it useful to have a free text section where they could add additional visit information for patients. This requirement will therefore be added but made a not required field.



**Figure 24:** free form input question

Figure 25 was aimed to identify which platform the app should be developed for; 3 out of 4 participants currently have iPhones and 1 has an Android device. This will be considered during app design.



**Figure 25:** current device used

### 4.3 Requirement Refinement

The aim of this project is to develop an application that enables professional carers to update non-professional carers on a home care visit, with one of the main goals being to help reduce mental and physical health problems of non-professional carers by ensuring they are easily informed on overall patient care. The survey results validate the need for an application like this as non-professional carers want to be more frequently updated on patient care. As well as validating the need for an application, the survey results are instrumental in informing the questions that will be implemented on the apps patient survey.

Following the survey initial requirements were refined in order to ensure they were meeting user needs. The table below shows the refined requirements that will be followed through to design and implementation (Appendix B includes original requirements with comments on whether they were kept, changed or removed).

	Use Case	Acceptance Criteria
EPIC: Care Network Maintenance		
1	As a user I want to create an account.	User should be able to create an account when first accessing the site. Sign up information will include first name, last name, email, password and role. Following this, an account should be created.
2	As a family member, I must be able to sign up a new patient once I have created my account so that I can view the patient's visits.	Add a new patient to the application. New patient sign up information will include first name, last name and postcode.
3	As a family member I want to be able to have access to the patient's unique code so that I can give it to other family members and carers.	Ability to see unique patient code once on the application.
4	As a family member, I must be able to join a patient group once I have created my account so that I can view the patient's visits.	Join a patient group by having access to their unique code.
5	As a family member I want overall control of who can access the patient's information so that I know it is secure.	Family members can view who is in the patient group.
6	As a family member I want the ability to remove a carer from a patient group so that patient information is managed.	Ability to remove carer from a patient group.
7	As a family member I want the ability to remove a family member so that patient information is managed appropriately.	Ability to remove family member from a patient group.

	EPIC: Account Maintenance	
8	As a user I must be able to reset my password so that I can still log in if I have forgotten it.	Ability to reset password on the login page.
9	As a user I want to be able to log into the system using my credentials so that I can access my profile.	Log in successful if correct credentials are used
10	As a user, I want my account to be logged out of when I close my browser.	User logged out when leaving website.
11	As a user I want the ability to delete my account so that when I no longer need it all my information is removed.	Ability for user to delete account. Information about user deleted from system when account has been deleted
	EPIC: Care Visit	
12	As a carer I want to select the patient so that I can complete a questionnaire for them after my visit.	Ability when opening the application to a specific patient
13	As a carer I must answer the questions on the questionnaire so that I can inform families of patient wellbeing.	Ability to answer the questionnaire
14	As a carer I want to be able to submit a questionnaire where not all questions are filled in so that I do not need to fill in unnecessary information for a visit.	Ability to submit questionnaire answers where not all fields have been filled in
15	As a carer I must submit a completed questionnaire so that families can view my latest visit.	When submit button is pressed visit is updated to patients visit list.
16	As a family member I want to receive a phone notification when a carer has submitted a questionnaire so that I know when a new visit has been submitted.	Phone notification appears when new questionnaire is submitted by carer
	EPIC: Previous Visits	
17	As a family member I want to view the latest visit updates so that I can see how the person I care for is.	Ability to view the information sent by the carer on the screen
18	As a family member I want to view previous visit information so that I can see trends in the care receiver's behaviours.	Ability to look at a page with all the information regarding previous visits
19	As a family member I want to be able to search for a specific day on the history page so that I can look up the visits from that day.	Search functionality so that the history page can be viewed by day

20	As a family member I want to be able to search the visit history by carers name so that I can see what patient questionnaires that were filled in by a specific carer.	Search functionality so that the history page can be viewed by carer
21	As a carer I want to be able to select a patient and see all of their previous visits (not just the ones done by myself) so that I can review previous notes left by other carers.	Search functionality so that the history page can be viewed by carer
22	As a carer I want to be able to view my previously submitted questionnaires on a patient so that I can see trends.	Search functionality on patient by the history page can be viewed by carer
EPIC: Questionnaire		
23	As a family member I want to be able to select the questions that are relevant to the care receiver so that irrelevant questions are irradiated.	Ability to select what questions you want to the questionnaire
24	As a family member I want the ability to add a new question relevant to my patient to the questionnaire so that the questionnaire can adapt to my patient needs.	Ability to add a question to the questionnaire
25	As a principle family member I want the ability to delete a question from the patient's questionnaire so that the questionnaire can adapt to my patient needs.	Ability to delete a question to the questionnaire
EPIC: Questions		
26	As a carer I want to answer a question on whether the patient has eaten so that I can send the answer to the families.	Question asking if patient has eaten.
27	As a carer I want to answer a question on whether the patient has taken their medication so that I can send the answer to the families.	Question asking if patient has taken medication.
28	As a carer I want to answer a question on whether the patient has been washed/bathed so that I can send the answer to the families.	Question asking if patient has been washed or bathed.
29	As a carer I want to answer a question on whether the patient	Question asking if patient has been changed.

	has been changed so that I can send the answer to the families.	
30	As a carer I want to answer a question on patient mood so that I can send the answer to the families.	Question asking if patient mood.
31	As a carer I want to answer a question to advise a family visit so that I can send the answer to the families.	Question on whether family visit would be advised
32	As a carer I want to answer a question on any additional items that need picking up so that I can send the answer to the families.	Question on additional items.
33	As a carer I want to have an additional free text field so that I can inform family of any additional information from a visit.	Free text box added.

## 5. Technology Decisions

The following section will detail the stages for choosing the best technology solution to build the carer communication app.

### 5.1 Mobile development methodologies

#### 5.1.1 Theory

Mobile applications can be built as Native apps, Web apps or Hybrid apps. Each approach has advantages and disadvantages and it is important to use the model that best fits the project objectives. In order to determine which approach to use for a carer communication application, a critical evaluation has been conducted for each development method.

Native applications are developed for one specific platform e.g. Objective C for IOS, java for Android. As a general rule they provide a better user experience. This is because they are not limited by the need to function across multiple platforms and can therefore optimise all available device features [Budi, 2013]. As a result this increases efficiency and makes these applications faster than others [Viswanathan, 2018]. A downside of a native app is that often experienced developers are needed as the languages are complex, they are typically more costly and they can be over-complex for the development of simple apps. [Dua, 2018].

Web applications use a web browser on a device to display an application. They use web technologies such as JavaScript, HTML and CSS to display and style content [Morony, 2015]. The advantages of a web application are that you can build one application for all platforms as long as it can run a browser. They are very simple to build and maintain and do not need to be downloaded resulting in taking up no device storage for the user [Dua, 2018]. However, one main disadvantage is that the application can only be accessed when the user has Internet connectivity reducing its availability [Fox, 2015]. They do also lack the functionality of a native application e.g. push notifications, some device hardware such as vibrations and also certain touch gestures. The only access to the application is through the URL; this can affect user experience compared to clicking on an app icon. [Dua, 2018].

Hybrid apps are web pages in the native browser e.g. UIWebView in iOS. They are developed in HTML, CSS and JavaScript, and then wrapped in a native application using platforms e.g. Cordova [Ziflaj, 2014]. There are many advantages to hybrid app development, firstly it has a single codebase with cross-platform support, it is much quicker and costs less to develop than other web technologies. The applications can also then be downloaded from their relevant app stores [Vaughan et al, 2017]. However, they can work out more expensive than a web app because of the use of wrappers e.g. third party platform. They can be less interactive than a native app because you cannot develop using specific platform functionality [Dua, 2018].



### 5.1.2 Discussion

Approach best used for this 'Carer communication application ' project:

	Advantages	Disadvantages	Discussion
Native	<ul style="list-style-type: none"><li>• Excellent functionality</li><li>• Phone icon to open</li><li>• Best user experience</li></ul>	<ul style="list-style-type: none"><li>• Only supports one platform</li><li>• Experience in development language required</li></ul>	Availability by multiple platforms exceeds need for the best user experience.
Web	<ul style="list-style-type: none"><li>• Available on all platforms</li><li>• Simple to build</li><li>• No user storage required</li></ul>	<ul style="list-style-type: none"><li>• Lack of functionality e.g. push notifications</li><li>• User experience not as pleasing</li></ul>	Excellent platform availability. Simple care application so lack of certain platform functionality won't matter. No push notifications may affect user experience for visit updates.
Hybrid	<ul style="list-style-type: none"><li>• Available on multiple platforms</li><li>• Single code base</li><li>• Phone icon to open</li></ul>	<ul style="list-style-type: none"><li>• Involvement of third party platform</li><li>• Lack specific platform functionality</li></ul>	Good for platform availability. Simple care application so lack of certain platform functionality won't matter.

### 5.1.3. Decision

Application will be built as a web application. Future work will be turning web application into a hybrid application by using wrappers. This will then allow for notification updates to be implemented.

## 5.2 Web application architectural style

### 5.2.1 Theory

The two most prominent approaches to building a web application are:

- Traditional style, in which most of the applications logic is on the server
- Single paged application whereby the main user interface logic is implemented in the web browser and data is read and written through the server by using the Web APIs [Acadgild, 2017].

A key advantage to using the traditional style web page approach is that all of the business logic and data are kept on the server and users do not have access. This approach is very secure [Yaskevich, 2017]. However, development can become rather complex as client and server code is tightly coupled. This typically will result in a more lengthy application development phase [Skólski, 2016]. Another problem of using this approach is that a significant amount of time will be spent making requests to the server and waiting to receive responses. This can result in a poor user experiences, particularly with slow network connections [Acadgild, 2017]. The approach is therefore most commonly used for websites with static content rather than more dynamic web apps [Yaskevich, 2017].

Single paged applications (SPA) are much faster than the traditional web apps. This is because most of the resources such as the HTML, CSS and JavaScript are only loaded once. Subsequently, any changes require only transfer of data between the client and server. SPA's are also much easier to debug with browsers such as Chrome because you can monitor network operations, investigate page elements and view the associated data [Skólski, 2016]. Further advantages include the suitability to apply hybrid wrappers to transform the SPA into a mobile app - as discussed in (section 6.1.2) [Yaskevich, 2017]. However, a downside is that using a SPA requires additional focus on the security of the application. Attacks such as cross-site scripting (XSS) and man-in-the-middle must be considered e.g. XSS which enables attackers to inject client-side scripts into the web apps through user input fields [Skólski, 2016].

### 5.2.2 Discussion

The style best used for this 'Carer communication application ' project:

Architectural Style	Advantages	Disadvantages	Discussion
Traditional	<ul style="list-style-type: none"><li>• Higher security</li></ul>	<ul style="list-style-type: none"><li>• Longer development phase</li><li>• Best used for static web pages</li></ul>	Need application to be very fast and interactive for users. Pages are very dynamic.
Single web page	<ul style="list-style-type: none"><li>• Faster web apps</li><li>• Easier to debug</li></ul>	<ul style="list-style-type: none"><li>• Increased security risk</li></ul>	A fast application interface will enable users to have a good user experience. Ease of debugging will help in development phase. Careful development to increase security.

### 5.2.3 Decision

The application will be build using a single paged application. As a key benefit, a distinct API will be built which could allow the future development of a native application or integration into other applications.

## 5.3 Technology Stack

### 5.3.1.Theory

There are many technology stacks that could be used for server development e.g. Java/SpringBoot, Node.js/Express, C#/.net Web API.

Node.js uses an event-driven, non-blocking I/O model that makes it lightweight and efficient [Node]. This makes it perfect for data-intensive real-time applications that run across distributed devices [Stackshare].

.NET is a general purpose development platform. With .NET, you can use multiple languages, editors, and libraries to build native applications for web, mobile, desktop, gaming, and IoT for Windows, macOS, Linux, Android, and more [Stackshare]

A key element of Spring is infrastructural support at the application level: Spring focuses on the "plumbing" of enterprise applications so that teams can focus on application-level business logic, without unnecessary ties to specific deployment environments. [Stackshare]

### 5.3.2.Discussion

Architectural Style	Advantages	Disadvantages	Discussion
Java/Spring Boot	<ul style="list-style-type: none"><li>• Open Source</li><li>• Powerful</li><li>• Easy setup</li></ul>		Client and server in different languages
Node.js/Express	<ul style="list-style-type: none"><li>• JavaScript</li><li>• Good libraries</li><li>• Package management</li><li>• Very good for API's</li></ul>	<ul style="list-style-type: none"><li>• Single threaded</li><li>• Asynchronous programming</li></ul>	Client and server would be in same language allowing sharing of code.
C#/.net Web API	<ul style="list-style-type: none"><li>• Good documentation and support</li><li>• Good with MS stack e.g. MS SQLServer</li></ul>	<ul style="list-style-type: none"><li>• Must deploy on MS Windows o/s</li></ul>	Client and server in different languages

### 5.3.3.Decision

For this project, the Node.js/Express.js stack will be chosen primarily as this provides strong support for API development and a common language for client and server development i.e. JavaScript.

## 5.4 Database

The following section looks at the choice of technology for storing the application data i.e. users, questionnaires and visit records.

### 5.4.1.Theory

The two main database technologies that could be adopted are SQL and NoSQL. The primary difference between the two is that NoSQL doesn't involve the Structured Query Language [Gajani, 2017].

Relational databases (SQL) have a more structured, rigid method of storing data, e.g. a phonebook. In order to create an effective relational database, the data that needs to be stored must be organised in a very structured way. [Ashwini, 2017]

Non-relational (NoSQL) database are document-oriented and distributed, they are file folder like structures that can contain much more varied information such as a person's address and their online shopping preferences. [Wodehouse ].

Either database technology could be used without a significant disadvantage (SQL or NoSQL) but projects with very structured data are more suitable working with relational databases and projects with less structured data suit non-relational database structure. [Bitnine.net, 2018]

### 5.4.2 Discussion

Database	Theory	Discussion
Relational	<ul style="list-style-type: none"><li>Structured data</li></ul>	The data in the application will be very structured.
Non-relational	<ul style="list-style-type: none"><li>Unstructured data</li></ul>	The data in the application is not very fluid and therefore does not need to have a non-relational database structure.

### 5.4.3 Decision

The database will be built as an SQL relational database.

## 5.5 API

An Application Program Interface is going to be built to meet the main aim of the project, which is to make communication between non-professional and professional carers easier. In this project, a prototype web application is being built but by building an API, the core functionality can be released to the public and other software developers who can design products that are powered by its services e.g. incorporating it into other carer applications [Roos]. It will also mean that the functionality could be used on multiple platforms by building platform native user interfaces.

## 6. Specification

The following section provides details of the chosen technology being used for implementation and details techniques being used to keep high security within the application.

### 6.1 Technology Stack

This section details the chosen technology stack being used for implementing frontend and backend infrastructure. It also shows details of the packages and libraries utilised.

#### 6.1.1 Client-side

- HTML
  - The client side interface will be build using Hypertext Markup Language (HTML) which will be used to tell the web browser how to display the web page content [*w3schools HTML5 tutorial*]
- CSS
  - The style of the pages will be defined with Cascading Style Sheets using the W3.css framework. W3.css is a framework that is purely CSS based and suited to mobile web site development. It is cross-browser compatible and gives a simple approach to creating stylish web pages [*W3.css Tutorial*]
- JavaScript
  - JavaScript will be used to make the web pages interactive. In particular, JavaScript will be used to generate HTML for the data presented on the web pages. This will be achieved by using the JQuery library that includes Ajax for interacting with the server REST resources. [*JavaScript Tutorial*]
    - JQuery can be used to read and write data from the HTML DOM (Document Object Model). User inputs can be read from the DOM and sent to the server e.g. creating a new user. Data retrieve from the server can be formatted as HTML and written to the DOM e.g. writing a table of carer visits.
    - AJAX (Asynchronous JavaScript And XML) is part of JQuery and supports the HTTP protocol requests and responses necessary to send and receive data from the server e.g. GET /users/visit.

#### 6.1.2 Server-side

The website will be built using an architectural style REST (Representational State Transfer)

- Node.js
  - Node.js provides runtime environment in which JavaScript is executed. This allows JavaScript to be used for server-side development as opposed to JavaScript being executed in the browser for client-side.

- The Node.js technology stack includes a package manager (npm) that is used to download and install packages of code from other developers. The rich set of packages available assists with development for example Express.js for REST server development. [node.js]
- Express.js
  - This package is used to build API's and is particularly suited to developing RESTful interfaces. The package has many important features that assist in developing an API:
    - Handling of incoming and outgoing HTTP requests
    - Routing of HTTP requests (GET/PUT/POST/DELETE) to specific handlers
    - Chaining of handlers to simplify stages of the request processing i.e. validation of user credentials, request processing, error handling. [Express]

### 6.1.3 Libraries and modules

- uuid
  - This package is used to generate a uuid, which is a unique identifier. It would be almost impossible to guess a uuid as it is a very long string of characters. The library used to generate the uuid guarantees that you'd never get the same string twice i.e. you couldn't have two patients with the same uuid. [uuid]
- Jwt
  - JSON Web Tokens are a standard method for 'representing claims securely between two parties'. Their primary use in this application is for the server to provide a token to validated clients after login. Subsequently, the client sends the token with every request and the token is checked. The jwt package is used to generate and validate tokens. Tokens can be set to expire after a given period of time. [jwt]
- Bcrypt
  - Bcrypt is a 'password hashing function' that is used in this application to encrypt password before storing in the database and therefore protect against passwords being read. The bcrypt package support encryption and decryption of data using the Bcrypt hashing function. [bcrypt]
- Moment.js
  - The Moment package provides a set of utility functions for working with dates and times in JavaScript. In this application. Moment.js is used to format dates and times for display. [moment.js]
- MySQL
  - The MySQL package provide an interface to MySQL databases with many useful features including:

- Simple functions to perform SQL requests (SELECT/INSERT/UPDATE/DELETE) and execute callback functions to handle the data and errors returned by MySQL
- Connection pooling to allow a defined number of MySQL server connections to be shared across many users.
- Escaping query values to protect against SQL injection attacks. [MySQL]

## 6.2 Development tools

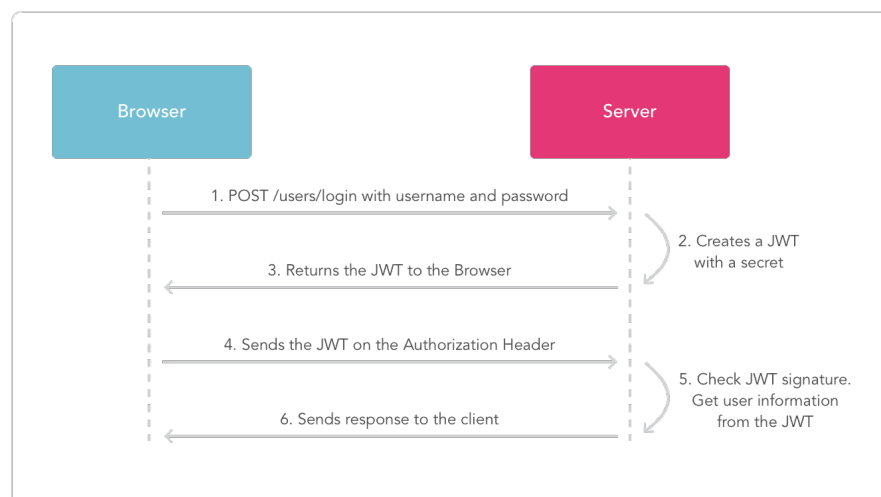
- WebStorm
  - JavaScript Integrated Development Environment developed tool designed by JetBrains. [JetBrains]
- phpMyAdmin
  - Administration of MySQL database from a web interface [phpMyAdmin]
- Google Chrome
  - Web browser with development tools that can be used for testing and client side debugging [Chrome]
- Gitlab
  - Web based git repository used for version control

## 6.3 Security

### JSON Web Token (JWT)

The system will be designed to ensure that all HTTP requests are from an authorised client i.e. a user login has been validated. Each HTTP request will be digitally signed using the JWT and therefore it will be known that the request has come from an authorised user. The JWT will include the user ID of the requestor allowing the server to restrict access to data based on business rules e.g. GET /visits will show a carer only the visits for their patients [jwt]

Figure 26 shows the how the JSON Web token process works:



**Figure 26:** How the JSON Web Token process works [jwt]

### Database

The database layer provides a level of security. The current set up involves access to the account via account name and password in the code. In the future, to add another layer of security this would be made into environment variables on the server and then have an encrypted password.

A JavaScript brycpt hash is used to store user passwords in the database (instead of storing the passwords as plaintext). The hash is used to check if the input password does or does not match the login details stored. The hash is not human readable and which means at no point will the password be exposed.

MySQL parameter placeholders have been written into the SQL statement to prevent any SQL injection attacks.

### HTTPS

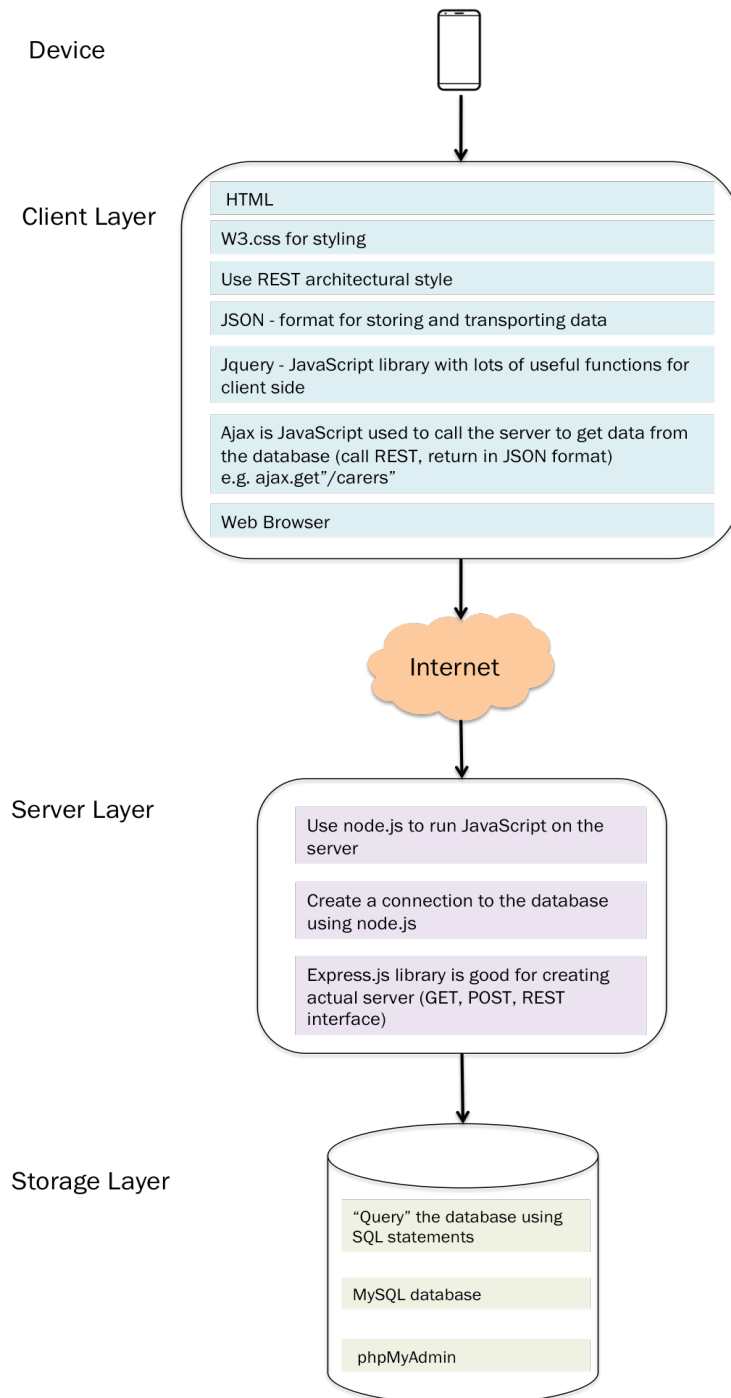
When the application is deployed, it would use Hypertext Transport Protocol Secure. This would encrypt the request/response data between client and server in order to prevent attack by intercepting data in transit. This is currently not being used as this is an application prototype and therefore code is running on a local host. HTTPS also requires a SSL certificate, so if the application were deployed this would need to be purchased and installed.



## 7. Designs

### 7.1 Technology stack

Figure 27 shows a visual representation of the overall technology stack chosen for development (section 6.1).

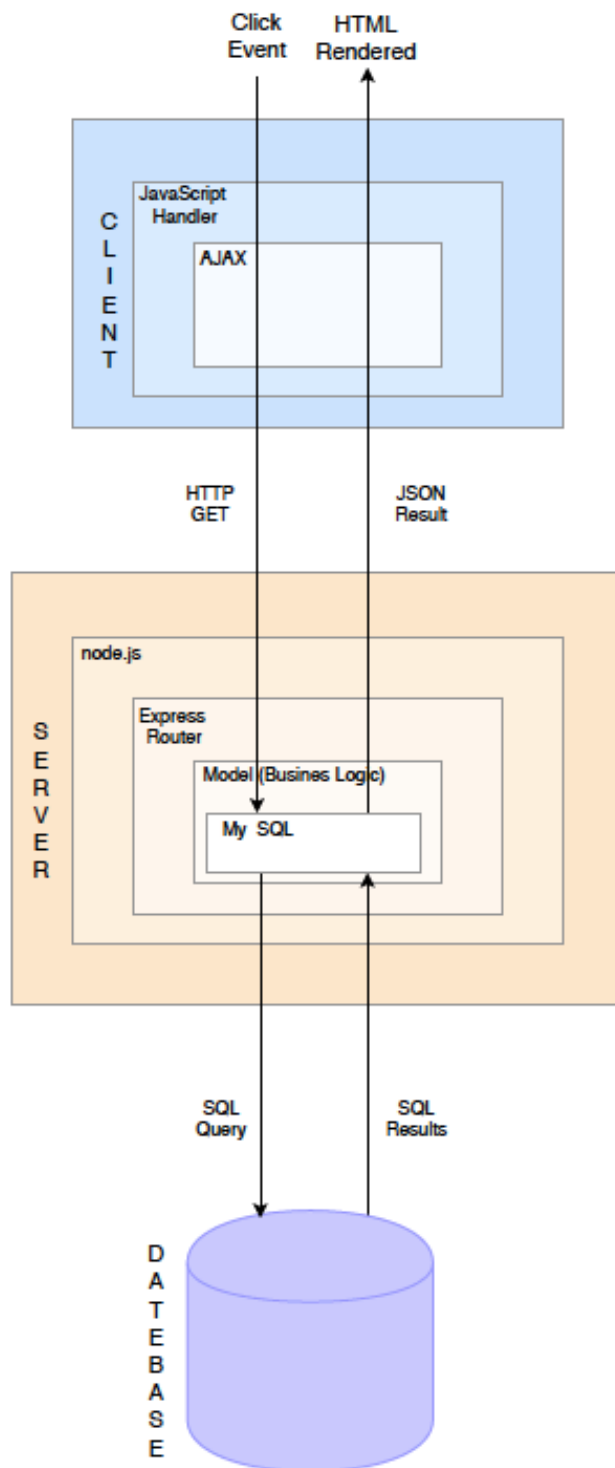


**Figure 27:** Technology stack design

## 7.2 Software Architecture

### 7.2.1 GET request

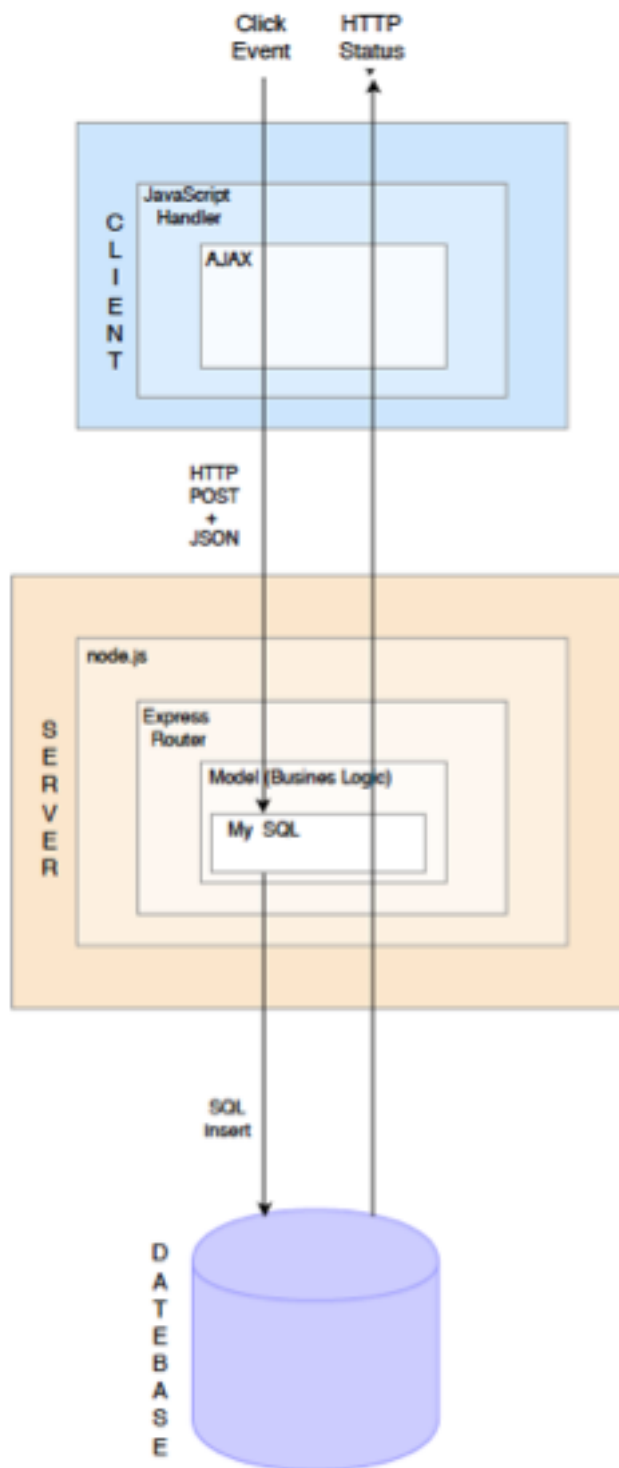
Figure 28 displays how a GET request will be handled by the system



**Figure 28:** GET request diagram

### 7.2.2 POST request

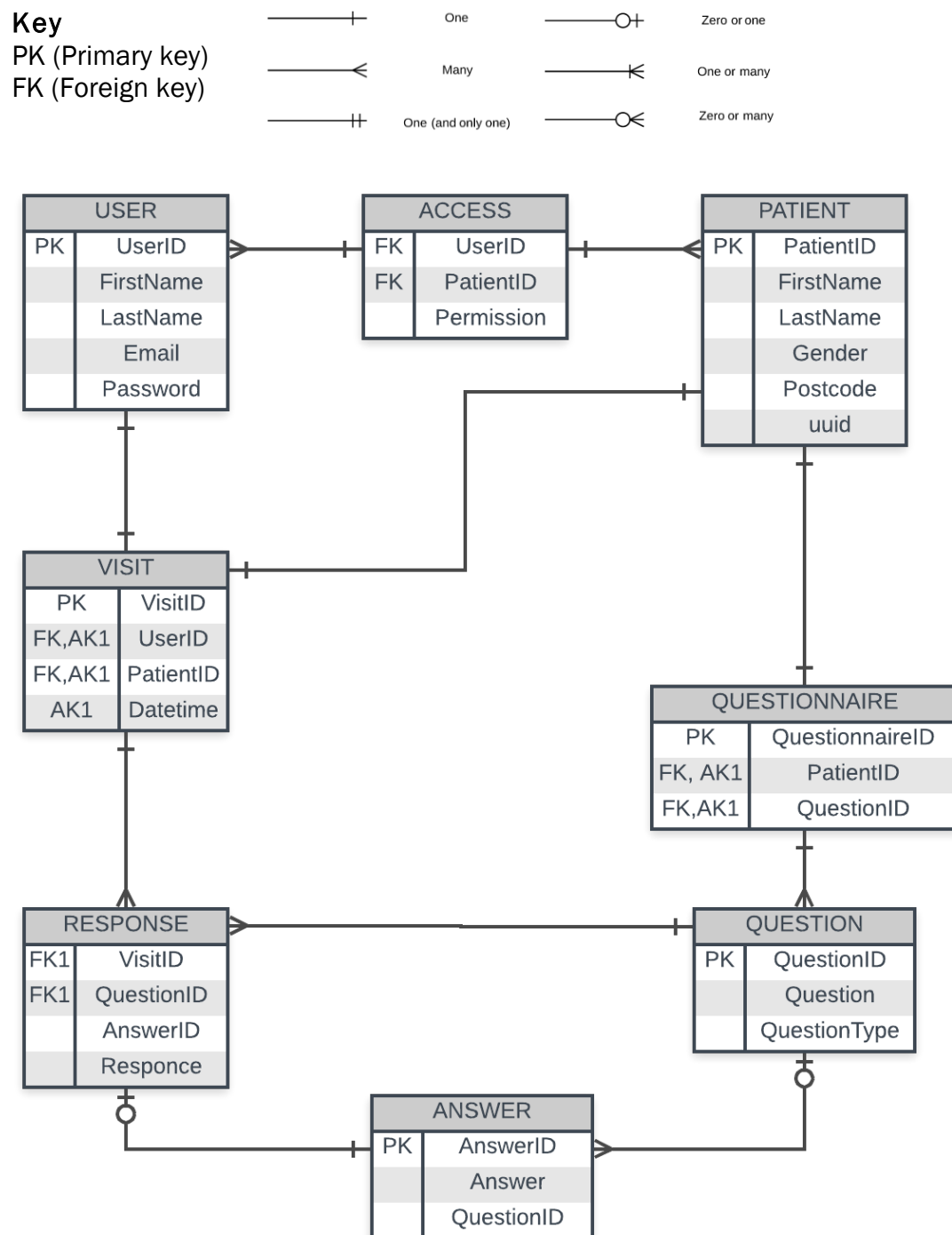
Figure 29 displays how a POST request will be handled by the system



**Figure 29:** POST request diagram

## 7.3 Database

Figure 30 is the entity relationship database design for the application. There will be a total of 8 tables all with different type relationships e.g. many to many, many to one. The table's relations have been formed using keys [LucidCharts].



**Figure 30: Database design**

## 7.4 API Endpoints

The table is a representation of the RESTful API endpoints that are going to be used in the application. The most successful APIs are simple and clear to understand and use. There is no official way to design an endpoint diagram – the table below is broken down into HTTP methods (GET, POST, PUT) and define what actions should be performed on the resource. The simplest way to understand an endpoint is “The URL is a sentence, where resources are nouns and HTTP methods are verbs” [Mahesh Haldar, 2017].

Resource	GET (read)	POST (create)	PUT (update)
/users	Gets all users, or get users by type or patient id	Insert a new user	
/users/patient	Get patient for family		
/users/group	Get group members	Assign a user to a patient group	
/users/permission			Update user permissions
/users/login		Insert email and password	
/users/:id	Return a user with specific id		
/patients	Get all patients	Insert a new patient	
/patients/{id}	Gets one patient by id		
/patients/questions		Insert questions by user id	
/patients/:id/questions	Gets the questions for a patient		
/patients/:id/visits	Get all of the visits made to a patient		
/patients/:id/visits/{id}	Return specific visit to given patient		
/patients/:id/visits/:id/response	Get the responses to all questions for a given visit		
/questions	Return list of all questions		
/visits	Get all the visits	Create a new visit	
/visits/patient	Get all visits for a patient		

## 7.5 State Transition diagrams

State-transition diagrams describe states that an object can have; these include the events under which an object changes state (transitions) and the activities taken during the life of an object (actions) [Copeland, 2003].

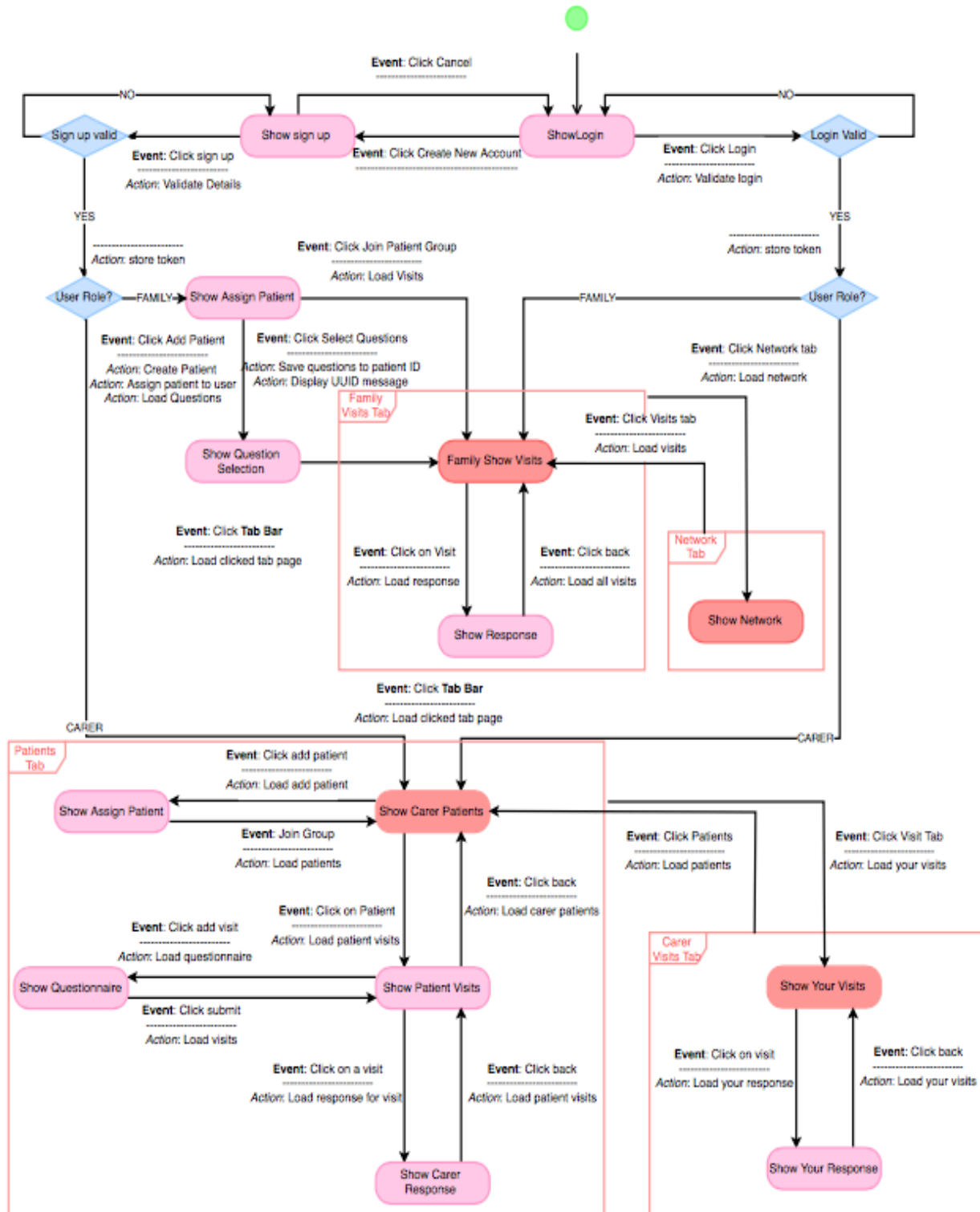
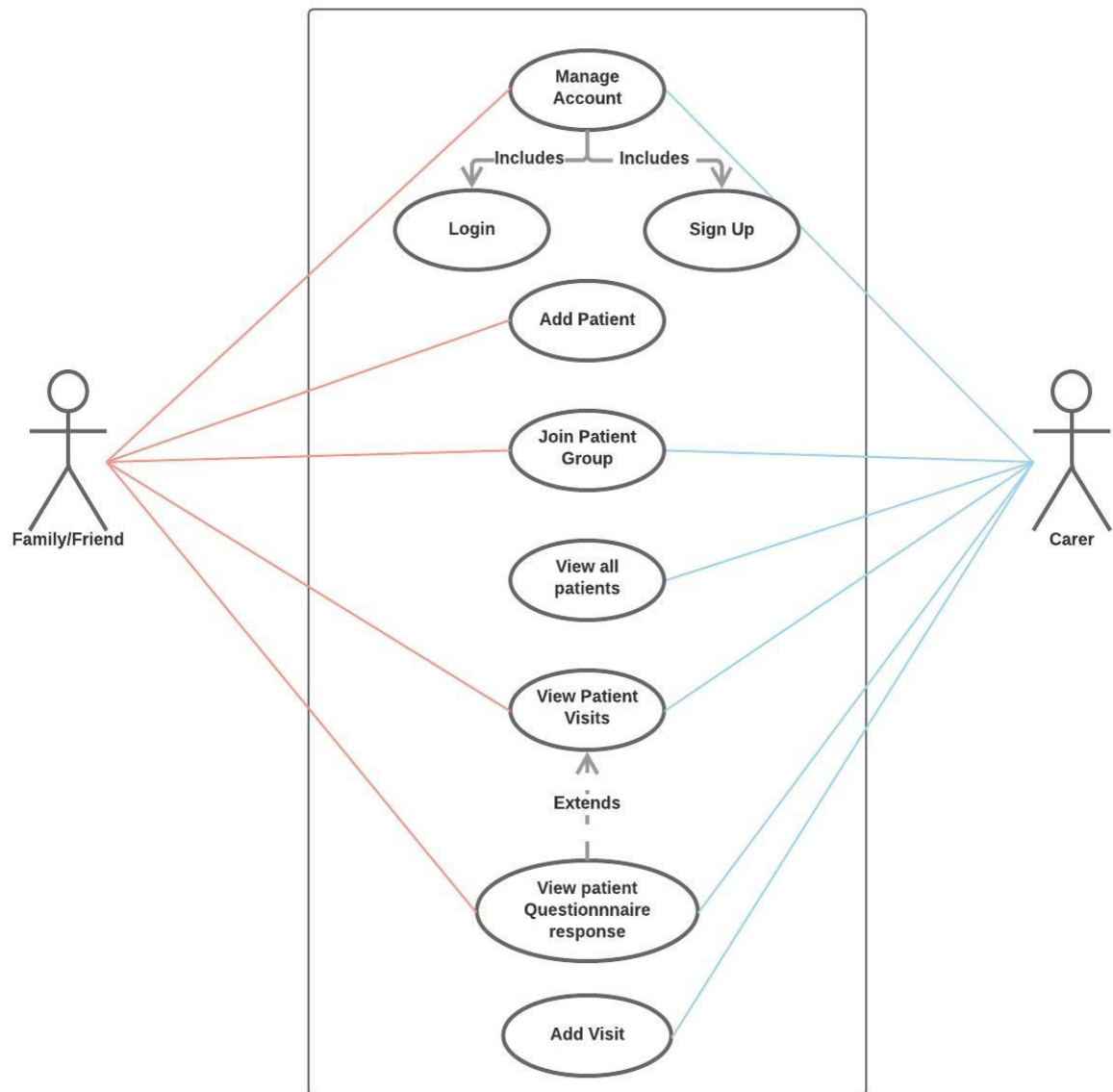


Figure 31: State transition diagram of implemented code

## 7.6 Use case diagrams

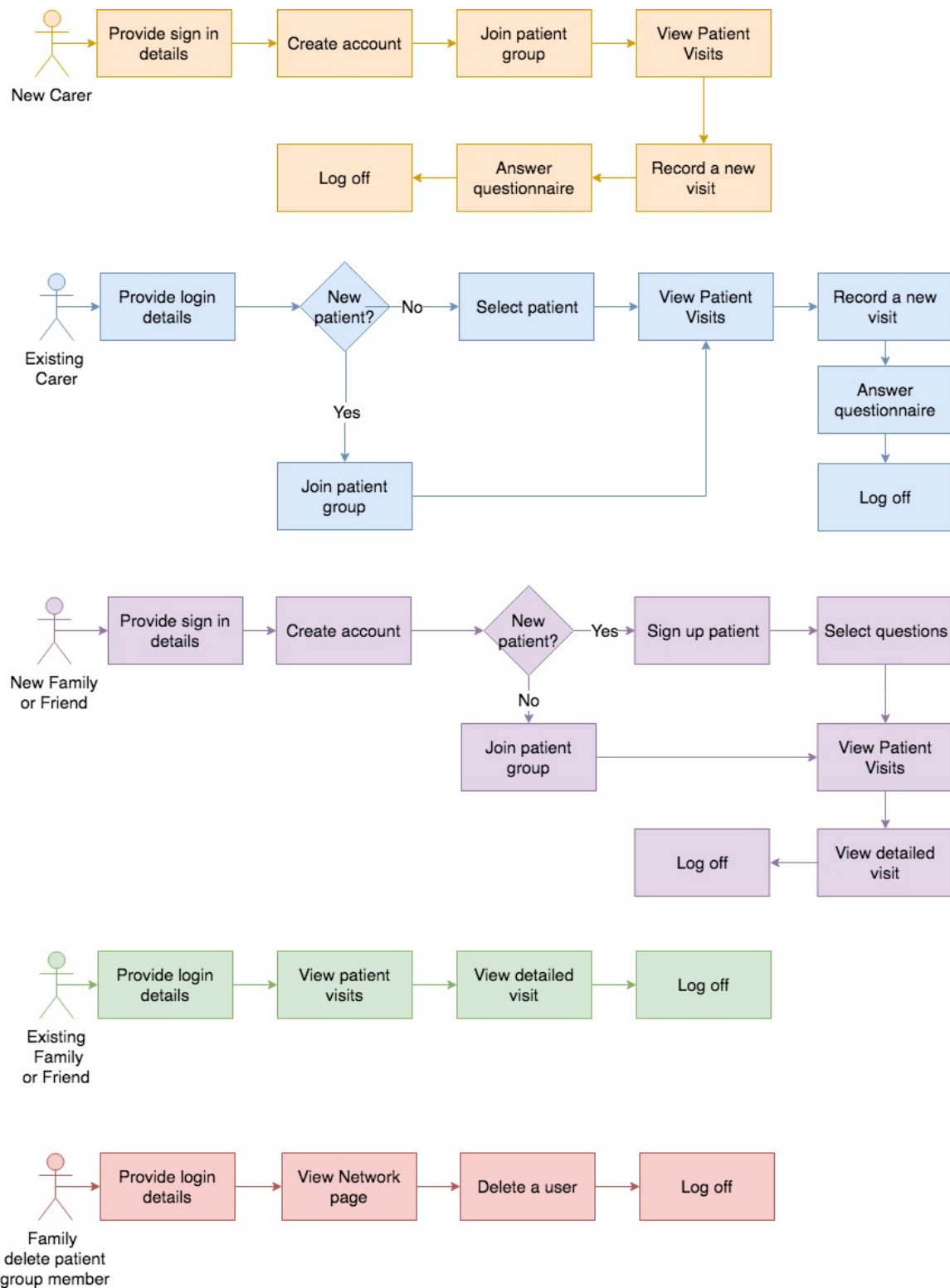
The below use case diagram is a representation of how the non-professional carers and professional carers will interact with the designed system.



**Figure 32:** Use case diagram of user interaction in the system

## 7.7 Flow charts

The below flow charts show expected user interacting within the application. It is broken down depending professional or non-professional role and also by whether the user has a pre-existing account.



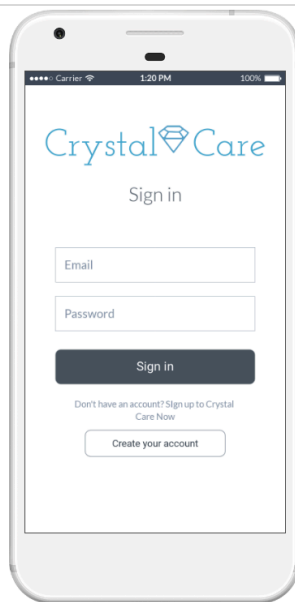
**Figure 33:** Expected user flows



## 7.8 Wireframes of interface

Throughout designing the application, the principles of 'Google Material Design' documentation have been used and the wireframes have been annotated using these design principles [Material Design].

The below screenshots have been taken from an interactive user interface design. The software 'Marvel' was used to create realistic user screens and flows through the system.

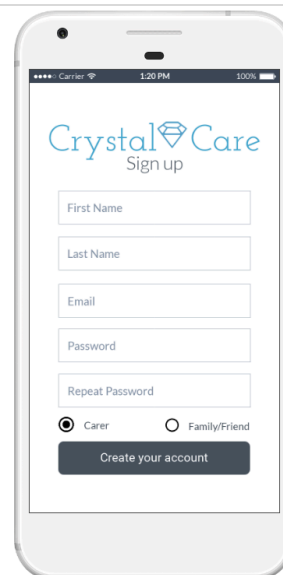


**Figure 34:** Sign In

**Buttons:** Two button types; raised button used for 'sign in' due to greater number of uses and flat button for create account as users are required to only do this once.

**Name:** Play on words 'crystal clear'. Emphasises a structured and straightforward method to caring.

**Logo:** Simple crystal carried through design, can offer reassurance to user that they remain on the app and provides consistency throughout app pages.

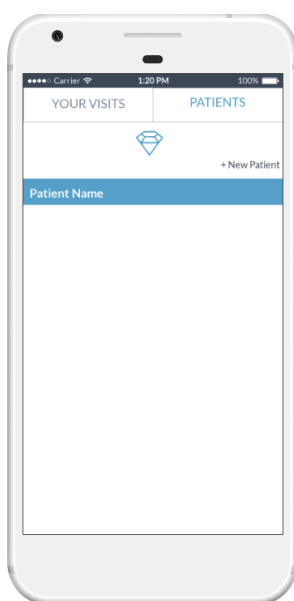


**Figure 35:** Sign Up

**Placeholder:** Text in input fields until user begins to type. Informs user of what to type in box.

**Button Text:** Use of lower case button text due to length of text, hard to read long pieces of capitalized text.

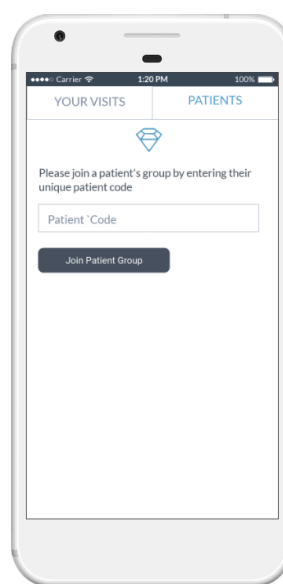
**Password:** Password is hidden by midline dots that are put in place of characters when password is typed.



**Figure 36:** Patient Page

**Tab Bar:** Top- level navigation used to display content that is grouped. The consistent positioning of the tab bar and names will become familiar for users and reinforce ease of use.

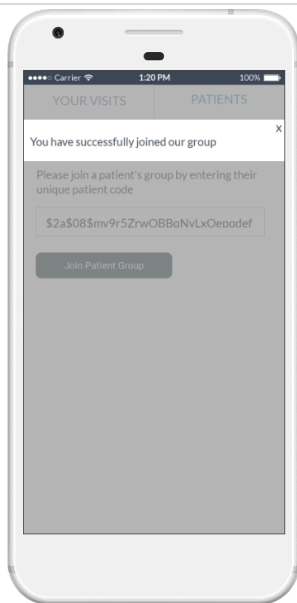
**Tab Name:** Clearly informs users of what they will find within tabs. Short and capitalised text for best practise.



**Figure 37:** Join Patient group

**Button colour:** A darker button colour has been applied to denote importance and purpose

**Tab Colour:** Use of the apps main colour palette to inform user of what tab page they are currently on.



**Modal:** Success messages to inform users that they have successfully created an account. Freezes background to ensure users read the modal.

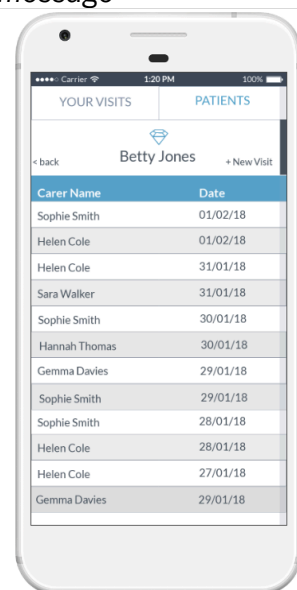
**Figure 38:** Successfully joined group message



**Button:** Use of flat button for adding new patient. The action is not essential for every time use and therefore fits subtly in the background.

**Icon:** Use of plus as users are familiar that a '+' within an app is usually some form of adding.

**Figure 39:** Patient added

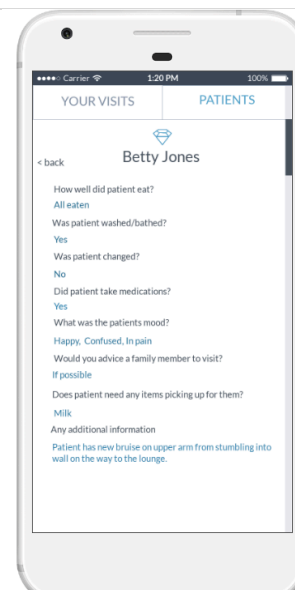


**Header:** When patient is clicked on, name appears as header to inform users of where they are on the application and avoids submitting form to wrong patients accidentally.

**Row hover:** Used to show user what row of the table they are on.

**Figure 40:** Visits page

**Table format:** Structured method of displaying repetitive information.



**Back button:** The button returns users to the page that they previously viewed. It navigates users upward through the hierarchy until the home page is found.

**Figure 41:** Questionnaire responses

**Logo:** Position and size remains kept throughout.

**Figure 42: Questionnaire**

**Radio Button:** Allows the carer to select one of the options from a selection. Used so that the user can see all the available option clearly. Also helpful as one option must be clicked and therefore avoids carers not answering a question. Box selected changed colour to show user what they have selected.

**Colour:** The colour alternates for questions and answers to help users distinguish between the two when reading the questionnaire.

**Multiline text area:** users can see everything they input at once.

**Figure 43: Questionnaire 2**

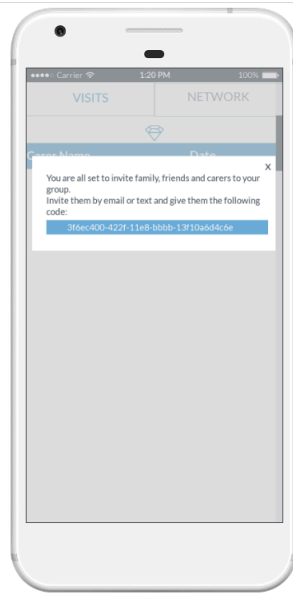
**Button:** Two raised dark buttons on the same page because either option is just as important as the other but no user would use both sections.

**Headings:** Two heading in the same format to show importance of both.

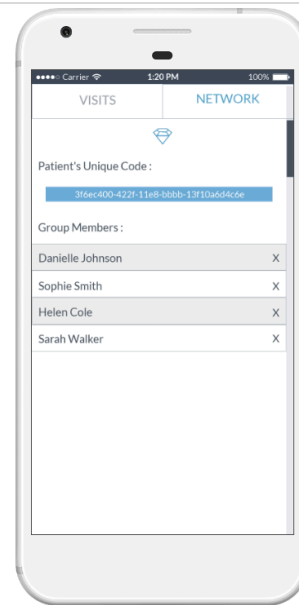
**Figure 44: Sign up/join patient group**

**Checkbox:** Checkboxes allow the user to select multiple options from a set.

**Figure 45: Question Selection**



**Modal:** Used to display the patient unique code. Pop up used to emphasise readers to read the information before continuing to use the application. Important code highlighted with theme colour to make it stand out.



**Delete:** 'x' to remove members from a patient group.

**Colour:** monochromatic scheme using blue to represent security and trust and feeling of calmness [Fadilloğlu, 2016].

**Figure 46:** Patient code message

**Figure 47:** Network members

## 8. Interface Testing

### 8.1 Think Aloud Usability Testing

Ethical approval ID: COMSC/Ethics/2018/011

Conducting 'think aloud' usability tests aimed to test the usability of the proposed user interface, in order to help make design changes during the implementation of the application. It aimed to find out how users interact with the interface and adapt interface designs based on these responses. Interactive prototype features of the Marvel software, loaded on a mobile device enabled a user to interact with the application design and flow through given tasks. The study was broken down into three different groups with two participants per group:

#### Group 1

The first group completed the tasks to test the app from the point of view of the professional carers. The participants will be asked to complete the following tasks and think aloud while completing the tasks:

Participant 1		
Task	Done	Notes
Create an account	✓	
Add a new patient (unique patient code given)	✓	Change 'our group' to 'the group' in alert. Could add patient name to alert.
Look for latest visit of patient 'Betty Jones' by all carers	✓	
Add a new visit for 'Betty Jones'	✓	Change 'Submit Form' button to 'Complete Visit' button.
Look at all the visits you have made	✓	Change 'VISITS' to 'MY VISITS' in the tab bar.
Look at a detailed view of your latest visit	✓	

Participant 2		
Task	Done	Notes
Create an account	✓	Participant wanted confirmation that account was created. Add alert saying 'Welcome to Crystal Care, you have successfully created an account'.
Add a new patient (unique patient code given)	✓	
Look for latest visit of patient 'Betty Jones' by all carers	✓	Spelling error on questionnaire. Change 'advice' to 'advise' on suggest patient visit question.
Add a new visit for 'Betty Jones'	✓	
Look at all the visits you have made	✓	
Look at a detailed view of your latest visit	✓	

### Group 2

The second group, were non-professional carers and it focused on setting up a new patient on the application. Participants will be asked to talk aloud about their steps and thoughts for the following questions:

Participant 3		
Task	Done	Notes
Create an account	✓	
Add a new patient	✓	
Select the questions they want answered by the carers for the patient	✓	
Delete 'Sarah Walker' member of the patients group	✓	Change 'NETWORK' to 'MY NETWORK' in the tab bar.

Participant 4		
Task	Done	Notes
Create an account	✓	
Add a new patient	✓	
Select the questions they want answered by the carers for the patient	✓	Change 'medications' to 'medication(s)' in the question.
Delete 'Sarah Walker' member of the patients group	✓	

### Group 3

The final group were non-professional carer who already has a patient set up. They were asked to complete the following tasks:

Participant 5		
Task	Done	Notes
Sign in to the application	✓	
Look at the latest carers visit	✓	
Look at the patients network	✓	Participant asked about multiple patients. Current application only supports one patient per family member (further work).

Participant 6		
Task	Done	Notes
Sign in to the application	✓	
Look at the latest carers visit	✓	
Look at the patients network	✓	

## 8.2 Evaluation

Overall, the 'think aloud' usability testing was completed successfully. Participants found the application simple and easy to use and did not struggle with navigation. Main changes to the application design will be tab titles, an additional alert when first joining the application and a few minor spelling checks.

## 9. Implementation

The following section details the implementation of the API and web app

### 9.1 Backend infrastructure

The backend infrastructure was responsible for presenting an API, applying business logic and importantly managing the storage and retrieval of data.

#### 9.1.1 Initial Set Up

The first stages of implementation involved getting the environment setup:

- Installation of MySQL server
- Setup of Apache server to host phpMySqlAdmin
- Creation of DB schema (tables)
- Installation of WebStorm
- Creation of project in Cardiff University GitLab

Implementation was then focused on installation of Node.js and Express.js and setting up a good framework for development. This involved:

- Configuring the server to listen for HTTP requests on a given port
- Creating a pool of MySQL database connections
- Adding router modules for the required paths

#### 9.1.2 Express router configuration

For this project, a route has been added to send the initial client HTML page (index.html). This is only for the test system. In the final deployment, a standard web server such as Apache could be used.

For each REST resource, a router module was added

- The router configuration for every route (except for login and sign-up) uses a function to check the JWT in the HTTP header. Express allows the request to be forwarded to a series of functions. For example:



- Each module defines the callback functions for HTTP methods (GET/POST/PUT/DELETE) and paths.
- The callbacks are responsible for retrieving inputs from the request path or request body, calling a 'model' function to perform the required processing and then returning results and status.

```
router.get('/', verifyToken, function(req, res, next){
  patientModel.getAllPatients(req.userId, function (err, result) {
    if (err) throw err;
    res.json(result);
  });
});
```

**Figure 48:** Set up of simple 'GET' showing token verification function.

- The HTTP status codes returned include 201 for success; 401 for unauthorised; etc

```
if (result.auth) {
  res.status(201).send(result); //return success
} else {
  res.status(409).send(result); //return conflict
}
```

**Figure 49:** HTTP status codes returned for adding a new user to the application.

- The data is then returned in JSON format

### 9.1.3 Models

The Model modules implement business logic and database interaction.

- A Model module is defined for each resource e.g. patientModel.js, userModel.js, visitModel.js, questionModel.js.
- The model functions implement Create, Retrieve, Update and Delete (CRUD) operations on the database.
- The database connections are retrieved from the connection pool and released after use

```
exports.getByQuestionnaireID = function(QuestionnaireID, cb) {
  dbPool.getConnection(function(err, connection){
    if (err) {
      connection.release();
      cb(err, null);
      throw err;
    }
    connection.query("SELECT QuestionID FROM `QUESTIONNAIRE` WHERE PatientID = ?", QuestionnaireID,cb);
    connection.release();
  });
}
```

**Figure 50:** Example of database connection being released.

- In some cases, the model functions will perform several database operations e.g. inserting a visit and then the associated question responses.
  - The asynchronous nature of node.js makes it difficult to link sequential operations as callback define further callbacks. In these cases the code for the callbacks included nesting (one callback definition another callback) and using bind. Bind allows the scope of the outer function to be passed to an inner callback function that is executed asynchronously.



```

var visit = JSON.parse(requestBody.data);
var patientId = visit.patientId;
connection.query("INSERT INTO VISIT( UserID, PatientID, DateTime) VALUES (?, ?, NOW())",
[userId, patientId], (function(err, result) {
    if (err) throw err;
    var visitId = result.insertId;
    var anslen = this.answers.length;
    for (var i=0; i < anslen; i++) {
        var answer = this.answers[i];
        connection.query("INSERT INTO RESPONSE( VisitID, QuestionID, AnswerID, Response) VALUES (?, ?, ?, ?)",
        [visitId, answer.questionId, answer.answerId, answer.response],
        function (err, result) {
            if (err) throw err;
        });
    }
    connection.release();
}).bind(visit)

```

**Figure 51:** Example using nesting and bind

- In addition to CRUD operations, some specific functions were implemented for:
  - Sign-up included encrypting the user password using bcrypt

```

var hashedPassword = bcrypt.hashSync(userDetails.password, 8);

```

**Figure 52:** Password encryption code

- Login included creating the JSON Web Token [Rahic, 2017]

```

function verifyToken(req, res, next) {
    var token = req.headers['x-access-token'];
    if (!token)
        return res.status(403).send({ auth: false, message: 'No token provided.' });
    jwt.verify(token, config.secret, function(err, decoded) {
        if (err)
            return res.status(500).send({ auth: false, message: 'Failed to authenticate token.'
            // if everything good, save to request for use in other routes
            req.userId = decoded.id;
            next();
        });
    });
}
module.exports = verifyToken;

```

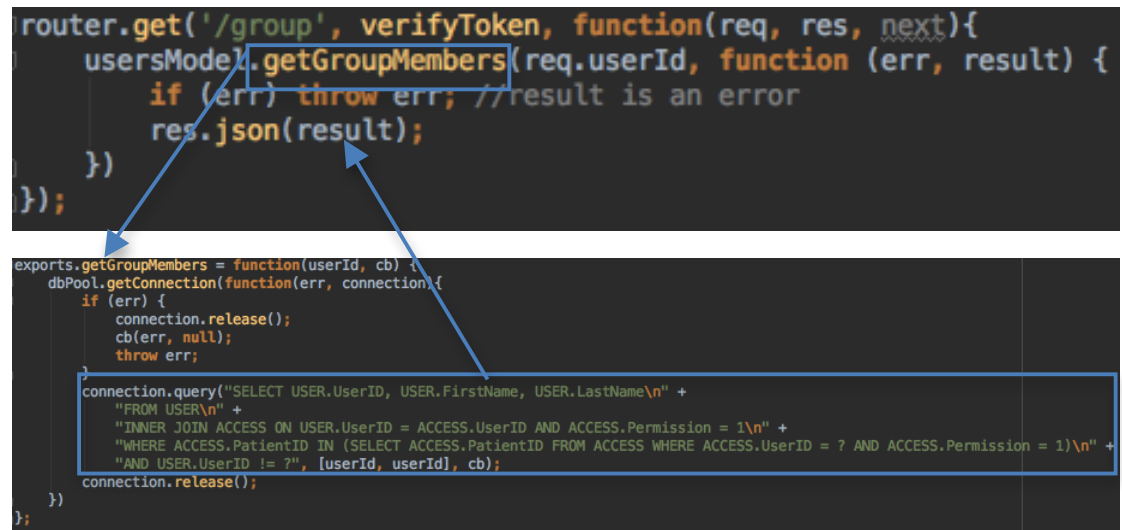
**Figure 53:** JSON Web Token

### 9.1.4 Example API

The example shows getting all members of a patient group using the API:

- 1) A GET request on 'users/group' is called from the 'users.js' router.
- 2) The JWT token is verified
- 3) The function 'getGroupMembers' is called; this is stored in 'usersModel.js'.
- 4) The data returned will either be an error or the result from the database query returned in a JSON format.

(See Appendix D for demonstration of API using postman)



```
router.get('/group', verifyToken, function(req, res, next){
  usersModel.getGroupMembers(req.userId, function (err, result) {
    if (err) throw err; //result is an error
    res.json(result);
  })
});

exports.getGroupMembers = function(userId, cb) {
  dbPool.getConnection(function(err, connection){
    if (err) {
      connection.release();
      cb(err, null);
      throw err;
    }
    connection.query("SELECT USER.UserID, USER.FirstName, USER.LastName\n" +
      "FROM USER\n" +
      "INNER JOIN ACCESS ON USER.UserID = ACCESS.UserID AND ACCESS.Permission = 1\n" +
      "WHERE ACCESS.PatientID IN (SELECT ACCESS.PatientID FROM ACCESS WHERE ACCESS.UserID = ? AND ACCESS.Permission = 1)\n" +
      "AND USER.UserID != ?", [userId, userId], cb);
    connection.release();
  });
};
```

Figure 54: Example API setup

## 9.2 Client

The following section details the prototyped web app demonstrating the API's functionality.

### 9.2.1 Structure

The structure of the client side has been broken down into three main pages:

- Index.html is used for login/signup. This then loads:
  - Onepage.html if the user is a professional carer
  - Family.html if the user is a non-professional carer
- Each html file contains a skeleton HTML structure for the page with <div> elements for all of the main areas. All elements that are referenced from JavaScript using JQuery are assigned an id.
- JavaScript scripts are then embedded in the HTML for dynamic behaviour e.g. loading data, validation, event handling
- The 'Single Page Application' behaviour is produced by JavaScript jquery hide and show operations on the main page sections.

```
function showQuestionnaire(patientId) {  
    $("#patients").hide();  
    $("#visits").hide();  
    $("#questionnaire").show();  
    $("#response").hide();  
    $("#allVisit").hide();  
    $("#assignPatient").hide();  
    fillQuestions(patientId);  
}
```

**Figure 55:** *jQuery hide and show operations*

- Data returned from the server is used to write HTML strings that are then insert to the HTML DOM by jquery.

```
var table = [];  
$.each(data, function (index, obj) {  
    table.push("<tr><td style='display:none;'>" + obj.QuestionID + "</td><td>"  
});  
$("#questionPickerTableBody").html(table.join(" "));
```

**Figure 56:** *Shows creation of table HTML and addition to DOM*

### 9.2.2 Event handlers

- Event handling callbacks are defined in all events, primarily button clicks or table row selection.

```
$("#visitsBackButton").on("click", function(){  
    showPatients();  
});
```

**Figure 57:** On click event handling

- Callbacks can result in a view state transition. This was implemented by changing the hidden and shown HTML areas.
- Callbacks are also responsible for getting input data from the HTML DOM using jQuery and formatting as JSON; interacting with the server by calling functions containing AJAX calls; and then populating data field and tables using jQuery

```
function fillPatientTable() {  
    $.ajax({  
        type: "GET",  
        dataType: "json",  
        headers: {"x-access-token": sessionStorage.getItem("token")},  
        url: "/patients",  
        success: function (data) {  
            var table = [];  
            $.each(data, function (index, obj) {  
                table.push("<tr><td style='display:none;'> " + obj.PatientID + "</td>");  
            });  
            $("#patientTableBody").html(table.join(" "));  
        },  
        error: function(err) {  
            if (err.status >= 400) {  
                showMessage(err.statusText);  
            }  
        }  
    });  
}
```

**Figure 58:** Getting data from HTML DOM

- The event handlers can be required to perform a sequence of operations e.g. inserting a visit and then refreshing the visit table.
  - This was difficult to implement due to JavaScript asynchronous processing e.g. table refresh must not happen before data insert but must not block other user requests by waiting
  - Ajax provides a ‘.when()’ and ‘.then()’ structure to allow asynchronous operations to be sequenced but this is difficult to get working and to debug

```

$( "#addPatientButton" ).on( "click", function() {
    if ( validPatientDetails() ) {
        $.when( newPatient() ).then( showPickQuestions() );
    }
});

```

**Figure 58:** *.when and .then example*

### 9.2.3 Server interaction

- Ajax calls are used to interact with the server
  - Calls specify the resource path, http operation and JSON data to send in the request body
  - The HTTP request header is setup to contain the JWT token to allow the server to authenticate every request
  - Callbacks are defined to be run on success or failure

```

function assignPatient(uuid, patientLastName) {
    var patient = {"lastName": patientLastName,
                  "uuid": uuid};
    return $.ajax({
        type: "POST",
        dataType: "json",
        headers: {"x-access-token": sessionStorage.getItem("token")},
        url: "users/group",
        data: {data: JSON.stringify(patient)},
        success: function(data){},
        error: function() {showMessage("Failed to find patient")}
    })
}

```

**Figure 59:** *AJAX call structure*

### 9.2.4 Sessions

- Session storage is used to hold JWT and a small set of state variables e.g. selected patient

```

sessionStorage.setItem("token", data.token);

```

**Figure 60:** *Session storage*

### 9.2.5 Styling

- Styling was specified using the W3.css framework:
  - Overall styling options such as the 'viewport' and a theme are set for use through the application

- Classes are set on the HTML elements in order to set styles, alignment, colours and any general formatting

```
<table id="visitTable" class = "w3-table-all w3-hoverable">
  <thead>
    <tr class="w3-theme">
      <th>Carer Name</th>
      <th>Visit Date/Time</th>
    </tr>
  </thead>
  <tbody id="visitTableBody"></tbody>
</table>
```

**Figure 61:** Set theme and classes on HTML element e.g. w3-hoverable

- Classes are added and removed dynamically to change the display according to user actions e.g. to highlight invalid inputs

```
if(firstName!="" && validateName(firstName)) {
  $("#firstNameInput").removeClass("w3-border-red");
} else {
  $("#firstNameInput").addClass("w3-border-red");
  return false;
}
```

**Figure 62:** Adding/removing classes dynamically

- Creating a modal pop up to display information messages

```
<div id="message" class="w3-modal">
  <div class="w3-modal-content">
    <div class="w3-container">
      <span onclick="document.g
      <div id="messageText">Som
    </div>
  </div>
</div>
```

**Figure 63:** Use of modal to display messages

## 10. Testing

Throughout the development phase, numerous tests were conducted in order to fix any noticeable errors or bugs that appeared during this phase. Following on from this, test cases were produced based on the expected user flows (see section 7.7). This gained insight into whether the application's main functionality had been met. The results from these tests indicated whether development of the application had been a success and provided guidance for potential future advancements.

### 10.1 Strategy

The testing was broken down into 2 cycles. The first (cycle 1) tested the 'finished' product. Within this, some bugs or malfunctions were found. These failed tests were put into an issues table with the issue remediation stated. Once these issues had been fixed, a second phase (cycle 2) of testing was performed. This ensured that failed test cases had been fixed and also ensured that no regression had taken place to passed test cases.

## 10.2 Test Cases

### 1.0 Sign In

ID	Scenario	Steps	Test Data	Expected Results	Actual Results	Cycle 1	Cycle 2
1.1	Test the “Sign In” button keeps the user on the Sign In page.	1) “Sign In” button clicked.		User should not Sign In to application	Red border displayed round email box. User remains on Sign in page	PASS	No regression
1.2	Test the “Sign In” button has shadow hover effect when hovered over.	1) Hover over Sign In button		Sign In button should have a shadow around it.	As expected	PASS	No regression
1.3	Test the “Enter Email” text box allows input	1) Input email address	Email: d_e_johnson@mac.com	The text box allows and displays the inputted values	As expected	PASS	No regression
1.4	Test the “Password” text box allows input	1) Input password	Password: passtest	The text box allows the inputted values	As expected	PASS	No regression
1.5	Test that the “Password” text box keeps the values hidden	1) Password entered	Password: passtest	The text box does not allow the input values to be seen	As expected	PASS	No regression
1.6	Test user Sign In with valid data	1) Enter email 2) Enter Password 3) Click Sign in	Email: d_e_johnson@mac.com Password: passtest	The user should Sign In to the application	As expected	PASS	No regression
1.7	Test user Sign In with invalid Data	1) Enter email 2) Enter Password 3) Click Sign in	Email: d_e_johnson@mac.com Password:	The user should not be able to Sign In to the application, alert to user.	As expected.	PASS	No regression



			passtest123				
--	--	--	-------------	--	--	--	--

## 2.0 Sign Up

ID	Scenario	Steps	Test Data	Expected Results	Actual Result	Cycle 1	Cycle 2
2.1	Test that the link: "Create your account" takes the user to Sign Up page.	1) Click 'Create your account'		The user should be taken to the sign in view.	As expected	PASS	No regression
2.2	Test the "Create your account" button on sign up page has shadow hover affect when hovered over	1) Hover over 'create you account' button		Create your account button should have a shadow around it.	As expected	PASS	No regression
2.3	Test the "First Name" text box allows input	1) Input first name	Enter 'Danielle'	The text box allows and displays the inputted values	As expected	PASS	No regression
2.4	Test the "Last Name" text box allows input	1) Input last name	Enter 'Johnson'	The text box allows and displays the inputted values	As expected	PASS	No regression
2.5	Test the "Email" text box allows input	1) Input email address	Enter 'd_e_johnson@mac.com'	The text box allows and displays the inputted values	As expected	PASS	No regression
2.6	Test the "Password" text box allows input	1) Input password	Enter; passtest	The text box allows the inputted values	As expected	PASS	No regression
2.7	Test the "Repeat Password" text box allows input	1) Input the password again	Enter: passtest	The text box allows the inputted values	As expected	PASS	No regression
2.8	Test that the "Password" and	1) Password entered 2) Repeat Password	Enter "passtest"	The text boxes do not allow the input values to	As expected	PASS	No regression

	"repeat Password" text box keeps the values hidden	entered		be seen			
2.9	Test that repeat password matches the password	1) Password entered 2) Repeat Password entered	Enter password: passtest Repeat password: passtest1	The sign up details are invalid and user should not be taken to next page	As expected. Red border around repeat password input box	PASS	No regression
2.10	Test user Sign Up with valid data and is a family member	1) Enter first name 2) Enter last name 3) Enter email 4) Enter Password 5) Enter repeat password 6) Click radio button family/friend 6) Click Create your account	First name: Danielle Last name: Johnson Email: d_e_johnson@mac.com Password: passtest Repeat password: passtest Family/friend radio button selected	The user should be signed up and taken to the add patient/join patient page	As expected	PASS	No regression
2.11	Test user Sign Up with valid data and is a carer	1) Enter first name 2) Enter last name 3) Enter email 4) Enter Password 5) Enter repeat password 6) Click radio button carer 6) Click Create your account	First name: 'Rosie' Last name: 'Cole' Email: 'rosie@cole.com' Password: passTry Repeat password: passTry Carer radio button selected	The user should be signed up and taken to the patient page	As expected	PASS	No regression

2.11	Test user Sign Up with valid data and is a carer	1) Enter first name 2) Enter last name 3) Enter email 4) Enter Password 5) Enter repeat password 6) Click radio button carer 6) Click Create your account	First name: 'Rosie' Last name: 'Cole' Email: 'rosie@cole.com' Password: passTry Repeat password: passTry Carer radio button selected	The user should be signed up and taken to the patient page	As expected	PASS	No regression
2.12	Test user Sign Up with invalid data	1) Enter first name 2) Enter last name 3) Enter email	First name: '1234' Last name: 'Johnson' Email:	The user not should be signed up and taken to the add patient/join	Not as expected. User was	FAIL	PASS

### 3.0 New family or friend (see section 7.7, video available in Appendix F/G)

#### Preconditions:

1) User has signed up to the application (Use Case 2.0).

ID	Scenario	Steps	Test Data	Expected Results	Actual Results	Cycle 1	Cycle 2
3.1	Test the "Add patient" button keeps the user on the Sign patient up page.	1) "Add Patient" button clicked.		User should not be taken to new display	As expected. Red border displayed around the field missing.	PASS	No regression
3.2	Test the "Add patient" button has shadow hover effect when hovered over.	1) Hover over Add Patient button		Add patient button should have a shadow around it.	As expected	PASS	No regression
3.3	Test the "First Name"	1) Input first name	First name:	The text box allows	As expected	PASS	No

	text box allows input		Helen	and displays the inputted values			regression
3.4	Test the “Last Name” text box allows input	1) Input last name	Last name: Smith	The text box allows and displays the inputted values	As expected	PASS	No regression
3.5	Test the “Postcode” text box allows input	1) Input Postcode	Postcode: CF24 4NS	The text box allows and displays the inputted values	As expected	PASS	No regression
3.6	Test ‘Add patient’ button takes you to the question selection page.	1) Enter patient information 2) Click ‘Add patient’	First Name: Helen Last Name: Smith Postcode: CF24 4NS Female	The user should be taken to the question selection page for the questionnaire.	As expected	PASS	No regression
3.7	Patient added with invalid first name/last name	1) Enter patient information 2) Click ‘Add patient’	First Name: 12345 Last Name: Jones Postcode: CF24 4NS Female	The patient should not be signed up and taken to the visit page.	Not as expected. Patient was able to create account with numbers as a name.	FAIL	PASS
3.8	Patient added with invalid postcode	1) Enter patient information 2) Click ‘Add patient’	First Name: Helen Last Name: Smith Postcode: 123456abc Female	The patient should not be signed up and taken to the visit page.	Not as expected. Patient was able to create account with invalid postcode	FAIL	PASS
3.9	Test question	1) Add patient		The user should be	User can submit form	FAIL	PASS

3.9	Test question selection page to see if you can submit with no questions.	1) Add patient 2) Keep all checkboxes unchecked		The user should be told they must select at least one question.	User can submit form with no questions selected.	FAIL	PASS
3.10	Test question selection page to see if you can submit with questions.	1) Add patient 2) Select questions to be seen	Check: eaten, taken medication and additional comments	Taken to patient page, pop up box explaining uuid. Questions stored to patient name.	As expected	PASS	No regression
3.11	Test the “Join Patient Group” button keeps the user on the sign up patient page	1) “Join Patient Group” button clicked.		User should not be taken to new display	As expected. Red border displayed around the field missing.	PASS	No regression
3.12	Test the “Join Patient Group” button has shadow hover effect when hovered over.	1) Hover over “Join Patient Group” button		“Join Patient Group” button should have a shadow around it.	As expected	PASS	No regression
3.13	Test invalid patient code	1) Input invalid patient code 2) Click ‘Join Patient Group’	Code: 123455534243423 Last name: Smith	Remain on add new patient/join patient group page. Alert saying incorrect patient code	Not as expected. User given success message and taken to a patient visit page that has not been set up.	FAIL	PASS
3.14	Test invalid patient last name	1) Input vaild patient code 2) Input invaild patient last name 3) Click ‘Join Patient Group’	Code: af51d500-4de7-11e8-97e1-5b17b5c1de73 Last name:	Remain on add new patient/join patient group page. Alert saying invalid details	Not as expected. User given success message and taken to a patient visit page that has not been set up.	FAIL	PASS

3.15	Test valid patient code	1) Input valid patient code 2) Click 'Join Patient Group'	Code: af51d500-4de7-11e8-97e1-5b17b5c1de73 Last name: Smith	User given 'successfully joined group' modal. Taken to patients visit page.	As expected.	PASS	No regression
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#### 4.0 New carer (see section 7.7, video available in Appendix E)

Preconditions:

1) User has signed up to the application (Use Case 2.0).

ID	Scenario	Steps	Test Data	Expected Results	Actual Result	Cycle 1	Cycle 2
4.1	Test '+ new patient' button	1) Click + new patient' button		The user should be taken to the join patient group page.	As expected	PASS	PASS
4.2	Test the "Join Patient Group" button keeps the user on the join patient group page	1) "Join Patient Group" button clicked.		User should not be taken to new display	As expected. Red border displayed around the field missing.	PASS	PASS
4.3	Test invalid patient code	1) Input invalid patient code 2) Click 'Join Patient Group'	Code: 123455534243423 Last name: Smith	Remain on join patient group page. Alert saying incorrect patient code	Not as expected. User given success message and taken to	FAIL	PASS

					a patients page		
4.4	Test invalid patient last name	1) Input valid patient code 2) Input invalid last name 2) Click 'Join Patient Group'	Code: af51d500-4de7-11e8-97e1-5b17b5c1de73  Last name: test	Patient added to the patient list table.	Not as expected. User given success message and taken to a patients page	FAIL	PASS
4.5	Test valid patient code	1) Input valid patient code 2) Input invalid last name 2) Click 'Join Patient Group'	Code: af51d500-4de7-11e8-97e1-5b17b5c1de73  Last name: Smith	User shown success message. Taken to patients view. New patient added to the list.	As expected.	PASS	No regression
4.6	Test 'PATIENTS' tab bar takes to patients	1) Click 'PATIENTS' on tab bar		User taken directly to patients page	As expected	PASS	No regression
4.7	Click on patient name to view the specific patients visits	1) Click on a 'Helen Smith' in patient table		Taken to 'Helen Smith' visits table.	As expected	PASS	No regression
4.8	Test patient visit table is in chronological order with latest visit at the top of the table.	1) Click on 'Helen Smith'. 2) Look at visit list order		Expect that latest dated visit in the date column is at the top of the page.	As expected. Date format could be improved.	PASS	No regression
4.9	Click on a specific visit and see details from the visit.	1) Click on 'Helen Smith'. 2) Click on 'Rosie		Taken to Rosie Coles latest visit of 'Helen Smith'. Details of the	As expected	PASS	No regression

4.9	Click on a specific visit and see details from the visit.	1) Click on 'Helen Smith'. 2) Click on 'Rosie Cole' latest visit		Taken to Rosie Coles latest visit of 'Helen Smith'. Details of the visit shown.	As expected	PASS	No regression
4.10	Test if back button on specific visit page works	1) Click on 'Helen Smith' 2) Click on 'Rosie cole' latest visit 3) Click back button		Expect to be taken back to the visits table for 'Helen Smith'	As expected	PASS	No regression
4.11	Add a new patient visit	1) Click 'Helen Smith' 2) Click '+ New Visit'		Expect to be taken to a questionnaire view displaying patient questions.	As expected	PASS	No regression
4.12	Radio buttons on questionnaire view are functional.	1) Click on 'All food eaten' and then 'No food eaten'		Expect radio button highlighting to move from 'all food eaten' to 'no food eaten'	As expected	PASS	No regression
4.13	Submit a questionnaire with no answers	1) Click no radio buttons 2) Click submit		Expect no visit to be added. Alert saying no answers have been selected.	Taken to visit page	FAIL	PASS
4.14	Submit a questionnaire with answers	1) Select radio buttons for answers 2) Click Submit button	How well did patient eat? 'All food eaten' Did patient take medication? 'Yes' Additional comment: fell over	Expect patients visit table to update with newest visit. Also expect 'My Visits' table to update with the new visit. When click on the visit is should show selected answers 'All food eaten' and 'Yes'	Not as expected. 'My Visits' table did update but patients table did not.	PASS	No regression



## 5.0 Existing carer (see section 7.7)

Preconditions:

1) User has signed in to the application (Use Case 1.0).

ID	Scenario	Steps	Test Data	Expected Results	Actual Result	Cycle 1	Cycle 2
5.1	Test 'PATIENTS' tab bar takes to patients	1) Click 'PATIENTS' on tab bar		User taken directly to patients page	As expected	PASS	No regression
5.2	Click on patient name to view the specific patients visits	1) Click on a 'Helen Smith' in patient table		Taken to 'Helen Smith visits table.	As expected	PASS	No regression
5.3	Test patient visit table is in chronological order with latest visit at the top of the table.	1) Click on 'Helen Smith'. 2) Look at visit list order		Expect that latest dated visit in the date column is at the top of the page.	As expected. Date format could be improved.	PASS	No regression
5.4	Click on a specific visit and see details from the visit.	1) Click on 'Helen Smith' 2) Click on 'Rosie Cole' latest visit		Taken to Rosie Cole latest visit of 'Helen Smith'. Details of the visit shown.	As expected	PASS	No regression
5.5	Test if back button on specific visit page works	1) Click on 'Helen Smith' 2) Click on 'Rosie Cole' latest visit 3) Click back button		Expect to be taken back to the visits table for 'Helen Smith'	As expected	PASS	No regression
5.6	Add a new patient visit	1) Click 'Helen Smith' 2) Click '+ New Visit'		Expect to be taken to a questionnaire view	As expected	PASS	No regression

5.6	Add a new patient visit	1) Click 'Helen Smith' 2) Click '+ New Visit'		Expect to be taken to a questionnaire view displaying patient questions.	As expected	PASS	No regression
5.7	Radio buttons on questionnaire view are functional.	1) Click on 'All food eaten' and then 'No food eaten'		Expect radio button highlighting to move from 'all food eaten' to 'no food eaten'	As expected	PASS	No regression
5.8	Submit a questionnaire with no answers	1) Click no radio buttons 2) Click submit		Expect no visit to be added. Alert saying no answers have been selected.	Taken to visit page	FAIL	PASS
5.9	Click back button on questionnaire page	1) Click radio buttons 2) Click back button		Expect warning alert to questionnaire deletion.	Taken to patient page.	PASS	No regression
5.10	Submit a questionnaire with answers	1) Select radio buttons for answers 2) Click Submit button	How well did patient eat? 'All food eaten' Did patient take medication? 'Yes'	Expect patients visit table to update with newest visit. Also expect 'My Visits' table to update with the new visit. When click on the visit is should show	As expected	PASS	No regression

## 6.0 Existing Family/friends (see section 7.7)

Preconditions:

1) User has signed in to the application (Use Case 1.0).

ID	Scenario	Steps	Test Data	Expected Results	Actual Result	Cycle 1	Cycle 2
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6.1	Test 'MY VISITS tab bar takes to patients visits	1) Click VISITS on the tab bar		User taken to visits page for their patient	As expected	PASS	PASS
6.2	Click on a specific visit and see details from the visit.	1) Click on Rosie Cole latest visit		Taken to Rosie Cole latest visit. Details of the visit shown.	As expected	PASS	PASS
6.3	Test if back button on specific visit page works	1) Click on 'Rosie Cole' latest visit 2) Click back button		Expect to be taken back to the visits table for the patient.	As expected	PASS	PASS
6.4	Test visit table is in chronological order with latest visit at the top of the table.	1) Look at visit list order		Expect that latest dated visit in the date column is at the top of the page.	As expected. Date format could be improved.	PASS	PASS

## 7.0 Family Delete Patient Group member (see section 7.7, video available in Appendix H)

Preconditions:

1) User has signed in to the application (Use Case 1.0).

ID	Scenario	Steps	Test Data	Expected Results	Actual Result	Cycle 1	Cycle 2
7.1	Test 'MY NETWORK tab bar takes to your network page	1) Click MY NETWORK on the tab bar		User taken to network page for their patient	As expected	PASS	PASS
7.2	Click on a specific visit and see details from the visit.	1) Click on 'Rosie Cole' latest visit		Taken to Rosie Cole latest visit. Details of the visit shown.	As expected	PASS	PASS
7.3	Test if back button on specific visit page	1) Click on 'Rosie Cole' latest visit		Expect to be taken back to the visits table for the	As expected	PASS	PASS

7.3	Test if back button on specific visit page works	1) Click on 'Rosie Cole' latest visit 2) Click back button		Expect to be taken back to the visits table for the patient.	As expected	PASS	PASS
7.4	Delete a user from a patients group	1) Click on 'MY NETWORK' tab	Delete 'Andy Jones'	Name was removed from visit list. That user	As expected	PASS	PASS

### 10.3 Remediation

Test Case ID	Issue	Remediation
2.12	User can input invalid information e.g. numbers for a name	Regular expressions used to capture invalid user information.
3.7	User can input invalid information for patient sign up e.g. numbers for a name	Regular expressions used to capture invalid patient information.
3.8	User can input invalid postcode when adding patient up	Regular expressions used to capture invalid postcode.
3.9	User can select no questions on the question selection page and still submit.	Change so that questions page must have at least 1 question selected. Alert added if not.
3.13/4.3	User can input invalid patient code when joining a patient group.	Change so that patient code is checked against patient codes in database
3.14/4.4	User can input invalid patient last name when joining patient group.	Change so that patient last name is checked against patient codes in database
4.13/5.12	User can submit a questionnaire with no answers.	Message appears when user tries to submit with no answers.

## 11. Results and Evaluation

### 11.1 Testing

The system created clearly demonstrates a simple and fast way for professional carers to update non-professional carers on home visits.

The first set of testing conducted was based on the interface design and system flows from 'think aloud usability testing'. The results from this testing were very positive and only minor changes to interface were implemented.

The functionality was tested against user flow diagrams and although issues were found in cycle one of testing, by cycle two of testing they had all been fixed and user flows were successful as shown in the table.

ID	Test Case Flow	Cycle 1	Cycle 2
1.0	Sign in	7/7 pass	7/7 pass
2.0	Sign up	11/11 pass	11/11 pass
3.0	New Family/friend	9/14 pass	14/14 pass
4.0	New Carer	12/15 pass	15/15 pass
5.0	Existing Carer	9/10 pass	10/10 pass
6.0	Existing Family/friend	4/4 pass	4/4 pass
7.0	Family delete member	4/4 pass	4/4 pass

Improvements to testing could include:

- More negative testing to try and identify flaws
- Additional testing at API level e.g. using postman to make HTTP requests and analyse responses
- Non-functional testing such as performance, load testing. This would not make sense to do until app has been deployed.
- User testing once system is deployable e.g. trial groups to test and provide feedback

### 11.2 Technology decisions

In retrospect, the use of Node.js/Express.js as a technology stack was difficult. Although it enabled an easy sever set up and use of the same language client/server side, being asynchronous made a lot of the callback coding very challenging. The particular problems are caused by the need to create sequences of asynchronous operations and manage the scope of variables e.g. one function setting up another call-back function means that inner call-back is isolated from the outer call-back scope.

Initially, a single page application was chosen for implementation. However, the management of the user interface state became very complex for the family views and the carer views. A decision was made to keep these views in separate HTML pages and choose the appropriate page at login. This did result in some

duplication of code. In future, managing states using different application architecture (e.g. FLUX [*Flux*]) would enable better handling of states.

### 11.3 Functionality

When looking at the requirements list, a large amount of functionality was met. However there are additional requirements that are not available in the current version of the app:

1. Reset a password
2. Search functionality to look for a specific visit
3. Adapt questionnaire by adding or remove questions after it was initially created
4. Notifications for new visits

The requirements were removed from the development as they were of a lower priority than more fundamental user requirements. Ideally they should be included in further development.

## 12. Future Work

There are a number of areas of future work that would be required for the application to be released and other enhancements that could benefit the design and implementation, these include:

- Deployment
  - Running server outside of IDE
  - Encryption and storage of database password
  - Implementation of HTTPS
  - Deployment of client pages to a web server
- Turning the web application into a hybrid application to allow for download to mobile devices
  - Add notification functionality e.g. when carer visits, send a notification to the non-professional carers and alert them that a new visit has taken place
- Extension of the API and user interface to support customisation of questions and more styles of questions e.g. slider bars, multi-selections
- Richer design of questionnaire response page for improved visual impact
- Implement password management e.g. forgotten password
- Improve security of the process of joining a group e.g. two stage sign up and request notifications
- Add profile pictures to the user accounts
- Provide search functionality within visits and patient lists.
- Analyse and display trends in the responses for a patient e.g. changes in eating patterns
- Add functionality that allows a non-professional carer to have multiple 'patients'. Currently application is limited to one patient per family member.
- Use the API to incorporate the app functionality into pre-existing carer management apps e.g. apps that professional carers currently use to manage visit schedules, patient care duties and addresses. This will enable the use of only one app for a visit.

## 13. Conclusions

I have first hand experience of being in a family with an elderly relative whose care was provided by family members and professional carers. This inspired me to look into using technology to improve the communications within this care group.

To start my project, I researched the use of technology to address healthcare communication needs and the availability of existing solutions to this perceived communication difficulty. I found some applications such as Care.ly [Care.ly] targeting care networks with a broad range of functions but nothing that specifically focused on professional carers recording information on their visits for family member and friend to read and get reassurance. To improve my understanding of the need for such an application, I performed two surveys: one for professional carers and one for the family and friends of the care receiver. The results of these surveys reinforced my view that there was a need for such an application and helped in understanding the information that would be beneficial to capture.

I created a set of requirements by focusing on two key workflows: firstly for a carer making a visit to their patient and recording the answer to a small set of questions; and secondly for a friend or family member to review the answers to these questions. I also captured requirements for new users to sign up to the application and set up patient questionnaires.

I developed an application using a technology stack based on JavaScript which my research showed would allow me to build a fully working system. I thought it would be particularly important to provide an API on top of a relational database which could allow different mobile client applications to be developed, with the possibility to integrate the API into other carer systems. For my prototype user interface, I built an HTML/JavaScript/JQuery based web app that could be wrapped as a hybrid mobile app.

My technology choices were successful for building a complete system but the complexity of working with asynchronous callback in JavaScript was challenging. I was surprised to discover the complexity of creating the functionality to have a secure system for user sign-up, login, registration of a new patient and joining a care group. However, I knew that it was very important to have a secure solution given the privacy concerns of patients and their care groups.

I have been successful in building an application that can be demonstrated for the proposed workflows. I used these workflows as the basis for my testing and I was able to identify and fix many bugs.

I feel that the creation of an API for the requirement was a very important feature. By building a web app, I was able to demonstrate the value of the API but also get a better understanding of the ways to make an application straightforward and efficient to use.



At the end of the implementation and testing phase of the project, I had a number of ideas about how the project could be taken forward. I feel that it would be important to provide a notification system to alert family members when new visits had been recorded. This would require a hybrid or native mobile app to be built. Also it would be good to investigate the possibility to use the API within other carer systems. For my prototype web app, there could be more styles of question response provided (e.g. sliders and selecting multiple answers) and the display of responses could be made more visually interesting. It would be especially beneficial to trial the application with a small set of carers and get feedback to further refine the workflows and use this to improve the API and web app.

## 14. Reflection on Learning

Completing this project has been very rewarding but has also been very challenging along the way and as a result I have learned a lot about project approach and app development. I better understand the importance of managing competing priorities in a project and would adapt my approach in future projects. I also significantly improved my programming skills and can use my experience in any future coding I do. The following sections explain some of my learning in more detail.

### Time Management

Due to the strict project deadline, time manage in this project was critical. In order to plan enough time to complete the project milestones, I created a timetable to plan in which weeks I would focus of each key work stream (requirements gathering, design, implementation, testing). This was very useful as it pushed me to complete tasks as planned and made it obvious to see if I was spending too much time on one task. However, whilst it was useful, I have never completed a project of this size and it was difficult to estimate the length of time each phase would take. I used online resources that detailed typical timescales for app development to help inform my estimates, however, this is not a reliable source due to the nature of app development projects being so specific. It's also dependent on personal experience and skill sets. Having completed this project I have a much better understanding of project phase timescales so would be able to plan another project more effectively. I think it is important to anticipate that it's not always possible to hit rigid deadlines throughout the project phases so I would definitely built more time into each phase so there was some contingency.

### Survey and Ethical Approval

One very important part of this project was the gathering of information through a survey. Before the project, I was unaware of the importance of considering the confidentiality and privacy of information gathered by survey. I also learned a great deal about constructing a survey with questions that would provide the information needed for the project. The setup of the survey using GoogleForms required a lot of careful planning in order to gain the respondents permission before asking the survey questions.

### Development Approach

The great thing about adopting an iterative approach was that it allowed me to understand and learn the techniques required for the project as I progressed. Having never developed an API or web application, it was important to learn and research theories as I went along and not default to using techniques that I had previously learnt in University e.g. PHP as a server side scripting language.

## Programming

Entering into this project, I had the most concerns about the programming aspect as I had never developed anything close to this level of this complexity before and have never written in JavaScript. It has been a massive learning curve and resulted in a huge improvement in my development skills. Whilst undergoing my research, I found online tutorials and web blogs much more helpful than official language documents as it was easy to find developers that had faced similar problems and learn how they tackled the problem or set up technology stacks. When approaching future projects, I will definitely adopt this approach and learn from other people's experience. I will also aim to keep coding so I can continue to learn and upskill!

Another key learning when it came to programming was not to panic when I discovered a bug or broke a section of code that previously worked as a result of other changes. This is expected behaviour when coding and is not an issue as long as the correct testing procedures are in place. I learnt that searching error messages and using version history was incredibly helpful when investigating and fixing issues.

## Problem Solving

Completing this project has helped to develop my problem solving skills. An example of this is the problems I encountered programming with Node.js/Express.js. It is an asynchronous language, which means that the functions run as soon as they possibly can. When trying to enter information into multiple database tables in a specific order this became extremely problematic. In the end, I managed to eradicate the problem using the call back functions but this was very complex to achieve.

## Communication

I had weekly project meetings with my supervisor to discuss ideas or problems I was facing and importantly to give him an update on project progress. As these meetings were brief I needed to make sure I used this time to communicate any discussion points or updates in a concise manner. As a result I think this project has helped me to develop my communication skills with senior members of a team. I also learnt how beneficial it was to talk through a problem with my supervisor so would definitely ensure I had frequent communication with any team members in future projects.

Another example of testing my communication skills was the communication with the participants of think aloud usability testing. Watching people work on and critique a system I designed was nerve racking but it was important to maintain a professional manner, ensure I was not biased and ensure I was being clear on what they needed to do. On a project note, usability testing is an approach I had previously never encountered but is one that I would always use going forward. It's such a simple method but so effective compared to other testing methods I have previously used.

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## Appendices

### Appendix A: Initial Functional Requirements

	Use Case	Acceptance Criteria
EPIC: Care Network Maintenance		
1	As a user I want to create an account (username and password) on the application so that I can use this to login.	When opening the application, the user should see a screen to create an account After clicking create new account the users should type in a new username and password and press continue Account should be created
2	As a principle family member I must define the care receiver on the application so that other family members and carers can view information.	Press 'add new care receiver' Type in name of care receiver
3	As a principle family member I want overall control of who can access the care receivers information so that I know the person I am caring for's information is kept secure.	- Only principle family member can add a new carers and family members
4	As a principle family member I want the ability to change who the principle family member is so that if I am unable to control access anymore the patient doesn't need to be set up again.	- Ability to change person in control of access
5	As a family member I must send a request to the principle family member that want to see the care receiver's information so that they can also receive updates from the application.	Click send request for specific care receiver to principle family member
6	As a professional carer I must send a request to the principle family member so that they can receive updates from my visits.	- Click send request for specific care receiver to principle family member
7	As a principle family member I must accept the request sent from the family member so that they can view updates.	- Accept request from family member
8	As a principle family member I must accept the request sent from	- Accept request from carer

	the professional carer so that I can update family after visits.	
9	As a principle family member I want the ability to remove a carer so that carer information is managed appropriately.	- Select remove carer from the page
10	As a principle family member I want the ability to remove a family member so that carer information is managed appropriately.	- Select remove family member from the page
EPIC: Account Maintenance		
11	As a user I must be able to reset my password so that I can still log in if I have forgotten it.	- Ability to reset password on the login page
12	As a user I want to be able to log into the system using my credentials so that I can access my profile.	- Log in successful if correct credentials are used
13	As a user, I want to stay logged in when I exit the application, so that I do not have to log in every time I use the application.	- When opening the application, if a user hasn't logged out of the application then they should be still logged in.
14	As a user, I want to be able to log off the application, so that I know my patient's information is protected when I am not on my phone.	- There must be log out functionality
15	As a user I want the ability to delete my account so that when I no longer need it all my information is removed.	- Ability for user to delete account - Information about user deleted from system when account has been deleted
16	As a user I want the ability to create an account so that I can log in.	Ability to create an account Information about user stored on the system
EPIC: Care Visit		
17	As a carer I want to select the patient so that I can complete a questionnaire for them after my visit.	- Ability when opening the application to select the patients name
18	As a carer I must answer the questions on the questionnaire so that I can inform families of patient wellbeing.	- Ability to answer the questionnaire
19	As a carer I want to be able to submit a questionnaire where not all questions are filled in so that I do not need to fill in unnecessary information for a visit.	- Ability to submit questionnaire answers where not all fields have been filled in
20	As a carer I must submit answers from the questionnaire so that the	- When submit button is pressed a phone notification appears on the

	family's phones receive an update.	principle family member and family members phones.
	EPIC: Updates	
21	As a (principle) family member I want to receive a phone notification when a carer has submitted a questionnaire so that I know when a new form has been submitted.	Phone notification appears when new questionnaire is submitted by carer
22	As a principle family member, I want to receive a phone notification for a family member/carers 'friend' request so that I am alerted when I need to accept/reject the request.	Phone notification appears on principle family member device when a 'friend' request is sent.
23	As a family member/professional carer I want to be notified that I have been accepted/rejected as a 'friend' to the patient so that I can see when my request was updated.	Phone notification appears on device of family member or carer when the 'friend'
24	As a principle family member I want to see friend request notifications on the homepage of the application so that I can click on the 'notification' and find the request.	Open the notification and view the most recent questionnaire form
25	As a carer I want to be able to see which patients I have requested to be friends with so that I can keep track of my requests.	- Record of friend requests sent on a page
	EPIC: Previous Visits	
26	As a family member I want to view the latest visit updates so that I can see how the person I care for is.	- Ability to view the information sent by the carer on the screen
27	As a family member I want to view previous visit information so that I can see trends in the care receiver's behaviours.	- Ability to look at a page with all the information regarding previous visits
28	As a family member I want to be able to search for a specific day on the history page so that I can look up the visits from that day.	- Search functionality so that the history page can be viewed by day
29	As a family member I want to be able to search the visit history by carers name so that I can see what patient questionnaires were filled in by a specific carer.	- Search functionality so that the history page can be viewed by carer
30	As a carer I want to be able to select a patient and see all of their	- Search functionality so that the history page can be viewed by carer

	previous visits (not just the ones done by myself) so that I can review previous notes left by other carers.	
31	As a carer I want to be able to view my previously submitted questionnaires on a patient so that I can see trends.	- Search functionality on patient by the history page can be viewed by carer
<b>EPIC: Questionnaire</b>		
32	As a principle family member I want to be able to select the questions that are relevant to the care receiver so that irrelevant questions are irradiated.	- Ability to select what questions you want to the questionnaire
33	As a principle family member I want the ability to add a new question relevant to my patient to the questionnaire so that I can view the information after a visit.	- Ability to add a question to the questionnaire
34	As a principle family member I want the ability to delete a question from the patients questionnaire so that I can review only needed questions.	- Ability to delete a question to the questionnaire

## Appendix B: Updates on requirements

	Use Case	Acceptance Criteria	Updates
<b>EPIC: Care Network Maintenance</b>			
1	As a user I want to create an account (username and password) on the application so that I can use this to login.	When opening the application, the user should see a screen to create an account After clicking create new account the users should type in a new username and password and press continue Account should be created	Yes
2	As a principle family member I must define the care receiver on the application so that other family members and carers can view information.	Press 'add new care receiver' Type in name of care receiver	Concept of 'principle family member' no longer exists. 'Care Receiver' referred to as 'patient'. Family member

			who first creates the account will create the patient.
3	As a principle family member I want overall control of who can access the care receivers information so that I know the person I am caring for's information is kept secure.	- Only principle family member can add a new carers and family members	Family members can send out a unique patient code to carers and other family/friends to join a patients group.
4	As a principle family member I want the ability to change who the principle family member is so that if I am unable to control access anymore the patient doesn't need to be set up again.	- Ability to change person in control of access	This function is no longer required due to no principle family member. All family members will be to control who has access to the patient's information.
5	As a family member I must send a request to the principle family member that want to see the care receiver's information so that they can also receive updates from the application.	Click send request for specific care receiver to principle family member	The function no longer exists, once a family member has been given the patient unique code then they can view their information.
6	As a professional carer I must send a request to the principle family member so that they can receive updates from my visits.	- Click send request for specific care receiver to principle family member	The function no longer exists, once a family member has given a professional carer the patient unique code then they can view their information.
7	As a principle family member I must accept the request sent from the family member so that they can view updates.	- Accept request from family member	No longer needed
8	As a principle family member I must accept the request sent from the professional carer so that I can update family after visits.	- Accept request from carer	No longer needed
9	As a principle family member I want the ability to remove a carer so that	- Select remove carer from the page	Updated so that all family members can delete a carer

	carer information is managed appropriately.		they do not want to be able to see patient information any longer.
10	As a principle family member I want the ability to remove a family member so that carer information is managed appropriately.	- Select remove family member from the page	Changed so that all family members can delete a family member they do not want to be able to see patient information any longer.
EPIC: Account Maintenance			
11	As a user I must be able to reset my password so that I can still log in if I have forgotten it.	- Ability to reset password on the login page	Yes
12	As a user I want to be able to log into the system using my credentials so that I can access my profile.	- Log in successful if correct credentials are used	Yes
13	As a user, I want to stay logged in when I exit the application, so that I do not have to log in every time I use the application.	- When opening the application, if a user hasn't logged out of the application then they should be still logged in.	Yes
14	As a user, I want to be able to log off the application, so that I know my patient's information is protected when I am not on my phone.	- There must be log out functionality	Yes
15	As a user I want the ability to delete my account so that when I no longer need it all my information is removed.	- Ability for user to delete account - Information about user deleted from system when account has been deleted	Yes
16	As a user I want the ability to create an account so that I can log in.	Ability to create an account Information about user stored on the system	Yes
EPIC: Care Visit			
17	As a carer I want to select the patient so that I can complete a questionnaire for them after my visit.	- Ability when opening the application to select the patients name	Yes
18	As a carer I must answer the questions on the questionnaire so that I can	- Ability to answer the questionnaire	Yes

	inform families of patient wellbeing.		
19	As a carer I want to be able to submit a questionnaire where not all questions are filled in so that I do not need to fill in unnecessary information for a visit.	- Ability to submit questionnaire answers where not all fields have been filled in	Yes
20	As a carer I must submit answers from the questionnaire so that family members can view them.	- When submit button is pressed answers are saved to a new visit	Yes
EPIC: Updates			
21	As a (principle) family member I want to receive a phone notification when a carer has submitted a questionnaire so that I know when a new form has been submitted.	Phone notification appears when new questionnaire is submitted by carer	Yes
22	As a principle family member, I want to receive a phone notification for a family member/carers 'friend' request so that I am alerted when I need to accept/reject the request.	Phone notification appears on principle family member device when a 'friend' request is sent.	No longer friend requests
23	As a family member/professional carer I want to be notified that I have been accepted/rejected as a 'friend' to the patient so that I can see when my request was updated.	Phone notification appears on device of family member or carer when the 'friend'	Yes
24	As a principle family member I want to see friend request notifications on the homepage of the application so that I can click on the 'notification' and find the request.	Open the notification and view the most recent questionnaire form	Changed approach to request
25	As a carer I want to be able to see which patients I have requested to be friends with so that I can keep track of my requests.	- Record of friend requests sent on a page	Changed approach to request
EPIC: Previous Visits			
26	As a family member I want	- Ability to view the	Yes



	to view the latest visit updates so that I can see how the person I care for is.	information sent by the carer on the screen	
27	As a family member I want to view previous visit information so that I can see trends in the care receiver's behaviours.	- Ability to look at a page with all the information regarding previous visits	Yes
29	As a family member I want to be able to search the visit history by carers name so that I can see what carer filled in questionnaires.	- Search functionality so that the history page can be viewed by carer	Yes
30	As a carer I want to be able to select a patient and see all of their previous visits (not just the ones done by myself) so that I can review previous notes left by other carers.	- Search functionality so that the history page can be viewed by carer	Yes
31	As a carer I want to be able to view my previously submitted questionnaires on a patient so that I can see trends.	- Search functionality on patient by the history page can be viewed by carer	Yes
EPIC: Questionnaire			
32	As a principle family member I want to be able to select the questions that are relevant to the care receiver so that irrelevant questions are irradiated.	- Ability to select what questions you want to the questionnaire	Yes
33	As a principle family member I want the ability to add a new question relevant to my patient to the questionnaire so that I can view the information after a visit.	- Ability to add a question to the questionnaire	Yes
34	As a principle family member I want the ability to delete a question from the patient's questionnaire so that I can review only needed questions.	- Ability to delete a question to the questionnaire	Yes

# Appendix C: Survey set up

Non Professional Carers

You are being invited to take part in a research study. Before you decide to participate it is important for you to understand why the research is being done and what it will involve. Please take the time to read the following information. Please email if there is anything that is not clear or if you would like more information.

This study is being conducted by Cardiff University. As a volunteer, you have responded to our request for participants to take part because you are a non professional carer (family or friend to a care receiver).

This study is being conducted to help design an application for professional carers and non-professional carers (family) to communicate on. The application will enable the professional carers to fill in a short questionnaire on the application including objective and subjective questions e.g. has patient eaten, patient mood. The answers to the questionnaires can then be viewed by the family/friends.

It is up to you to decide whether or not you want to take part in the study. If you decide to take part you are still free to withdraw at any time and without giving a reason.

All information that is collected from your questionnaire will be kept strictly confidential and anonymous using Google Forms. In any sort of output we might publish, we will not include information that will make it possible for other people to know your name or identify you in any way.

NEXT

Page 1 of 6

Never submit passwords through Google Forms.

Professional Carers

You are being invited to take part in a research study. Before you decide to participate it is important for you to understand why the research is being done and what it will involve. Please take the time to read the following information. Please email if there is anything that is not clear or if you would like more information.

This study is being conducted by Cardiff University. As a volunteer, you have responded to our request for participants to take part because you are a professional carer.

This study is being conducted to help design an application for professional carers and non-professional carers (family) to communicate on. The application will enable the professional carers to fill in a short questionnaire on the application including objective and subjective questions e.g. has patient eaten, patient mood. The answers to the questionnaires can then be viewed by the family/friends.

It is up to you to decide whether or not you want to take part in the study. If you decide to take part you are still free to withdraw at any time and without giving a reason.

All information that is collected from your questionnaire will be kept strictly confidential and anonymous using Google Forms. In any sort of output we might publish, we will not include information that will make it possible for other people to know your name or identify you in any way.

NEXT

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Never submit passwords through Google Forms.

Non Professional Carers

\* Required

Ethics

You are under no pressure to give your consent and you are free to withdraw from this study at any time. By accepting clicking 'I agree', you are agreeing to the following:

-I confirm that I have all of the prerequisites for participation as outlined in the Information Sheet, and consent that, where appropriate, any personal equipment I provide can be used for the purposes of this study.

-I confirm that I have read and understand the information Sheet and have had the opportunity to ask questions about it.

-I understand that participation in this study is entirely voluntary and that I can withdraw from the study at any time without giving a reason.

-I understand that I am free to ask any questions at any time and that I am free to withdraw or discuss my concerns with the lead researcher (Danielle Johnson).

-I also understand that at the end of the study I will be provided with additional information and feedback about the purpose of the study.

-I understand that the information provided by me will be held confidentially, such that only the researchers can trace this information back to me individually. The information will be retained for up to 5 years when it will be deleted/destroyed. I understand that I can ask for the information I provide to be deleted/destroyed at any time.

-I agree to data generated from my participation can be shared with other researchers.

Do you agree to the terms and conditions? \*

☐ I agree

☐ I do not agree

BACK

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Never submit passwords through Google Forms.

Professional Carers

\* Required

Ethics

You are under no pressure to give your consent and you are free to withdraw from this study at any time. By accepting clicking 'I agree', you are agreeing to the following:

-I confirm that I have all of the prerequisites for participation as outlined in the Information Sheet, and consent that, where appropriate, any personal equipment I provide can be used for the purposes of this study.

-I confirm that I have read and understand the information Sheet and have had the opportunity to ask questions about it.

-I understand that participation in this study is entirely voluntary and that I can withdraw from the study at any time without giving a reason.

-I understand that I am free to ask any questions at any time and that I am free to withdraw or discuss my concerns with the lead researcher (Danielle Johnson).

-I also understand that at the end of the study I will be provided with additional information and feedback about the purpose of the study.

-I understand that the information provided by me will be held confidentially, such that only the researchers can trace this information back to me individually. The information will be retained for up to 5 years when it will be deleted/destroyed. I understand that I can ask for the information I provide to be deleted/destroyed at any time.

-I agree to data generated from my participation can be shared with other researchers.

Do you agree to the terms and conditions: \*

☐ I agree

☐ I do not agree

BACK

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Never submit passwords through Google Forms.

Non Professional Carers

Non Professional Carers

How would you rate the communication between you and the professional carers?

1 2 3 4 5

Poor ☐ ☐ ☐ ☐ ☐ Excellent

Does your relation meet their carer while you are not present?

☐ Always

☐ Never

☐ Sometimes

How often do the professional carers contact you?

☐ Every day

☐ Once a week

☐ Once a month

☐ Only when something has happened

☐ Never

Professional Carers

Professional Carers

How long have you been a carer?

☐ 0-5 years

☐ 6-10 years

☐ 10+ years

Statistics currently show a rise in family members being involved in caring alongside professionals. In your experience, is this the case?

☐ Yes

☐ No

☐ Unsure

How do you currently record patient care?

☐ On paper (daily log)

☐ On a system provided by the agency

☐ Other: \_\_\_\_\_

## Appendix D: Video of API demonstration in Postman

Postman is a tool for testing API's. The video shows two calls to the Carer Communications API:

- An http POST request to the users/login resource is made with the request body holding the user email and password. The API responds with a valid authorisation status and a JWT token value.
- An http GET request is then made to the visits/patient with the JWT token value supplied in the request header. The API responds with JSON data for a patient visit.

<https://drive.google.com/file/d/1V2F0Juja15aJOXKmb0musupkgwql4Nez/view?usp=sharing>

Appendix E: Video on a new carer, adding a patient and filling in a visit

[https://drive.google.com/file/d/1weNS\\_14mUeAlIXs8ML22urOuFw\\_R9C1V/view](https://drive.google.com/file/d/1weNS_14mUeAlIXs8ML22urOuFw_R9C1V/view)

Appendix F: Video on a new family member signing up and adding a patient

[https://drive.google.com/file/d/15W\\_1RrkZit80cskOoMoFENDDhBIAAj98/view](https://drive.google.com/file/d/15W_1RrkZit80cskOoMoFENDDhBIAAj98/view)

Appendix G: Video on friend joining a patient group

<https://drive.google.com/file/d/1qrFv6J9l34lHbnb1fr7lOh8g8Tlv94tQ/view>

Appendix H: Family member deleting user from care network

[https://drive.google.com/file/d/1hX1C8lr\\_we8ZGgzeHag-7XK75qe8Yzg0/view](https://drive.google.com/file/d/1hX1C8lr_we8ZGgzeHag-7XK75qe8Yzg0/view)