INSTITUTO UNIVERSITÁRIO EGAS MONIZ

MESTRADO INTEGRADO EM CIÊNCIAS FARMACÊUTICAS

THE FEASIBILITY OF IMPLEMENTING VIRTUAL CLINICS AS FOLLOW-UP OF SECONDARY PREVENTION THERAPY POST ACUTE MYOCARDIAL INFARCTION

Trabalho submetido por
Vanessa Fonseca Rijo
para a obtenção do grau de Mestre em Ciências Farmacêuticas

Outubro de 2019

INSTITUTO UNIVERSITÁRIO EGAS MONIZ

MESTRADO INTEGRADO EM CIÊNCIAS FARMACÊUTICAS

THE FEASIBILITY OF IMPLEMENTING VIRTUAL CLINICS AS FOLLOW-UP OF SECONDARY PREVENTION POST ACUTE MYOCARDIAL INFARCTION

Trabalho submetido por
Vanessa Fonseca Rijo
para a obtenção do grau de **Mestre** em Ciências Farmacêuticas

Trabalho orientado por
Prof. Doutora Filipa Alves da Costa

e coorientado por
Dr. Sotiris Antoniou

Outubro de 2019

Acknowledgements

First of all, I would like to thank my supervisor ***Professor Filipa Alves da Costa*** for all the support she has given me throughout this project, along my university years and during my internship period at St. Bartholomew's Hospital in London. I am grateful to have had a supervisor who was able to push me to the best of my abilities and always willing to help and motivate me to improve.

I would like to thank the ***Pharmacy Team*** at St. Bartholomew's Hospital for all the support and guidance given, especially ***Sotiris Antoniou,*** Consultant Pharmacist, for his help, ideas and valuable contributions to this project and ***Sadeer Fadhil,*** High Specialist Cardiac Pharmacist, for being my go to person at the hospital, for being tireless and always ready to help me overcome any issues encountered.

Also, I would like to thank ***Professor Perpétua Gomes*** for all the help, guidance and advice she has given me throughout my university years. Thank you to ***Egas Moniz***, my second home for the last five years for all the friends and memories it helped to create.

To my friends, thank you for their friendship, support and motivation specially to ***Catarina***, ***Gonçalo*** and ***Bernardo*** for being there since the beginning and always being able to light up the mood and remind me that we are all on the same boat. A special thank you to ***Miguel***, for being my safe haven, my best friend and the one that helps me see the silver lining in every situation. To ***Joana*** and ***Carolina***, my oldest friends, I couldn't be more grateful to have you in my life.

A very special thank you to all my family, ***Grandparents***, ***Nuno*** and ***Sónia*** whom I can always count on and for always believing in me and always expecting the best of me. To my brother ***Thomas***, I couldn't be prouder of the person you are and of your ability to always make me laugh and make life lighter.

A huge thank you to my parents, ***Carlos*** and ***Christine*** for all the support, for always giving me the tools I needed and for every opportunity they gave me. Thank you for making me the person I am today and for showing me that if you want something you have to fight for it and that being told no is always a guarantee so you should always give it a try.

I couldn't be prouder of the people I have in my life; I am sincerely thankful.

Resumo

Introdução: Aproximadamente 1,4 milhões de indivíduos no Reino Unido sobreviveram a um Enfarte Agudo do Miocárdio (EAM). Aquando da alta hospitalar, são prescritos medicamentos de segunda prevenção. Portanto, o tempo para educar e ajustar a medicação para obter resultados otimizados é escasso. A *eHealth* tem crescido exponencialmente sendo vista como forma para criar proximidade entre o profissional de saúde e o paciente. É importante avaliar a aplicabilidade da *app* assim como a população abrangida para ser uma ferramenta válida para substituição de consultas presenciais.

Objetivos: O objetivo principal deste projeto é desenvolver uma clínica virtual para contribuir de forma eficiente na prestação de cuidados de saúde e promover proximidade entre os profissionais de saúde. Como passo intermédio, este projeto pretende explorar a aplicabilidade de implementar o mesmo. O objetivo específico é avaliar a opinião dos pacientes sobre a utilidade e aceitabilidade de ter Clínicas Virtuais de forma a usar a tecnologia para melhorar a prestação de cuidados de saúde.

Metodologia: Um questionário de autorrelato foi desenvolvido para avaliar as barreiras e facilidades de um acompanhamento feito em clínicas virtuais após um EAM. O questionário englobou perguntas sociodemográficas, avaliação da literacia em saúde e afirmações de forma a demonstrar a experiência dos pacientes no uso de *smartphones* e *apps.* Os dados foram recolhidos e analisados através do programa SPSS 25. Nesta análise, foi focada a validade do questionário, análise univariada e bivariada.

Resultados: Um total de 50 pacientes participaram sendo a idade média 61 ± 14, 76% eram do sexo masculino e 12% do sexo feminino, 42% eram da parte Este de Londres, 48% eram brancos e 68% tinham o ensino secundário ou menos. A maioria dos respondentes, (n=50;70%) consideraram que têm a habilidade para usar um *smartphone*, 42% concordam que um *app* poderia ser um substituto para consultas presenciais*,* 62% gostariam de ter uma app para monitorizarem a sua condição e 74% concordam que ter acesso a um profissional de saúde através de uma *app* teria um grande impacto na sua saúde. Pacientes mais novos mostraram mais prontidão em usar a *app* ($p< 0.001$).

Conclusão: Os dados coletados mostram potencial em ter uma Clínica Virtual para prevenção secundária. No entanto, são necessários mais estudos para apoiar o seu uso como substituto a consultas presenciais.

Palavras-chave: EAM; Acompanhamento; Clínica Virtual; Prevenção Secundária

Abstract

Introduction: Approximately 1.4 million people in the UK have survived a Myocardial Infarction (MI). When discharged, patients leave with a secondary prevention therapy. However, time to educate patients and adjust medication to an optimal treatment is limited. eHealth has grown exponentially being seen as a means to create proximity between professionals and patients. It is important to assess the feasibility of an app in order to be a valid replacement for face-to-face consultations.

Objective: This project's ultimate aim is to develop a virtual clinic to contribute to efficient delivery of healthcare and to promote proximity between healthcare professionals and patients. As an intermediate step, the current project aims to explore the feasibility of implementing such technology. The specific objective is to assess people's opinion on the utility and the acceptability of a virtual clinic as a means to use technology to improve healthcare provision.

Methods: A paper and pencil self-report questionnaire was developed to assess barriers and enablers of follow-up using virtual clinics, after MI. The questionnaire comprised sociodemographic data, a Health Literacy assessment tool and statements to reflect patients' views and experiences on the use of smartphones and applications. Data was collected and subsequently analyzed. Analysis was processed using SPSS 25 and focused on questionnaire validation, univariate and bivariate statistics.

Results: A total of 50 patients participated, the mean age was 61 ± 14, 76% were male and 12% were female, 42% were from East London and 48% were white and 68% have a high school degree or less. The majority of respondents (n=50; 70%) consider they have skills to use a smartphone, 42% agree the app may be a substitute to face to face consultations, 62% would like to have an app to monitor their condition and 74% agree that having access to a healthcare professional through an app would have a great impact in their health. Younger patients were more prompt to use apps ($p < 0.001$).

Conclusion: Data gathered showed potential of having a virtual clinical app as a secondary prevention follow-up. However, further studies must be developed to support the use of Virtual Clinic apps for future replacement of follow-up face-to-face consultations for secondary prevention therapy.

Keywords: Myocardial Infarction; Follow-up; Virtual Clinic; Secondary Prevention Therapy

Table of Contents

Resumo 1

Abstract 3

Table of Contents 5

List of Figures 8

List of Tables 9

List of Graphs 10

List of Abbreviations 11

Chapter 1 – Introduction 13

1.1 - Background 13

1.2 - Necessity 14

1.3 - Study Setting 15

Chapter 2 – Contextualization 16

2.1 - Acute Coronary Syndromes (ACS) 16

2.1.1 - Epidemiology 16

2.1.2 - Heart Anatomy 17

2.1.3 - Pathogenesis 18

2.1.4 - Clinical Patterns of ACS 20

2.1.5 - Symptoms and Diagnosis 21

2.2 - Acute Management of ACS 25

2.3 - Secondary Prevention Therapy 27

2.3.1 - Risk Factors Management 27

2.3.2 - Pharmacological Therapy 28

2.3.3 - Adherence and Follow-up 31

2.4 - Digital Health and Literacy 32

2.4.1 - Ortus iHealth 33

Chapter 3 – Aims and Research Questions 34

3.1 - Aim 34

3.2 - Objectives 34

3.3 - Research Questions 34

3.4 - Hypothesis Formulation 35

3.4.1 - Gender's Influence on the Willingness to use a Virtual Clinic App 35

3.4.2 - Age's Influence on the Willingness to use a Virtual Clinic App 35

3.4.3 - Education's Influence on the Willingness to use a Virtual Clinic App 35

Chapter 4 – Methodology 37

4.1 - Study Design and Duration 37

4.2 - Population 37

4.2.1 - Inclusion and Exclusion Criteria 37

4.3 - Data Collection 38

4.3.1 - Sociodemographic Data 38

4.3.2 - Attitude Measurement 38

4.3.3 - Newest Vital Sign (NVS) Score 39

4.4 - Statistic Analysis 39

4.5. - Ethics and Confidentiality Issues 40

Chapter 5 - Results 41

5.1 - Sample Characteristics 41

5.2 - Checking assumptions for the selection of the most suitable test 47

5.3 - Exploring the Scale's validity and reliability 49

5.4 - Bivariate Analysis 51

5.4.1 - Hypothesis 56

Chapter 6 - Discussion 58

6.1 - Collected Data....58

6.2 - Hypothesis and Research Questions Interpretation....59

6.3 - Study Limitations and Practical Implications....61

Chapter 7 - Conclusion....62

References....63

Appendixes....69

List of Figures

Figure 1 - Surface of the heart....17
Figure 2 - Coronary Circulation....18
Figure 3 - Arteriosclerosis....19
Figure 4 - Atherosclerosis....20
Figure 5 - ECG Waves....22
Figure 6 - ECG Patterns....23
Figure 7 - ACS Pathway....26
Figure 8- Angioplasty....26
Figure 9 - Countries Using mHealth Programmes....32
Figure 10 - Ortus iHealth Screenshots....33

List of Tables

Table 1 - Newest Vital Sign Score 39
Table 2 - Sociodemographic Data 42
Table 3 -Smarphone Data 43
Table 4 - Patient Centered Care Data 43
Table 5 - Qualitative Data 46
Table 6 - One-Sample Kolmogorov-Smirnov Test for the variable Age 47
Table 7 - One-Sample Kolmogorov-Smirnov Test for the 13 statements 48
Table 8 - Rotated Component: Varimax Method 50
Table 9 - One-Sample Kolmogorov-Smirnov Test for the components: Ability and Promptness 50
Table 10 - Education Level's Influence Health Literacy 55

List of Graphs

Graph 1 – Age's Normal Distribution.....47
Graph 2 - Example of Statements Non-normal Distribution.....48
Graph 3 - Principal Component Factor Analysis 49
Graph 4 - Component's Distribution 50
Graph 5 - Gender's influence on the ability to use apps.....51
Graph 6 - Gender's influence on the Promptness to use apps. 52
Graph 7 - Age's influence on Ability to use apps.....52
Graph 8 - Age's influence on Promptness to use apps. 53
Graph 9 - Education Level's influence on the Ability to use apps. 54
Graph 10 - Education Level's influence on the Promptness to use apps.....54

List of Abbreviations

ACE – Angiotensin Converting Enzyme

ACS – Acute Coronary Syndrome

ARB – Angiotensin-II Receptor Blocker

BHC – Barts Heart Centre

BHF – British Heart Association

BMI – Body Mass Index

BP – Blood Pressure

CEU – Clinical Effectiveness Unit

CHD – Coronary Heart Disease

cTn – Cardiac Troponin

CVD – Cardiovascular Disease

DALY – Disability Adjusted Life Years

DAPT – Dual Antiplatelet Therapy

DNAR – Do Not Attempt Resuscitation

ECG – Electrocardiogram

ESC – European Society of Cardiology

GP – General Practitioner

GTN – Glyceryl Trinitrate

LAD – Left Descending Artery

LCx – Left Circumflex

LMCA – Left Main Coronary Artery

MI – Myocardial Infarction

mV – millivolts

NHS – National Health System

NICE – The National Institute for Health and Care Excellence

NRT – Nicotine Replacement Therapy

NSTE-ACS – Non-ST Elevation Acute Coronary Syndrome

NSTEMI – Non-ST Elevation Myocardial Infarction

NVS – Newest Vital Sign

PCI – Percutaneous Coronary Intervention

PPI – Proton Pump Inhibitor

RCA – Right Coronary Artery

SPSS – Statistical Software Package for Social Sciences

STEMI – ST Elevation Myocardial Infarction

UHC – Universal Health Coverage

UK – United Kingdom

WHO – World Health Organisation

Chapter 1 – Introduction

1.1 - Background

According to the British Heart Foundation (BHF), in the United Kingdom (UK), 7.4 million people live with heart and circulatory diseases, also known as cardiovascular diseases (CVD), being twice as many people than the ones living with Alzheimer's disease and cancer. The healthcare cost of CVD is estimated to be 19 billion pounds per year and accounting for a quarter (28%) of all UK deaths (British Heart Foundation., 2019b).

In august 2019, in the UK, 280 daily hospital admissions were due to a myocardial infarction (MI), 225 corresponding of England admissions (British Heart Foundation., 2019b, 2019a).

Approximately, 1.4 million people in the UK have survived a myocardial infarction (MI), and England accounts for 1.1 million of those people. (British Heart Foundation., 2019b, 2019a)

When discharged, patients leave with a secondary prevention therapy post myocardial infarction. As stated by the European Society of Cardiology (ESC), early discharge is appropriate in low-risk patients, preferably between 24h-48h. Thus, the time to educate the patient and adjust the medication to an optimal treatment plan is limited (Ibanez et al., 2018). It would be important to have tools that would help healthcare professionals to have regular follow-up of patients remotely.

In a world where technology is evolving at a fast pace it is vital that healthcare services keep up to date with evolution and keeps reinventing themselves using technology to its advantage. eHealth has been shown to have an immense growth in the last two decades and the World Health Organisation (WHO) believes that it's not possible to achieve universal health coverage (UHC) without its use (World Health Organization, 2016).

eHealth has been crucial for knowledge management and quality of care as well as promoting health and preventing diseases (Galbán & Vidal, 2019). It is possible to increase the access to health services through technology, for instance with smartphones.

Their use has been growing rapidly with more than 2.2 billion mobile subscriptions globally (World Health Organization, 2016). mHealth or mobile health is defined by WHO as the mobile usage for healthcare services such as monitoring patients, appointments reminders, telephone helplines, access to patient information which have been growing rapidly in a global scale (World Health Organization, 2016).

Notwithstanding, the use of mobile applications for healthcare purposes is still very scarce in the majority of countries, particularly if the application is designed for a specific purpose like post myocardial infarction follow-up. Ensuring patients have the necessary knowledge to use a smartphone and take the most advantages of the app is a vital step to the success of mHealth in the future.

1.2 - Necessity

The use of technology in healthcare has grown exponentially and continues to grow with more frequency. It can be seen as a means to facilitate and create proximity between the healthcare professional and the patient.

Having an app supporting a patient condition would not only be beneficial to the patient but also to the healthcare system. However, in order to guarantee that the app is successful, it is essential to make sure that patients have the right level of eHealth literacy to use this service to their advantage as well as being receptive to the idea of having an app to monitor their condition.

Myocardial infarctions can affect people from all age ranges but is more common amongst elder people (> 65 years old), accounting for 60% of hospitalizations due to acute coronary syndromes (ACS) (Engberding & Wenger, 2017).

Nowadays, people are expected to keep up with technology. However, this becomes a harder task for the elderly since they have more difficulty adapting and adjusting to these new technologies given their limited technological knowledge (Zoe, 2012).

Having an app monitoring a patient post myocardial infarction has numerous benefits. Nevertheless, it is important to assess the feasibility of the app as well as the populational range it can reach, so that it becomes, a valid replacement for face to face consultations.

1.3 - Study Setting

This study was conducted at St. Bartholomew's Hospital in London, UK. St. Bartholomew's Hospital is one of the five hospitals within Barts Health NHS Trust, the country's largest trust covering a population of 3 million people across London and Essex. (Barts Health NHS Trust, n.d.-a)

This hospital is renowned by their cancer and cardiac care centres of excellence, Barts Cancer Centre and Barts Heart Centre. The Barts Heart Centre (BHC) is Europe's largest specialised cardiovascular centre which aims to save more than 1000 lives a year being one of the busiest myocardial infarction centres in the UK. (Barts Health NHS Trust, n.d.-b)

Chapter 2 – Contextualization

2.1 - Acute Coronary Syndromes (ACS)

The term ACS is used to describe symptoms when there is a sudden obstruction or reduction of blood supply through the coronary arteries to the myocardium or a section of the heart also known as heart ischaemia (Gavalova, 2016).

Acute coronary syndromes can be divided into three clinical patterns; two different forms of MI: non-ST elevation myocardial infarction (NSTEMI) and ST elevation myocardial infarction (STEMI) and a third form, unstable angina, a more serious type of angina. (Keenan, Khatib, Lock, Ward, & Warren, 2012)

2.1.1 - Epidemiology

In a global scale, ACS is responsible for being the higgest mortality cause as well as loss of disability adjusted life years (DALYS). Seven million deaths and 129 million DALYs a year are due to ACS (Cherkasov et al., 2015).

In the United Kingdom, they are responsible for 280 hospitalizations per day costing 9 billion pounds a year (British Heart Foundation., 2019b). Furthermore, over 327.000 DALYS are lost due to ACS per year causing the individuals and their families to have a reduced quality of life (Charles River Associates, 2009).

Around 1.9 million people in England live with ACS being one of the lead causes of premature death. Every 6 minutes, a new patient is admitted due to a myocardial infarction and it is believed that around 1.1 million people in England have survived a myocardial infarction (British Heart Foundation., 2019a). Around 40 percent of those admissions were STEMI and 60 percent due to NSTEMI (Gavalova, 2016).

In the past two decades, the number of admissions due to STEMI have decreased and hospital mortality has decreased from 20 percent to 5 percent mainly as a result of an improvement in patient care, specialist follow-up and cardiac rehabilitation which results in quality of life improvements in patient and leads to better results (Gavalova, 2016). Another important reason is the increased access and faster uptake of drug treatment. (National Institute of Health and Care Excellence, 2013).

2.1.2 - Heart Anatomy

The heart is located in the mediastinum and is composed of four different chambers: two atria and two ventricles. The atria are the entrance chamber consisting of the superior and posterior areas of the heart which are composed of thin walls. The ventricles, on the other hand, located on the anterior and inferior area of the heart, are the chambers responsible for the ejection of blood to the rest of the body and lungs. Thus, its walls are thicker than the ones on the atria (Seeley, Stephens, & Tate, 2003).

The muscle responsible for the contraction of the heart sending the blood through the body is the **myocardium** and the vessels responsible for its blood supply are the **coronary arteries** that descend from the coronary sulcus.

The coronary sulcus separates the atria from the ventricle. The left and right ventricles are divided by two other sulci: the anterior interventricular sulcus and the posterior interventricular sulcus. The main arteries responsible for supplying the heart with blood are the right and left coronary artery (Seeley et al., 2003). Figure 1 represents the surface of the heart, where the main constituents of the heart are evident.

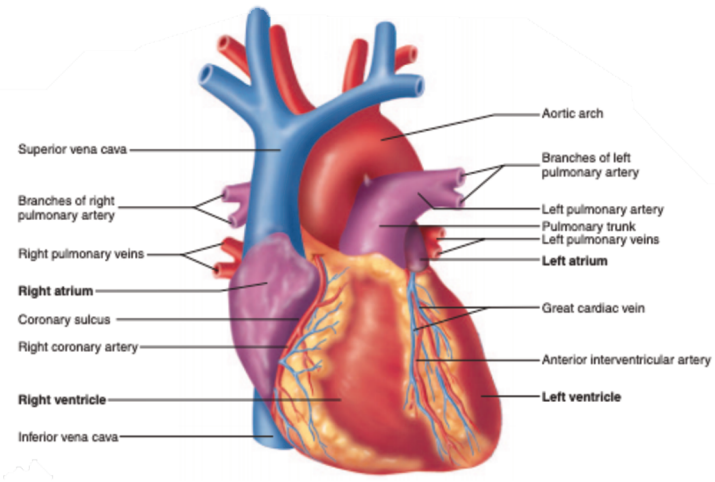


Figure 1 - Surface of the heart
Source: (Seeley et al., 2003)

The right and left coronary arteries leave the aorta and descend through the coronary sulcus. The **right coronary artery** (RCA) prolongs to the posterior part of the heart dividing into two different branches: the **right marginal artery**, that supplies the lateral wall of the right ventricle and the **posterior interventricular artery** also known as **left anterior descending artery** (LAD) that supplies blood to the posterior and inferior part of the heart.

The LAD is the main vessel of the **left main coronary artery** (LMCA) and supplies most of the blood to the anterior part of the heart. The left main coronary artery also divides into the **left marginal artery**, that supplies the lateral wall of the left ventricle, and into the **circumflex artery** (LCx), that supplies blood to the posterior side of the heart (Seeley et al., 2003). Figure 2 exemplifies the blood supply of the myocardium by the coronary arteries.

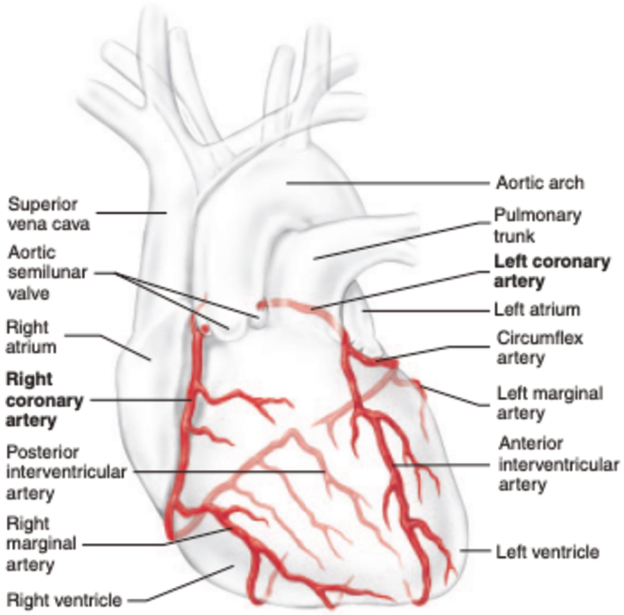


Figure 2 - Coronary Circulation

Source: (Seeley et al., 2003)

There are four main important arteries in ACS: the RCA, the LMCA which subsequently divides into the LAD, the LCx. Being the major suppliers of blood to the heart, when there is a blockage, it could leave permanent damage in the myocardium or in severe cases, death.

2.1.3 - Pathogenesis

For a MI to happen, there has to be a blockage, total or partial, in one of coronary arteries reducing or provoking a sudden loss of blood flow to the heart muscle causing pain and discomfort (Mcardle & British Heart Foundation., 2017).

Throughout the years, our arteries, once flexible and elastic, suffer a process called **arteriosclerosis** which is the thickening and stiffening of the artery walls that occasionally block blood flow from certain tissues and organs (Figure 3).

Arteriosclerosis is the main cause of CVD being aggravated by a number of risk

factors such as advanced age, smoking, sedentarism, high blood pressure, diabetes, hypercholesterolemia, amongst others.

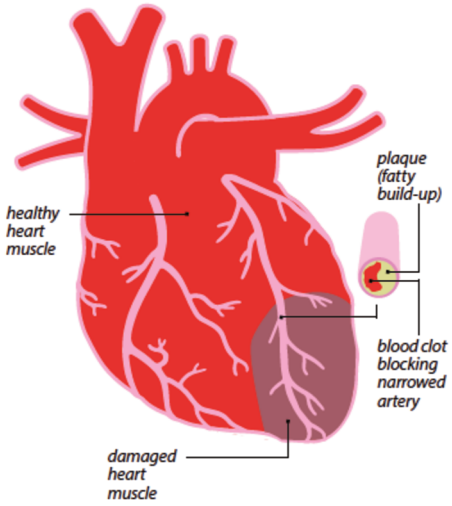


Figure 3 - Arteriosclerosis

Source: (Mcardle & British Heart Foundation., 2017)

This blockage is caused by the progressive build-up of fibro-fatty material that narrows and restricts the blood flow. These deposits gradually form **atheromas** or **atherosclerotic plaques** in the arteries. The arteries are composed of an elastic membrane that makes the artery contract and expand.

However, as mentioned previously, arteries lose their flexibility and elasticity throughout the years and allows the build-up of atherosclerotic plaques that is believed to be due to the several risk factors listed above.

This phenomenon is called **Atherosclerosis** and can develop progressively without symptoms and without being detected (Every & British Heart Foundation., 2017; Keenan et al., 2012). As Figure 4 shows, in a healthy artery, atherosclerotic plaque starts to build up and consequently the plaque ruptures, causing a clot and blocking the artery, hence blocking blood flow. This is when ACS occurs.

In coronary arteries, atherosclerosis is known as coronary heart disease (CHD) and patients diagnosed with CHD might experience chest pain (angina) when executing activities that require more effort and may need to rest or resort to medication to alleviate the pain. This is denominated of **stable angina**.

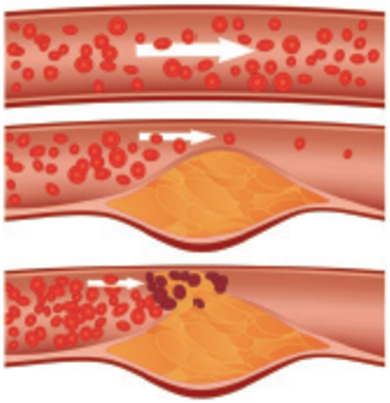


Figure 4 - Atherosclerosis

Source:(Keenan et al., 2012)

2.1.4 - Clinical Patterns of ACS

As stated previously, ACS is divided into three different clinical patterns: two types of MI and unstable angina.

Myocardial infarction is the most severe type of CHD. The artery is blocked for several minutes resulting in myocardial tissue death causing severe chest pain, electrocardiogram (ECG) variations and the increase of troponin levels, a cardiac enzyme released when there's cardiac tissue damage (Keenan et al., 2012). It is possible to divide MI into two different presentations according to the ECG changes:

- **STEMI:** ST elevation myocardial infarction. In this type of MI there is a complete blockage of the artery that can lead to myocardial muscle death. It is vital that blood flow is restored rapidly in order to preserve heart function (Ibanez et al., 2018).
- **NSTEMI**: Non-ST elevation myocardial infarction. In this type of MI there is a partial blockage resulting in the release of cardiac enzymes due to damage myocardial tissue (Ibanez et al., 2018).

The third clinical pattern of ACS is **unstable angina**. When a patient suffers from stable angina, the symptoms are consequence of the actions the patients took: effort, excitement, anger, along with others. In unstable angina, symptoms, such as chest pain, are felt more frequently without any specific trigger. It can occur when resting or when waking up. This severe form of angina can occur for long periods of time and acute medication fails to relieve the symptoms.

In this type of ACS, similarly to a NSTEMI, there is a partial blockage of the artery creating a 'stuttering' pattern related to the width of the clot. Therefore, the blood flow is dependent of the clot causing an erratic pattern without causing myocardial damage or troponin changes (Keenan et al., 2012).

Although there are crucial differences between unstable angina and NSTEMI, these are both often classified under a non-ST elevation ACS (NSTE-ACS).

2.1.5 - Symptoms and Diagnosis

Symptoms

In case of an ACS it is crucial to recognize the symptoms early on. It is common to mistake MI symptoms for respiratory or gastrointestinal issues. When experiencing any of the symptoms it is vital that the help of healthcare professionals is provided. When experiencing an ACS, people can present several number of symptoms (NICE guidelines, 2010):

- Chest pain: assure that it is cardiac pain during for more than 15 minutes. It may irradiate to either or both arms, neck, throat, jaw, teeth or back. It is relevant to understand the history of the chest pain, the risk factors the patient may present, any previous CVD or previous chest pain reports.
- Patients may experience nausea and vomiting, sweating, breathlessness or all of them simultaneously.
- Exacerbation of the chest pain or worsening of stable angina resulting in persistent chest pain with little or no effort. The exacerbation can also be linked to fluid retention or haemodynamic instability.

Diagnosis

To diagnose with accuracy the type of ACS the patient is suffering, there are a few steps that need to be taken as soon as the patient arrives to the hospital (Ibanez et al., 2018). After identifying the common symptoms of an ACS, it is necessary to look for the signs. For that reason, the patient is submitted to an electrocardiogram and blood tests to ensure healthcare professionals of the accurate ACS type.

Electrocardiogram

The electrocardiogram (ECG) is used to provide information from the heart, when there is cardiac excitation through potential differences. From the ECG it is possible to

monitor different areas of the heart as well as their size, heart rhythm, conduction or impulse, along with others (Silbernagl & Despopoulos, 2013).

The ECG illustrates electrical energy in millivolts (mV) as four different cardiac waves. The first wave is the **P wave** which corresponds to the atrial depolarization. Next, there is the **QRS complex** which corresponds to the depolarization of the ventricles followed by the **T wave** which corresponds to the repolarization of the ventricles (Silbernagl & Despopoulos, 2013) (Figure 5). To analyse the electrical conduction, the patient, when resting, is connected through 12 different leads positioned strategically on the chest.

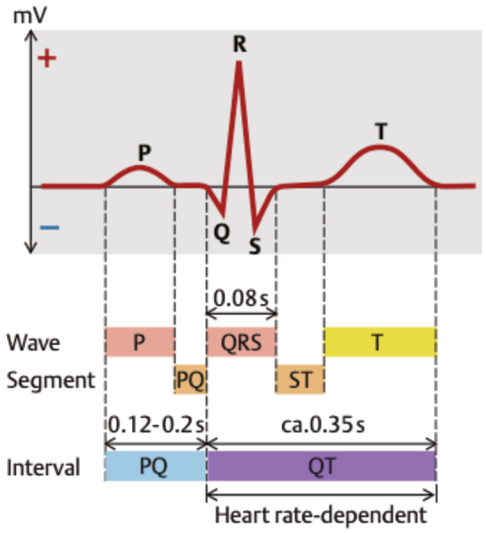


Figure 5 - ECG Waves

Source:(Silbernagl & Despopoulos, 2013)

For an initial diagnosis, it is important to start ECG monitoring as soon as possible and maintain it to allow a differential diagnosis and remain vigilant of any arrhythmias that might be life-threatening (Roffi, Patrono, Collet, Mueller, Valgimigli, Andreotti, Bax, Parkhomenko, et al., 2016).

An ECG can provide the healthcare professional a lot of information of where the myocardial tissue damage is happening and what type of ACS it is, for instance, when there is persistent ST elevation, the patient is suffering a STEMI, the worst type of MI. When there is no ST elevation or ST/T abnormalities, the patient might be either suffering a NSTEMI or from unstable angina that would be differentiated by cardiac markers after blood tests (Thygesen et al., 2012).

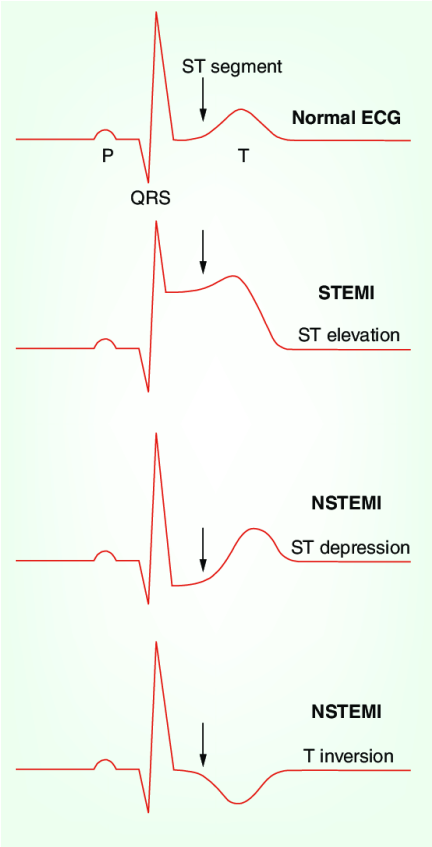


Figure 6 - ECG Patterns

Source: (Pleister, Selemon, Elton, & Elton, 2013)

Notwithstanding, the ECG can be hard to analyse and get a precise diagnose as patients might have other abnormalities and for that reason it is also important to resort to an emergency coronary angiography and to a Percutaneous Coronary Intervention (PCI).

Cardiac Markers

For a complete formal risk assessment of the condition, it is necessary to conduct blood tests to look for biochemical markers of cardiac damage (National Institute for Health and Care Excellence (NICE), 2010; National Institute for Health and Care Excellence, 2014).

It is possible to assess injury through biomarkers such as cardiac troponin (cTn) or creatine kinase MB fraction (previously used diagnose biomarker) when their blood levels are increased. Cardiac troponin can be divided into three separate structural proteins, troponin T, C and I. Cardiac troponin I and T exist in the contractile cells of the myocardium and are specific to the heart muscle. Thus, when these two types of troponin

are elevated in blood tests, it is commonly related to myocardial muscle damage (NICE guidelines, 2010; Thygesen et al., 2012).

Troponin levels tend to raise four hours after the first onset symptom and remain in elevated for the duration of two weeks making it an excellent biomarker for cardiac damage. When measuring troponin levels, it is necessary to complete this procedure twice to look for signs of further damage (continuous raising levels of troponin) or a sign that the condition is being resolved (no troponin levels elevation) (NICE guidelines, 2010).

Tests such as glucose, haemoglobin and creatinine should also be taken into account when dealing with ACS.

2.2 - Acute Management of ACS

When dealing with an ACS, the first stage is to take a 12-lead ECG to start managing the problem at the earliest. Afterwards, it is vital to assess the level of pain and offer pain relief such as (Herlitz, Hjalmarson, & Waagstein, 1989):

- glyceryl trinitrate (GTN) spray: the dose should be between 0.3-1mg to create vasodilatation of the coronary arteries to decrease myocardial oxygen consumption levels, myocardial preload, left ventricle diastolic volume and increase coronary collateral flow (Roffi, Patrono, Collet, Mueller, Valgimigli, Andreotti, Bax, Borger, et al., 2016).
- Intravenous opioids: morphine is commonly use on acute management; the dose varies between 5-10 mg administered regularly following patient needs. Morphine should be considered specially if an MI is suspected (NICE, 2010). Since morphine has side effects like nausea and vomiting, it is important to consider and antiemetic when administering the first opioid dose to prevent them, normally patient are given metoclopramide (Keenan et al., 2012).

Subsequently, the patient is offered a loading dose of Aspirin (300 mg) to minimize or prevent heart damage unless they are allergic or hemorrhaging. Aspirin in this dose will act as an antiplatelet and prevent or slow down the creation of atheromas (NICE guidelines, 2010).

If necessary, oxygen can be used in patient at risk of CO_2 retention. People with Chronic Obstructive Pulmonary Disease (COPD) should be specially taken into account when measuring oxygen saturation (National Institute for Health and Care Excellence, 2014). When arriving to the hospital, the patient is direct to a specific acute ward in order to conduct further testing and establish the treatment strategy, a coronary angiography is important to assess the severity of the coronary disease commonly followed by PCI or angioplasty, a reperfusion therapy to clear the artery blockage and return blood flow to the heart (Figure 7).

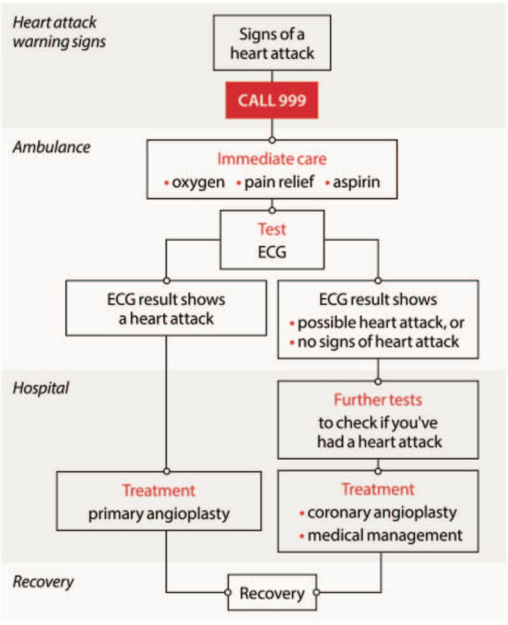


Figure 7 - ACS Pathway

Source:(Mcardle & British Heart Foundation., 2017)

In a coronary angioplasty, a balloon is placed to open the blocked artery, which is then inflated clearing the blockage, expanding the artery and subsequently placing a stent, a stainless-steel tube that should keep in place and hold the artery opened for a lifetime (Antoniou & Wright, 2013; Fischman, Leon, Baim, & et al, 1994) (Figure 8).

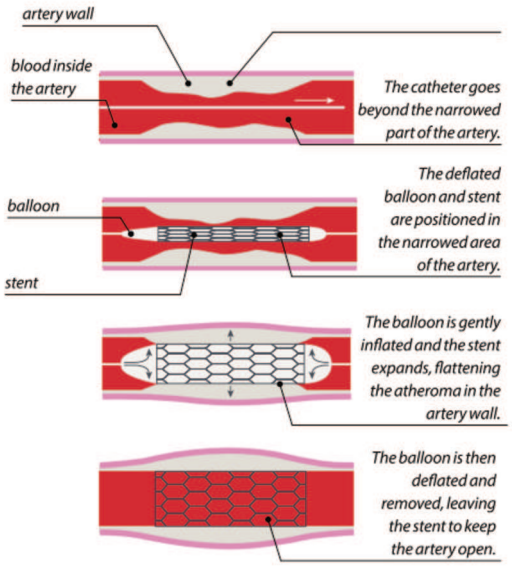


Figure 8- Angioplasty

Source: (Mcardle & British Heart Foundation., 2017)

2.3 - Secondary Prevention Therapy

When recovering and going through cardiac rehabilitation, it is crucial that the patient understands what he/she has been through and how to avoid having a second cardiovascular event. When managing patient with diagnosed NSTEMI and Unstable Angina, it is important to evaluate the future risk of having another event of this nature or evolving to a STEMI. This is established using risk scoring systems that allows to predict 6-month mortality for clinical management (National Institute for Health and Care Excellence, 2014).

Nevertheless, all ACS patients are guided on how to tackle risk factors and given a secondary prevention drug therapy following The National Institute for Health and Care Excellence (NICE) guidelines (NICE Pathways, 2019).

2.3.1 - Risk Factors Management

There are several preventable risk factors that when well managed can be of substantial help when dealing with cardiac complications. However, these sudden changes to a person's lifestyle may come as a shock so it is essential that the changes are made gradually and realistically tailored to the patient in order to achieve optimal results and permanent changes (NICE, 2013).

The European Society of Cardiology (ESC), developed guidelines on how to prevent cardiovascular diseases. Some key interventions rely on alcohol and smoking cessation, diet control and weight loss, exercise, hypertension management and drug therapy adherence.

Alcohol and Smoking cessation

Alcoholic beverages when highly and regularly consumed can be associated with a high risk of CVD. There are scores used as screening tools (AUDIT-C) to assess the risk of affecting a person's health commonly used when gathering patient information. This way, healthcare professionals can advise patients to moderate their consumption to the recommended levels and help them understand giving them The Brief Advice on hazardous and harmful drinking. On the other hand, smoking has a major role on CVD as it has a strong pro-thrombotic effect and thus being the most cost-effective approach of prevent CVD. There are a few interventions that can be made for smoking cessation such as Nicotine Replacement Therapy (NRT), brief interventions and assistance, amongst

other. The smoking cessation should start in hospital and continued as follow-up since the benefits have been proven by several studies (Piepoli et al., 2016).

Diet Control, Weight loss

When gathering patient information, is it necessary to calculate their Body Mass Index (BMI) since being overweight (BMI >25 kg/m^2) is strongly linked to all-cause mortality (Ibanez et al., 2018). This allows for a personalised dietary intervention. According to the ESC guidelines, a Mediterranean diet is recommended as well as reducing salt intake. Along with weight loss, dietary interventions have shown to have beneficial effects on CVD risk factors, for instance, Diabetes mellitus, hypertension and hyperlipidaemia.

Exercise

Part of the cardiac rehabilitation programme is to engage into a few activities adapted to the patient. This has shown beneficial physiological effects on cardiac rehabilitation improving all-cause and CVD mortality by 20-30% (Sattelmair, Pertman, Ding, Kohl, & Haskell, 2011).

Hypertension Management

The prevalence of hypertension is extremely high being the leading risk of CVD accounting for 9.4 million deaths (Stephen S Lim‡, Theo Vos, Abraham D Flaxman, Goodarz Danaei et al., 2012). This is a preventable risk factor that must be controlled if the previously mentioned interventions are followed. When a person is diagnosed with high blood pressure, he/she should be directed to a hypertension clinic and should be checked periodically by a healthcare professional controlling blood pressure as well as the suitability of pharmacotherapy scheme.

2.3.2 - Pharmacological Therapy

Additionally, to the non-pharmaceutical interventions, all ACS patients are offered secondary prevention therapy. According to ESC Guidelines, ACS can be pharmacologically managed with dual antiplatelet therapy (DAPT), a beta-blocker, a

statin and an angiotensin converting enzyme (ACE) inhibitor or angiotensin-II receptor blocker (ARB) (Ibanez et al., 2018; NICE, 2013).

The treatment is started during the patient's stay at the hospital and doses should be up titrated as much as possible before patient discharge to attempt to achieve optimal pharmacological therapy. Both patient and General Practitioner (GP) must be given a discharge summary letter with clear instructions on monitoring risk factors regularly and medication information and dose up titration (NICE Pathways, 2019).

Dual Antiplatelet Therapy (DAPT)

This dual therapy is composed by Aspirin and a P2Y12 inhibitor, such as Clopidogrel, Prasugrel or Ticagrelor. The benefits of dual antiplatelet following an ACS was established by the CURE, 1 COMMIT/CCS-28 and CLARITY-TIMI 289 trials. Aspirin in long term prevention, the dose should be between 75-100 mg once a day should indefinitely and in case of intolerance, switch to Clopidogrel. The second antiplatelet has been shown to reduce 1-year incidence of cardiovascular disease by approximately 20% compared to Aspirin alone (John Wilson, E. Newby, Dawson, & Irving, 2017).

Normally DAPT is continued for a period of 12 months continuing only with Aspirin after that period. However, this will depend of the patients bleeding risk, type of intervention (PCI or other) and the type of stenting used (Ibanez et al., 2018).

When using DAPT, it is important to have prophylactic dose gastrointestinal protection given to the patient. Commonly, healthcare professionals resort to proton pump inhibitors (PPI) for patients receiving DAPT in older patients (>65 years old), patients with gastrointestinal bleeding risk or helicobacter pylori infection or patients using anti-inflammatory or steroid medication. Lansoprazole is the most used PPI since 80 mg of Omeprazole reduces Clopidogrel effects and thus its use is discouraged ((MHRA), 2010; Baxter, 2006).

Beta-blockers

Beta-blockers, like bisoprolol, metoprolol, atenolol and others, are used to take the pressure of the heart and lower blood pressure consequently causing lower heart rate, reduction of oxygen consumption and myocardial contraction. They have anti-arrhythmic properties that may reduce ventricular arrhythmias. Its long-term use benefits have very strong evidence and its recommended that the treatment is started as soon as the patient is stable. The first dose given should be low and gradually up titrated to the maximum

dose tolerated by the patient (NICE, 2013). The treatment should take at least one year to allow the heart to heal from the stress caused by the cardiac event and the patient might fell some side effects such as tiredness when starting it.

Statins

Statins are also known as lipid lowering therapy. Its benefits have been demonstrated extensively and have shown vital outcomes when started early and intensively in ACS. These are used to lower cholesterol levels and also due to their anti-inflammatory properties. The levels are checked when the patient is admitted to the hospital and patients are then started on a high intensity statin, for instance, atorvastatin and rosuvastatin always taking into account their preference, reaction to side effects like myopathy and hepatotoxic properties (Deanfield & Al, 2015; Yusuf, 1988). No up titration is need for high intensity statin treatment and its common practise to medicate the patient with atorvastatin 80 mg once a day. It is crucial that the monitoring of statin treatment occurs regularly and accompanied by the patient's GP for monitoring or any side effects complaints. Dietary and lifestyle recommendations also take part in getting optimal results with statins (National Institute for Health Care Excellence, 2016). Liver function test should be run before starting a statin and measured following three months and one year later.

Angiotensin converting enzyme (ACE) inhibitors

ACE inhibitors or ARB's are part of the patient's treatment and should be offered post MI as soon as they are haemodynamically stable and with good renal function. Studies have confirmed the safety and benefits of starting an ACE inhibitor or ARB, having a small however significant reduction in 30-day mortality, especially in the first week of treatment (Infarction, 1998; "ISIS-4: A randomised factorial trial assessing early oral captopril, oral mononitrate, and intravenous magnesium sulphate in 58 050 patients with suspected acute myocardial infarction," 1995). This medication should be continued indefinitely and up titrated to maximum tolerated dose by the patient in 24h intervals, when this is not possible in hospital, up titration could take up to four to six weeks after hospital discharged and should be continued by the patients GP. Blood pressure, renal function and serum electrolytes should be measured in advance and redone after starting treatment and one year after and keep monitoring at least once a year (NICE, 2013).

2.3.3 - Adherence and Follow-up

Local research showed that high adherence to secondary prevention medication is strongly linked to prevention of future MI's. Hence, it is crucial to keep up with these patients to prevent further events from happening in the future when there is transition of care. A multi-disciplinary approach is important in cardiology care to improve medication management knowledge as well as enhance post discharge care (Anchah et al., 2017).

As previously stated, most of medication taken need close monitoring and dose adjustments so adherence to therapy and follow-up is crucial to continue a successful second prevention therapy along with risk factor management. With medication optimization, the healthcare professionals want to achieve the maximum benefit for patients (Royal Pharmaceutical Society, 2013). Adhering to treatment has been shown to lower mortality and morbidity and increase patient well-being. Plus, there is evidence that not complying with the treatment causes a 10% to 40% risk of rehospitalization and an increased risk of mortality by 50% to 80% (Ho et al., 2008).

According to an observational cohort study, after following patients after 6 months post discharge with secondary prevention therapy, shows that 41.8% were non-adherent (Brieger et al., 2018). It is vital to create proximity between patients and healthcare professionals in order to improve adherence numbers particularly in the first month of treatment (Keenan et al., 2012).

2.4 - Digital Health and Literacy

Little is known about the use of mobile applications medical follow-up. It is true that digital health has been increasing and internet is commonly used by the population. Over 68% of adults use smartphones and applications (apps) and its popularity has increased exponentially. Apps developed for the purpose of managing chronic diseases, allowing follow-up and educating patients are of extreme importance to provide high quality patient care (Ayyaswami et al., 2019).

The World Health Organization has designed Plans of Action to implement technology amongst healthcare professionals and different health sectors (World Health Organization, 2016)

. mHealth or mobile health is defined by WHO as the mobile usage for health care services such as monitoring patients, appointment reminders, along with others. The consultation between health care professionals and patients through a smartphone, named mobile telehealth, and data collection from patients through a mobile phone, names patient monitoring have been described has one of the areas most used by countries worldwide (Figure 9)(World Health Organization, 2016).

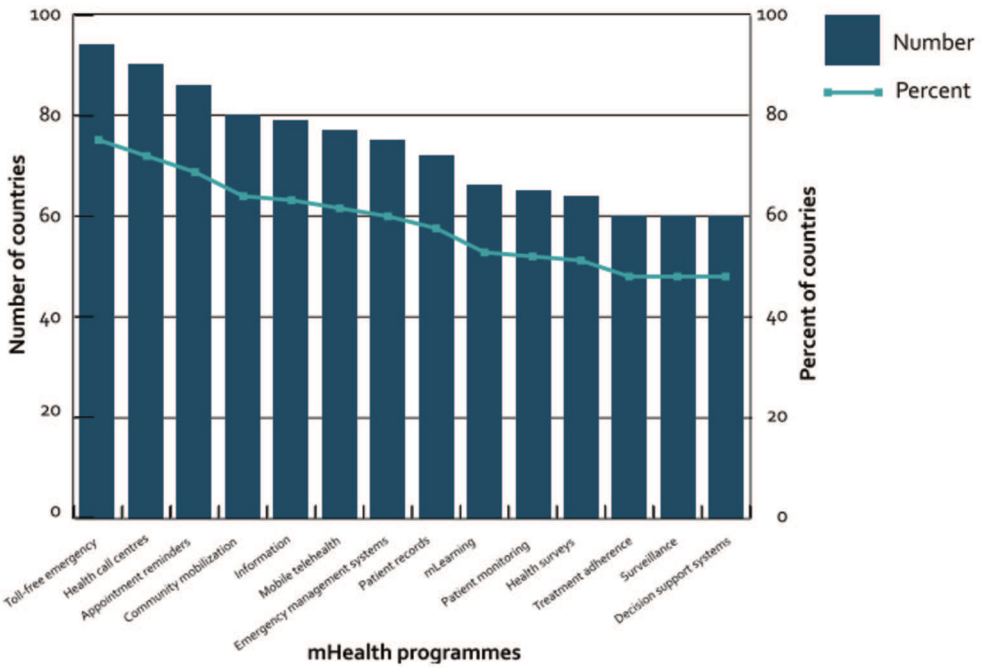


Figure 9 - Countries Using mHealth Programmes

Source:(World Health Organization, 2016)

Therefore, these are areas that health systems around the world should invest in to create proximity between patients and healthcare professionals, to allow for better follow-up and consequently better adherence and decrease preventable events from reoccurring, becoming a cost-effective solution.

2.4.1 - Ortus iHealth

Ortus iHealth is a virtual clinic app designed to communicate with the patient regularly after hospital discharge from an MI. It was developed to empower patients and increase communication between healthcare professionals and patients and create quicker and more regular follow.

This app would allow healthcare professionals to access patient data such as blood pressure measurements, relevant blood test levels, any relevant symptoms among others. Using this app, through a video consultation, healthcare professionals are able to provide personalized care through regular follow-up in a virtual clinic and monitor patient's condition more closely (Figure 10).

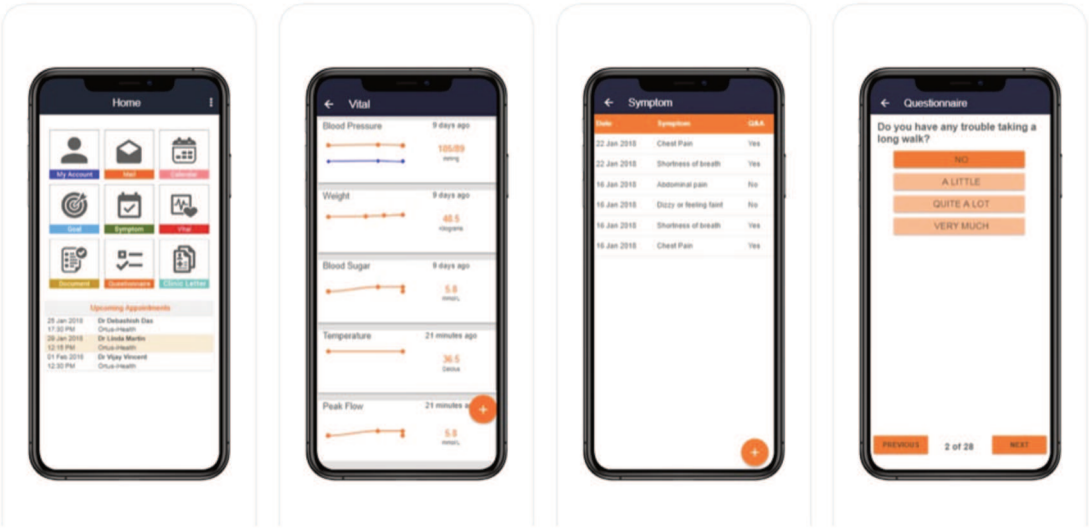


Figure 10 - Ortus iHealth Screenshots

Chapter 3 – Aims and Research Questions

3.1 - Aim

The aim of this project is to determine if a virtual clinic through an app would be beneficial as a substitute for regular follow-up face to face consultations. To reach this aim, the established strategy was to question patients about the feasibility of having a mobile application to follow their condition and analyse their willingness of having a remote follow-up instead of a face to face consultation with the cardiac specialist for the hospital.

3.2 - Objectives

The ultimate objective of this project was to assess the willingness of patients for having an app to monitor their condition remotely post MI. Specific objectives set to achieve the aim were:

- To evaluate the patients' perspective of having access to remote follow-up through a virtual clinic, by questioning their willingness.
- To judge the feasibility of implementing such virtual clinics, by accessing patient and environment-related factors.

3.3 - Research Questions

On this basis, the following specific research questions were developed:

1. Does gender influence the willingness to use an app?
2. Does age influence the promptness of using an app?
3. Does age influence the ability to use an app?
4. Does education influence the promptness of using an app?
5. Does education influence the ability to use an app?
6. Does educational level influence digital and health literacy?
7. Do patients deem the app an equivalent substitute to face to face consultations?
8. Are patients willing to help the clinician with the data needed for a follow-up consultation?

3.4 - Hypothesis Formulation

In order to analyse the data of this study, the following hypothesis were formulated.

3.4.1 - Gender's Influence on the Willingness to use a Virtual Clinic App

Hypothesis 1: Gender influences the ability to use apps.

H_0 – Males will tend to score low on the component Ability.

H_1 –Males will tend to score high on the component Ability.

Hypothesis 2: Gender influences the promptness to use apps.

H_0 – People over 65 will tend to score low on the component Promptness.

H_1 – People over 65 will tend to score high on the component Promptness.

3.4.2 - Age's Influence on the Willingness to use a Virtual Clinic App

Hypothesis 3: Age influences the ability to use apps.

H_0 – People over 65 will tend to score low on the component Ability.

H_1 – People over 65 will tend to score high on the component Ability.

Hypothesis 4: Age influences the promptness to use apps.

H_0 – People over 65 will tend to score low on the component Promptness.

H_1 – People over 65 will tend to score high on the component Promptness.

3.4.3 - Education's Influence on the Willingness to use a Virtual Clinic App

Hypothesis 5: Education Level influences the ability to use apps.

H_0 – People with level of education of bachelor's degree or above will tend to score low on the component Ability.

H_1 – People with level of education of bachelor's degree or above will tend to score high on the component Ability.

Hypothesis 6: Education Level influences the promptness to use apps.

H_0 – People with level of education of bachelor's degree or above will tend to score low on the component Promptness.

H_1 – People with level of education of bachelor's degree or above will tend to score high on the component Promptness.

Hypothesis 7: Health literacy is influenced by education level.

H_0 – Almost always adequate literacy is not related with a level of education of bachelor's degree or above.

H_1- Almost always adequate literacy is related with a level of education of bachelor's degree or above.

Chapter 4 – Methodology

4.1 - Study Design and Duration

An observational and cross-sectional study was developed, where patients were accessed in one single moment in time. This study took place between June and August 2019. The study can be divided in two different periods.

At a first phase, the questionnaire was developed and piloted amongst a five randomly selected patients notwithstanding, no significant changes were made to achieve the final version.

Following face validation by the research team, data collection was initiated and lasted three weeks between 24th June and 12th July 2019.

4.2 - Population

The study population was selected from the ward 3A East of St. Bartholomew's Hospital. This ward receives patients admitted with acute cardiology emergencies predominantly with ACS. To select patients, it was necessary to establish the ones that were suitable and adequate to this particular subject of study.

A priori sample size estimation was not possible since it was not conceivable to select more patients than those present in the 3A East ward, thus, after discussing the matter with the expert panel, the conclusion reached was to recruit all patients meeting the inclusion criteria during the study period the sample size subsequently.

4.2.1 - Inclusion and Exclusion Criteria

This study aimed to include every patient diagnosed with an ACS however, this was not possible hence, the need to create exclusion criteria.

Inclusion criteria comprised:

- Myocardial Infarction: STEMI;
- Myocardial Infarction: NSTEMI;
- Recurrent ACS.

Exclusion criteria included:

- Stable angina;

- Unstable angina;
- a signed *Do Not Attempt Resuscitation* form (DNAR);
- not physically or mentally capable;
- weekend patients.

4.3 - Data Collection

To collect the necessary data, a questionnaire was developed by the main researcher with the help of a panel of 3 experts in research and in Cardiology. Based on the Bite-Size Guide To Patient Insight: Writing An Effective Questionnaire (NHS, 2018), the structure and tone of the questionnaire was established.

Subsequently, the questionnaire was divided into three different parts, sociodemographic question, opinion assessment questions and health literacy assessment. (Appendix 1)

Following the willingness of the patient to participate in this study, the questionnaire was handed out to the patients in order for them to fill it in autonomously.

4.3.1 - Sociodemographic Data

The sociodemographic questions consisted of:

- Age
- Gender
- First three letters of the Post Code
- Ethnic Origin
- Educational Level
- Employment Status
- Mother Tongue
- Existence of a Carer

The options in the questions from this section of the questionnaire were formulated based on the National Health System (NHS) Data Dictionary (NHS, n.d.).

4.3.2 - Attitude Measurement

The data collection consisted of questions developed using the Likert Scale in order to assess the predisposition of using the app and the ease to use technology for the

purpose suggested. It was developed entirely by the panel of experts along with the main researcher with the aim of creating questions designed specifically for this study. The Likert Scale is often used to get feedback and collect people's opinions on a matter (Sullivan & Artino, 2013). The type of Likert Scale chosen ranges from "Strongly Disagree" to "Strongly Agree" allowing the respondent to freely choose in which degree they agree or disagree with the statements. It was decided to vary between positive and negative statements so as to avoid sleepers' questions and keep the patient's attention throughout the questionnaire.

4.3.3 - Newest Vital Sign (NVS) Score

To evaluate Health Literacy, a third part was created based on the Newest Vital Sign (NVS) developed with the purpose of evaluating health literacy of patients. It is a simple and quick tool to assess if the patient is able to understand and act upon health information (Pfizer, 2011). (Appendix 2)

This tool consists of 6 questions based on a nutrition label of an ice cream. After answering, patients are given a score, from 0 to 6 evaluating the number of correct answers **(Table 1)**.

Score	Indication
0-1	High likelihood (50% or more) of limited literacy
2-3	Possibility of limited literacy
4-6	Almost always indicates adequate literacy

Table 1 - Newest Vital Sign Score

Source: Adapted from *Pfizer, 2011*

4.4 - Statistic Analysis

Data collected were analysed using descriptive and bivariate statistics. Descriptive analysis focused on absolute and relative frequencies, and on dispersion measures such as means, median and standard deviation. Kolmogorov-Smirnov was used to ascertain the distribution of all variables to decide on the use of parametric or non-parametric tests. Bivariate analysis was used to explore associations between variables. Spearman test, Mann-Whitney test and chi-square test were used, respectively, in the presence of two continuous variables, continuous categorical variables, and two categorical variables. Data were presented using graphs and tables according to the type of data gathered. IBM Statistical Software Package for Social Sciences (SPSS) version 25 was used.

4.5. - Ethics and Confidentiality Issues

This study complied with all the requirements established by the Helsinki declaration, namely the respect for patient's autonomy and right to deny participation. Patients were informed about the processes followed to ensure the respect for their anonymity and confidentiality of their data. The project was submitted to the Clinical Effectiveness Unit (CEU) and approved under the protocol number 7983 (Appendix 1).

Chapter 5 - Results

5.1 - Sample Characteristics

Between the 24th June 2019 and 12th July 2019, 55 patients were admitted 3A East ward. Five patients did not meet the inclusion criteria and were excluded. The remaining 50 accepted to participate in the study.

Sociodemographic Data

Among the 50 respondents admitted with a myocardial infarction, 38 were male (76%) and 12 were female (25%). The mean age was 61 (± 14) years old, ranging from 34 to 87, 64% classified in the young age group (<65).

The sample characteristics are shown in **table 2**. Of highlight, 42% of respondents were from East London and 48% where white which comprises White British, White Irish, White Scottish. Concerning education, 68% of respondents had a High School degree. Regarding employment, 62% of respondents are part of England's active population and the majority of respondents had English as their mother tongue (74%). No respondents were cared for professionally but were cared for by an informal carer (44%) thus, 56% of them were not cared for. Vis-à-vis Health Literacy, 32% had results that show almost always indicates adequate literacy

Gender		
	Frequency	Percentage (%)
Male	38	76
Female	12	24
Other	0	0
Total	50	100
Age		
Mean age	61	
Standard Deviation	± 14	
Maximum	87	
Minimum	34	
Age Group		
	Frequency	Percentage (%)
Young (<65)	32	64
Old (>65)	18	36
Total	50	100
Postcode		
	Frequency	Percentage (%)
South	2	4
East	21	42
North	14	28
Outside of London	9	18
Omitted	4	8
Total	50	100

Ethnicity		
	Frequency	Percentage (%)
Asian	18	36
White	24	48
Black	5	10
Other	3	6
Total	50	100
Education		
	Frequency	Percentage (%)
Less than a high school diploma	16	32
High school Degree	18	36
Bachelor's Degree	7	14
Master's Degree	2	4
Doctorate	2	4
Other	3	6
Omitted	2	4
Total	50	100
Employment Status		
	Frequency	Percentage (%)
Unable to work	2	4
Employed for wages	20	40
Retired	17	34
Self-employed	11	22
Total	50	100
Native Language and Level of English		
	Frequency	Percentage (%)
English	37	74
Other: Very well	4	8
Other: Well	7	14
Other: Not well	1	2
Other: Not at all	1	2
Total	50	100
Carer		
	Frequency	Percentage (%)
No Carer	28	56
Professional Carer	0	0
Informal Carer	22	44
Total	50	100
Health Literacy (NVS)		
	Frequency	Percentage (%)
High likelihood (50% or more) of limited literacy	14	28
Possibility of limited literacy	15	30
Almost always indicate adequate literacy	16	32
Omitted	5	10
Total	50	100

Table 2 - Sociodemographic Data

mHealth and Patient Centered Care Data

Among the 50 respondents, 76% owned a smartphone. Although 70% considered they did not need any support to use it, 18% believed they needed help using a smartphone and had someone to do it and 12% believed they needed help but did not have anyone to assist them **(Table 3)**.

Smartphone		
	Frequency	Percentage (%)
Yes	38	76
No	12	24
Total	50	100
Having someone to help using a smartphone		
	Frequency	Percentage (%)
No	6	12
Yes	9	18
Omitted	35	70
Total	50	100

Table 3 -Smarphone Data

With the purpose of empowering patients to take part in their healthcare, there was the need to assess if respondents were willing to cooperate with the healthcare professional. Data shows that 44% of respondents own a Blood Pressure (BP) machine. Among the 56% who did not own a machine, 82% stated they were willing to buy one. Furthermore, it was asked if respondents were willing to go to their General Practitioner (GP) for regular blood tests and 92% confirmed their willingness to do so. **(Table 4)**

Owning a BP Machine		
	Frequency	Percentage (%)
Yes	22	44
No	28	56
Total	50	100
Willingness to buy a BP machine		
	Frequency	Percentage (%)
No	5	18
Yes	23	82
Total	28	100
Willingness to go to the GP for Blood tests		
	Frequency	Percentage (%)
Yes	4	8
No	46	92
Total	50	100

Table 4 - Patient Centered Care Data

From the Likert Scale statements, the data was gathered and laid out in a table with the correspondent statements **(Table 5)**.

From the statements used, the following information stood out, 70% of respondents believe they have the technological skills to use a smartphone, 68% states to use them on a daily basis, 62% are familiar with apps and 52% disagree that apps are hard to use. Amongst respondents, 58% stated to use their smartphone to search for health subjects online. Respondents were equally divided into those that already have a health app downloaded and those that do not have any.

Concerning condition monitoring, 62% would like to have an app to monitor their condition and 74% agree that having access to a healthcare professional through an app would have a great impact in their health. Regarding their follow-up, 74% of the respondents would prefer being followed by a cardiac specialist from the hospital. In terms of preferences for remote monitoring, 42% stated they would find video consultations acceptable, whereas 34% were undecided. Having a specialist from the hospital to follow-up regularly was considered important for 88% of the respondents and 66% agree that they would be happy to have follow-up through an app if it meant a quicker and more frequent follow-up. Plus, if given the support to use the app, 81% of the respondents would agree to use an app for follow-up.

1. "I have the technological skills to use a smartphone."						
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
Frequency	17	18	6	2	7	50
Percentage (%)	34	36	12	4	14	100
2. "I use my smartphone regularly, on a daily basis"						
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
Frequency	22	12	4	5	7	50
Percentage (%)	44	24	8	10	14	100
3. "I am familiar with smartphone applications (app)"						
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
Frequency	16	15	7	3	9	50
Percentage (%)	32	30	14	6	18	100
4. "I find apps hard to use so I don't have any on my smartphone."						
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
Frequency	7	9	8	8	18	50
Percentage (%)	14	18	16	16	36	100
5. "I use my smartphone/computer to research health related subjects on the internet."						
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
Frequency	13	16	6	6	9	50
Percentage (%)	26	32	12	12	18	100
6. "I have Health Apps installed on my smartphone."						
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
Frequency	8	8	9	11	14	50
Percentage (%)	16	16	18	22	28	100
7. "I would be happy to have an app to monitor and support my condition."						
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
Frequency	17	14	10	4	5	50
Percentage (%)	34	28	20	8	10	100
8. "I believe that having access to a healthcare professional through an app would have a great impact on my health."						
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
Frequency	17	20	10	1	2	50
Percentage (%)	34	40	20	2	4	100
9. "I would prefer being followed-up by a cardiac specialist from hospital than my general practitioner (GP)."						
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
Frequency	25	12	9	1	3	50
Percentage (%)	50	24	18	2	6	100

10. "A consultation through an app (video consultation) would more be acceptable compared to a face to face appointment."						
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
Frequency	12	9	17	3	9	50
Percentage (%)	24	18	34	6	18	100
11. "Having regular follow-up from a specialist is important to me following my hospital admission."						
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
Frequency	25	19	4	1	1	50
Percentage (%)	50	38	8	2	2	100
12. I would be happy for my specialist follow-up care to take place through an app if it offered more frequent or quicker follow up.						
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
Frequency	15	18	11	4	2	50
Percentage (%)	30	36	22	8	4	100
13. I would be willing to use an app if I was given support on how to use it.						
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Total
Frequency	18	23	3	4	2	50
Percentage (%)	35	46	6	8	4	100

Table 5 - Qualitative Data

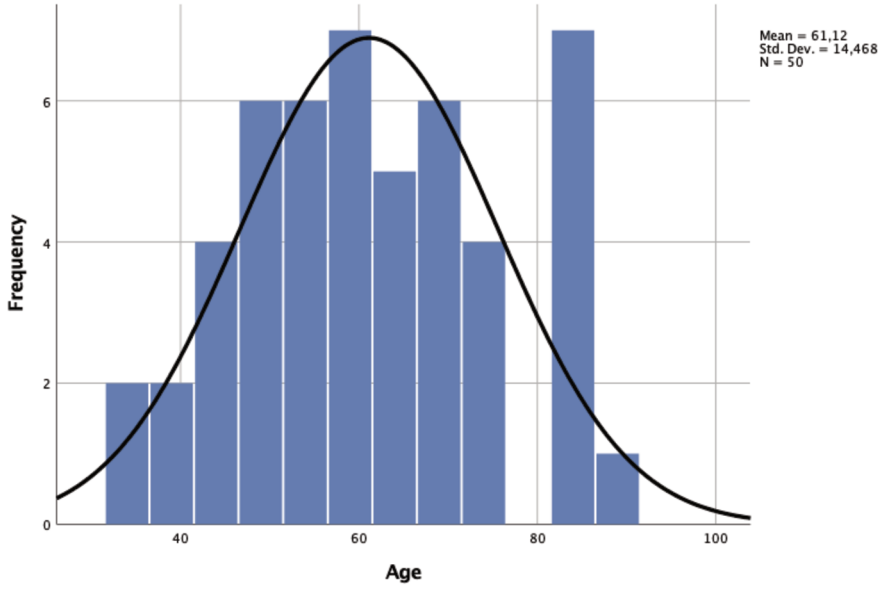
5.2 - Checking assumptions for the selection of the most suitable test

The Kolmogorov-Smirnov test was used to ascertain the distribution of variables and decide on the use of parametric or non-parametric tests. The test was run for the variable Age and the values obtained are shown in **Table 6**.

	N	Mean	Std. Deviation	Sig. (p-value)
Age	50	61.12	14.468	.200

Table 6 - One-Sample Kolmogorov-Smirnov Test for the variable Age

A p-value of 0.200 was extracted showing the variable Age follows a normal distribution as depicted in the graph below (**Graph 1**) thus, the test used with this variable was parametric.



Graph 1 – Age's Normal Distribution

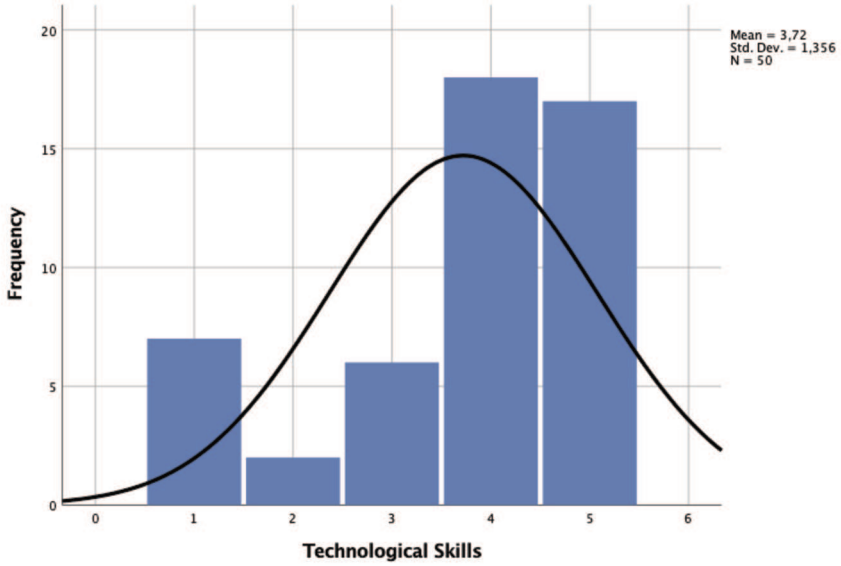
The Kolmogorov-Smirnov test was also used to determine the best approach test for the 13 statements presented in questionnaire and the values obtained are shown in **Table 7**.

Statements	n	Mean	Std. Deviation	Sig. (p-value)
1	50	3.72	1.356	<0.001
2	50	3.74	1.468	<0.001
3	50	3.52	1.460	<0.001
4	50	2.58	1.486	<0.001

5	50	3.36	1.453	<0.001
6	50	2.70	1.446	<0.001
7	50	3.68	1.301	<0.001
8	50	3.98	1.000	<0.001
9	50	4.10	1.147	<0.001
10	50	3.24	1.379	<0.001
11	50	4.32	0.868	<0.001
12	50	3.80	1.088	<0.001
13	50	4.02	1.059	<0.001

Table 7 - One-Sample Kolmogorov-Smirnov Test for the 13 statements

A p-value <0.001 was extracted thus, the 13 statements follow a non-normal distribution as depicted in the graph below (**Graph 2**) thus, the test used to analyse these data were non-parametric.

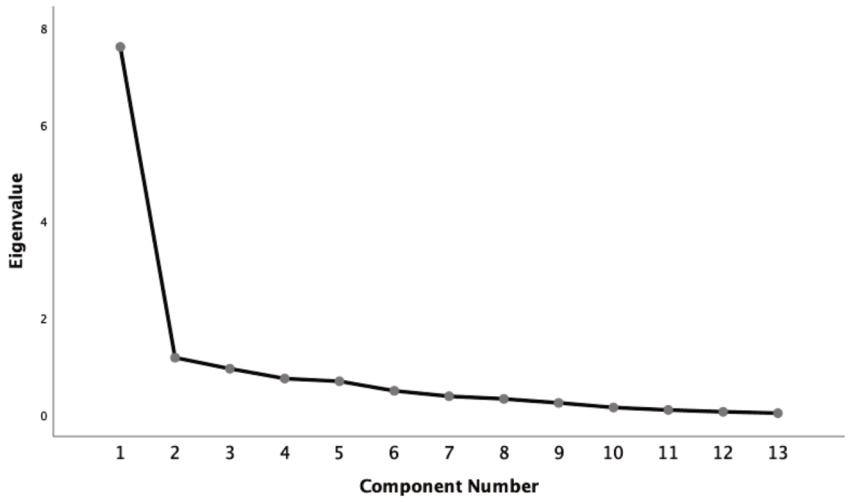


Graph 2 - Example of Statements Non-normal Distribution

5.3 - Exploring the Scale's validity and reliability

The questionnaire comprised 13 statements ranked using a 5-point Likert scale, which were subject to factor analysis using principal component analysis.

KMO and Bartlett's Test were run showing factor analysis as an adequate method ($p<0.001$). The scree plot suggested two dimensions were accountable for 67.6% of the variance (**Graph 3**).



Graph 3 - Principal Component Factor Analysis

The two components were extracted and rotated using the Varimax method and interpreted (**Table 8**) and subsequently evaluated in terms of reliability through Cronbach's alpha.

	Ability	**Promptness**
1	0.816	
2	0.768	
3	0.816	
4	-0.548	
5	0.790	
6	0.723	
7	0.719	
8		0.434
9		0.471
10	0.779	
11		0.935

12	0.887	
13	0.907	
Cronbach's α	**0.876**	**0.591**

Table 8 - Rotated Component: Varimax Method

The first domain included items measuring the user's ability to use new technologies and was as such named "Ability". The second domain measured the belief held by respondents that embracing technology would contribute to improved quality of care, hence named "Promptness".

The reliability of these two domains was 0.876 and 0.591, respectively, suggesting good and moderate reliability since the optimal value of Cronbach's alpha is discussed to be 0.700 in several studies to show ideal correlation (Smith, 1997; Streiner & Norman, 2003; Taber, 2018).

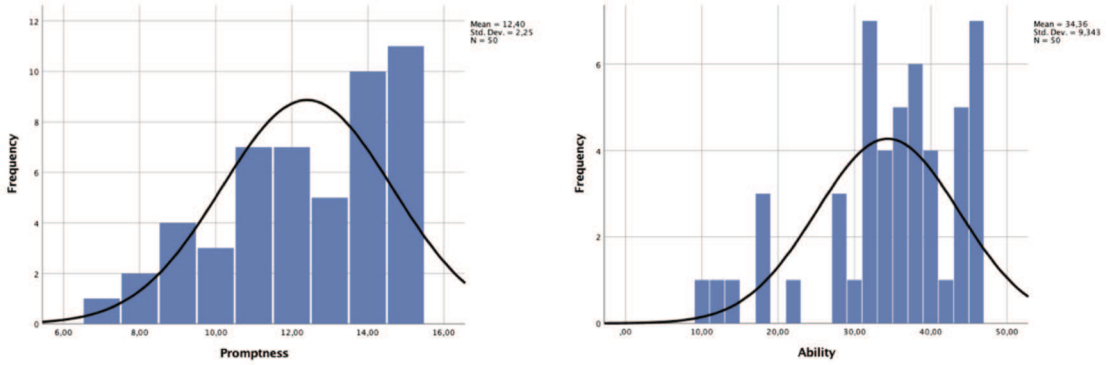
Distribution of the scales

The Kolmogorov-Smirnov test was used to determine the distribution for these 2 components, Ability and Promptness, and the values obtained are shown in **Table 9**.

	n	Mean	Std. Deviation	Sig. (p-value)
Ability	50	34.36	9.343	0.016
Promptness	50	12.40	2.249	<0.001

Table 9 - One-Sample Kolmogorov-Smirnov Test for the components: Ability and Promptness

For the two components, Ability and Promptness, a p-value of 0.016 and <0.001, respectively, was extracted therefore, these components follow a non-normal distribution as depicted in the graphs below **(Graph 4)** thus, the test used to analyse this data was non-parametric.



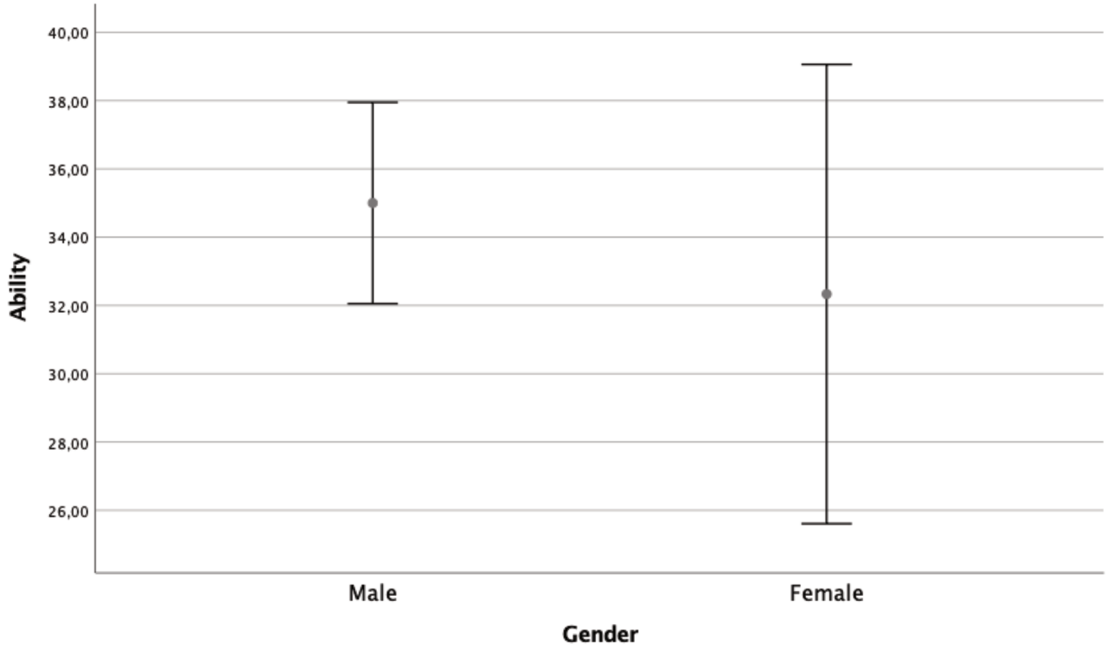
Graph 4 - Component's Distribution

5.4 - Bivariate Analysis

With the purpose to explore the hypotheses initially established, bivariate analysis was used.

Hypothesis 1

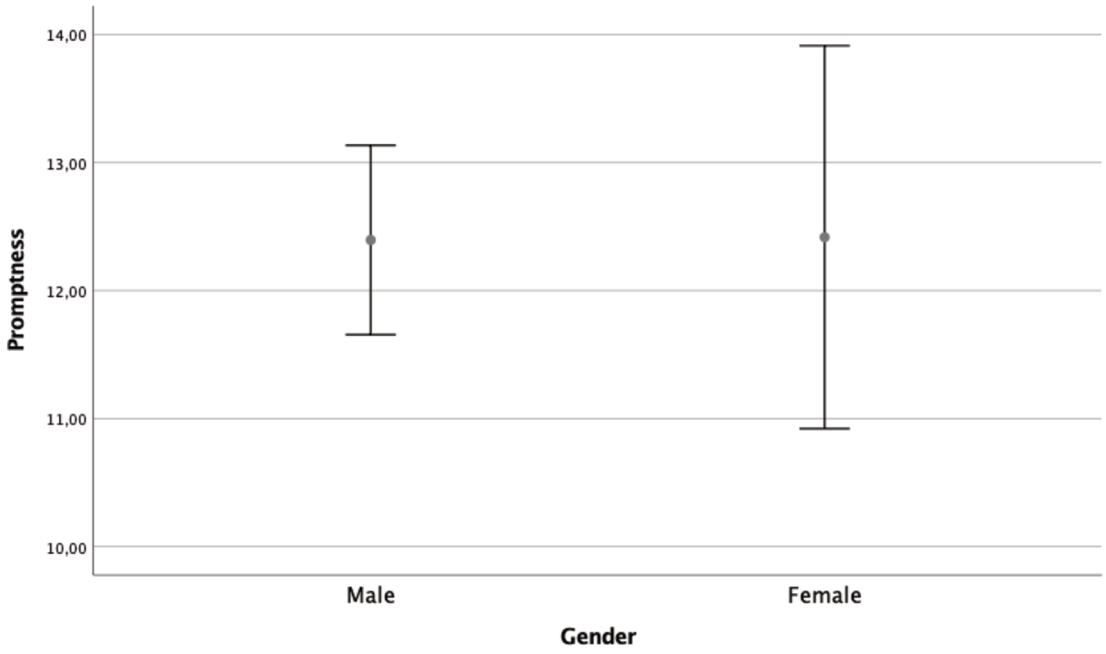
For this hypothesis, since the variables are non-parametric, the Mann-Whitney Test was used. This correlation showed a p-value of 0.594 meaning there is no association between gender and ability to use the Virtual Clinic App **(Graph 5)**.



Graph 5 - Gender's influence on the ability to use apps.

Hypothesis 2

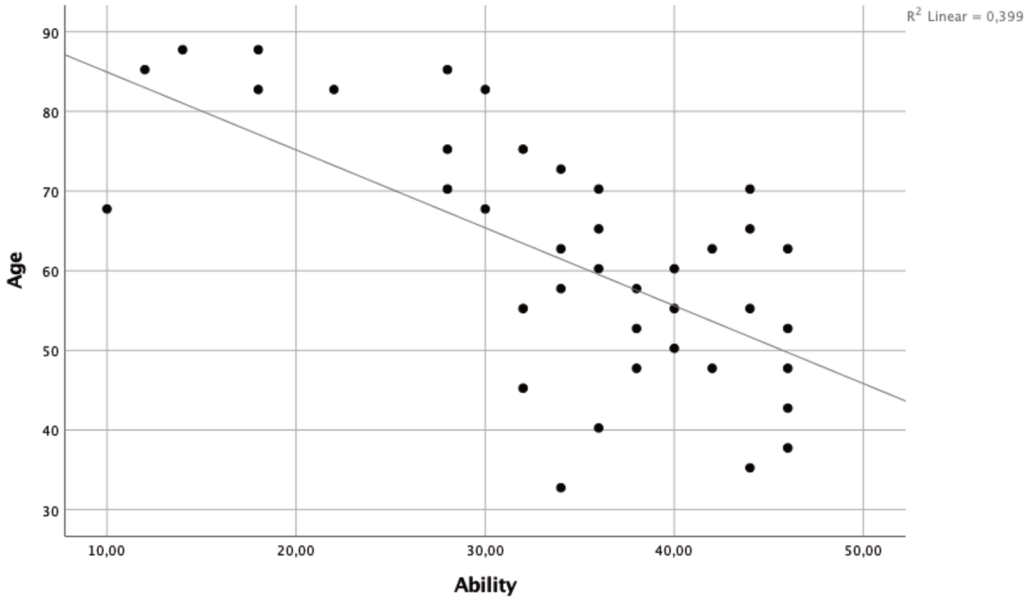
For this hypothesis, since the variables are non-parametric, the Mann-Whitney test was used. This correlation showed a p-value of 0.923 meaning there is no influence of Gender on the Promptness to use the Virtual Clinic App (**Graph)**.



Graph 6 - Gender's influence on the Promptness to use apps.

Hypothesis 3

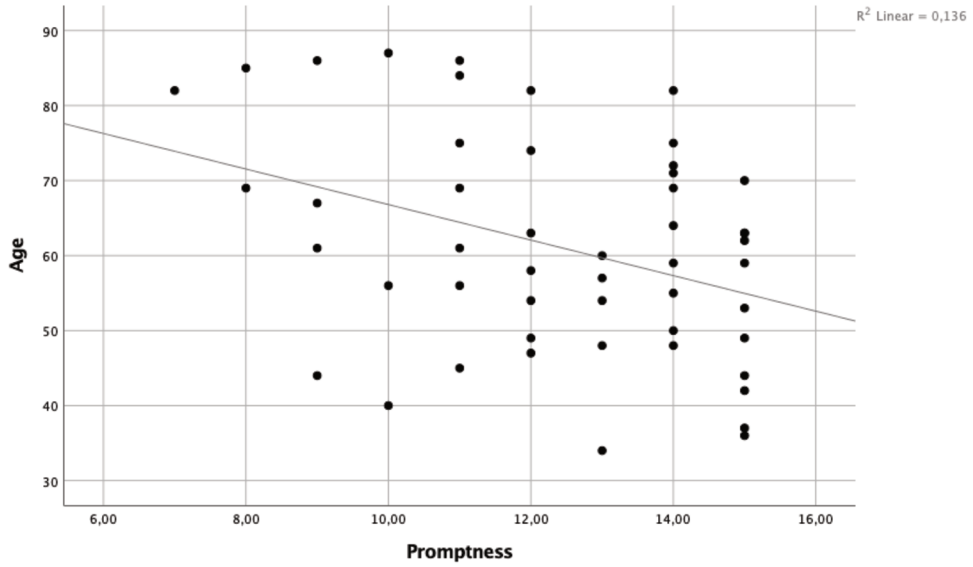
For this hypothesis, since the variables are non-parametric, the Spearman test was used. The correlation coefficient between the two variables was -0.552, with a p-value < 0.001, demonstrating Age and the Ability to use the Virtual Clinic App variables are inversely proportional (**Graph 7)**.



Graph 7 - Age's influence on Ability to use apps.

Hypothesis 4

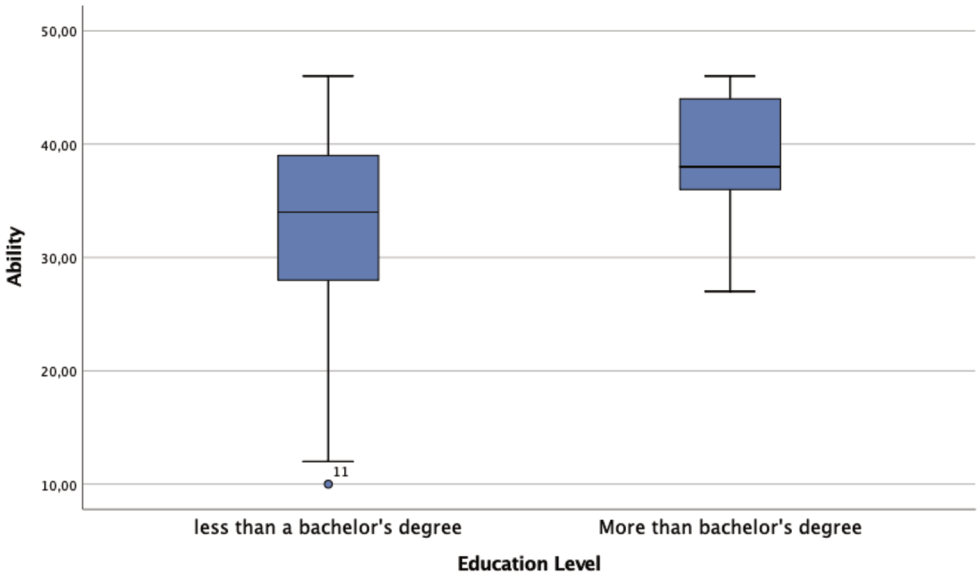
For this hypothesis, since the variables are non-parametric, the Spearman test was used. Also for Age and Ability to use the Virtual Clinic App, a correlation coefficient of -0.322 was obtained, with a p-value < 0.001, , demonstrating an inversely proportional and significant relationship **(Graph 8)**.



Graph 8 - Age's influence on Promptness to use apps.

Hypothesis 5

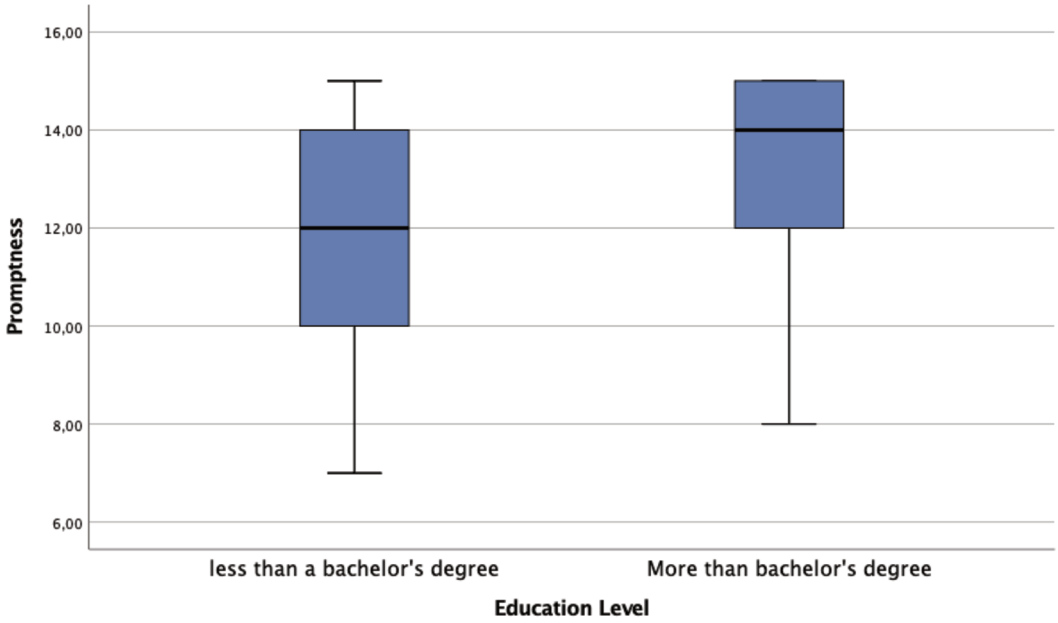
For this hypothesis, since the variables are non-parametric, the Mann-Whitney test was used. This correlation showed a p-value of 0.055 meaning there is no statistical significance between the educational level and Ability to use the Virtual Clinic. Nonetheless, as depicted in **Graph 9** there is a tendency for individuals with higher education levels obtained to have a greater ability to use apps.



Graph 9 - Education Level's influence on the Ability to use apps.

Hypothesis 6

For this hypothesis, since the variables are non-parametric, the Mann-Whitney test was used. This correlation showed a p-value of 0.108 meaning there is no statistical significance between the educational level and Promptness to use the Virtual Clinic as depicted in **Graph 10**. Unlike what was suggested for Ability, Promptness seems to be in fact independent of educational level.



Graph 10 - Education Level's influence on the Promptness to use apps

Hypothesis 7

For this hypothesis, since the variables are non-parametric, when correlating Education Level with Health Literacy the Chi-Square test was used. Respondents with less than a university degree showed more possibility of limited literacy (71%) whereas respondents with a university degree or higher had almost always adequate literacy (67%). Despite with a clear tendency **(Table 10)**, the association between these two variables was not significant (Fisher's Exact Test p-value= 0.057)**.**

			Health Literacy		**Total**	**p-value**
			Limited literacy or possible limited literacy	Almost always adequate literacy		
Education Level	Less than a bachelor's degree	Frequency	22	9	31	0.057
		Education Level (%)	**71%**	29%	100%	
		Health Literacy (%)	88%	60%	76%	
	More than bachelor's degree	Frequency	3	6	9	
		Education Level (%)	33%	**67%**	100%	
		Health Literacy (%)	12%	40%	24%	
Total	Frequency		25	15	40	
	Education Level (%)		63%	37%	100%	
	Health Literacy (%)		100%	100%	100%	

Table 10 - Education Level's Influence Health Literacy

5.4.1 - Hypothesis

Hypothesis 1: Gender influences the ability to use apps.

H_0 – Males will tend to score low on the component Ability.

H_1 –Males will tend to score high on the component Ability.

It is not possible to reject H_0 since the Mann- Whitney Test significance was $p = 0.594$ which means that H_1 is false hence, there is no gender influence on the ability of app use.

Hypothesis 2: Gender influences the promptness to use apps.

H_0 – People over 65 will tend to score low on the component Promptness.

H_1 – People over 65 will tend to score high on the component Promptness.

It is not possible to reject H_0 since the Mann- Whitney Test significance was $p = 0.923$ which means that H_1 is false hence, there is no gender influence on the promptness of app use.

Hypothesis 3: Age influences the ability to use apps.

H_0 – People over 65 will tend to score low on the component Ability.

H_1 – People over 65 will tend to score high on the component Ability.

It is possible to reject H_0 since the Spearman Test significance is $p < 0.001$ and a component correlation of -0.552 which means that H_1 is true, so age influences the ability of app use and it is inversely proportional.

Hypothesis 4: Age influences the promptness to use apps.

H_0 – People over 65 will tend to score low on the component Promptness.

H_1 – People over 65 will tend to score high on the component Promptness.

It is possible to reject H_0 since the Spearman Test significance is $p < 0.001$ and a component correlation of -0.322 which means that H_1 is true, so age influences the promptness of app use and it is inversely proportional.

Hypothesis 5: Education Level influences the ability to use apps.

H_0 – People with level of education of bachelor's degree or above will tend to score low on the component Ability.

H_1 – People with level of education of bachelor's degree or above will tend to score high on the component Ability.

It is not possible to reject H_0 since the Mann- Whitney Test significance was $p = 0.055$ which means that H_1 is false thus, there is no influence of education level on the Ability of app use.

Hypothesis 6: Education Level influences the promptness to use apps.

H_0 – People with level of education of bachelor's degree or above will tend to score low on the component Promptness.

H_1 – People with level of education of bachelor's degree or above will tend to score high on the component Promptness.

It is not possible to reject H_0 since the Mann- Whitney Test significance was $p = 0.108$ which means that H_1 is false thus, there is no influence of education level on the Ability of app use.

Hypothesis 7: Health literacy is influenced by education level.

H_0 – Almost always adequate literacy is not related with a level of education of bachelor's degree or above.

H_1- Almost always adequate literacy is related with a level of education of bachelor's degree or above.

It is not possible to reject H_0 since the Chi-Square Test significance is 0,057 which means that H_1 is false, so having almost always adequate literacy is not related with a level of education of bachelor's degree or above.

Chapter 6 - Discussion

Throughout this study it was possible to get different perspectives on the use of apps as a replacement to face to face consultations as well as the limitations healthcare professionals might encounter when trying to implement this service.

The number of studies concerning this subject are still very few, and data is very scarce when it comes to the application of mobile and digital health (Bull, 2016; World Health Organization, 2016). Hence the importance of conducting this type of study to assess not only the majority of population but also populational groups for example, older populations, minorities, low-income communities along with others. Several studies showed that mHealth can be helpful when it comes to prevention, however, it lacks the strong evidence to support this claim and it is still unknown which consequences it might have in long term use (Vodopivec-Jamsek, de Jongh, Gurol-Urganci, Atun, & Car, 2012).

6.1 - Collected Data

Most respondents belonged to the Young age group (<65years old), the youngest being 34 and the mean age being 61 years old.

Previous literature suggested a greater percentage of male could be expected , which was corroborated by our findings (Sanchis-Gomar, Perez-Quilis, Leischik, & Lucia, 2016). It was also expectable that most people were from the east of London given the location of the hospital, which was confirmed by our findings. The most prevalent ethnicity was being White (48%) and the most common mother tongue was English, concordant with the general ethnic and language description of the London population.

As expected, based on the W.H.O. Global eHealth Diffusion Report, 76% of respondents had a smartphone of which 70% knew how to use a smartphone making it easy for a Healthcare professional to apply the app as secondary prevention follow-up. Plus, even for those who do not know how to use an app, it would be possible to be given the support on how to use it which 81% of respondents agreed would make them willing to use the app (World Health Organization, 2016).

Also, respondents seemed keen on being empowered to take part in their health as the majority of respondents were willing to go for blood tests when needed (92%) and the majority of those who did not own a BP machine, were willing to buy one to self-monitor their blood pressure, and subsequently enter the data into the app making it available to the clinician.

Most respondents believed they had the technological skills to use a smartphone, which most use on a daily basis making it easy to implement an app for secondary prevention follow-up.

Plus, respondents seemed interested in having an app as a follow-up replacement as most stated they would like to have an app to monitor their condition and agree that having access to a healthcare professional through an app would have a great impact on their health. Additionally, having a specialist from the hospital, even if remotely, was considered important by nearly all the respondents.

Not only would the app allow a more frequent and quicker follow-up, which was perceived by most respondents, it would allow patient to have access to a cardiac specialist from the hospital. The model for remote monitoring was the question generating most hesitancy 34% were undecided if they would prefer video or face to face consultations.

6.2 - Hypothesis and Research Questions Interpretation

All the hypothesis formulated were analysed and a conclusion was reached in order to answer the research questions presented. Through analysing the results attained from the hypothesis formulation, it is fair to say that the strongest relation found was age's influence on ability and promptness to use the virtual clinic app.

Hypothesis 1 and 2 showed gender had no influence on the respondents' willingness to use an app. ´

Hypothesis 3 and 4 showed a strong influence of age on the willingness to use an app as secondary prevention follow-up being inversely proportional so younger people would tend to agree more with using an app.

With hypothesis 5, 6 and 7, it was expected to find a correlation between Education Level and Ability, Promptness and Health and Digital Literacy. However, these were statistically non-significant showing no relation between these variables.

Research Questions

Does gender influence the willingness to use an app?

As shown with hypothesis 1 and 2, there is no relation between the variables.

Does age influence the promptness of using an app?

As shown with hypothesis 3, age is inversely proportional to the promptness to use apps.

Does age influence the ability of using an app?

As shown with hypothesis 4, age is inversely proportional to the ability to use apps.

Does education influence the promptness of using an app?

As shown with hypothesis 5, education level has no relation with the promptness to use apps.

Does education influence the ability to use an app?

As shown with hypothesis 6, education level has no relation with the ability to use apps.

Does educational level influence digital and health literacy?

As shown with hypothesis 7, Education Level does not influence Digital and Health Literacy.

Do patients deem the app an equivalent substitute to face to face consultations?

The model for remote monitoring was the question generating most hesitancy 34% were undecided if they would prefer video or face to face consultations.

Are patients willing to help the clinician with the data needed for a follow-up consultation?

Research showed that the majority of respondents were willing to help the clinician going for blood tests when needed. Also, for the majority those who did not own a BP machine were willing to buy one to monitor their blood pressure.

6.3 - Study Limitations and Practical Implications

Although this study is valuable in its innovative approach to health care, trying to place the patient at the center of the decision-making process, it also has some limitations worth acknowledging. Some of the limitations were associated with the limited data collection time and the fact that data collection was restricted to one single site, making the sample size dependent of new incoming patients to the ward. In addition, although the questionnaire was subject to a brief validation process, full validation would probably lead to higher validity and reliability of the measurement tool. Also, the fact that data was collected using a questionnaire, instead of observation methods for instance, is inevitably associated with potentially dishonest answers, including social desirability bias. The fact that the survey was self-administered also contributes to potential low exhaustiveness of answers, with the possibility of getting blank questions.

The use of the NVS score, despite being a validated screening tool, lead to difficulties in the application of the survey tool. In fact, the research team felt respondents found this section of the questionnaire hard and confusing to answer.

This study allows a broader perspective on how apps would be accepted by patients. In a practical setting, not everyone would have the possibility or ability to have access to this Virtual Clinic app although as established by the W.H.O., mHealth should be accessible to everyone. In the long run, this app could be beneficial to hospitals and healthcare professional since it is less time consuming than face to face consultations, decreasing hospital waiting times and releasing healthcare professional's time to other equally important matters. On a patient point of view, it would not only be a comfortable and easy approach to health management, but it would also make the patient more aware of their symptoms, BP measurements, blood test results along with others. Since patient centered care is the approach that should be taken, having an app to monitor their condition would empower patients to take care of their health.

Chapter 7 - Conclusion

This study emerged from the need to assess the feasibility of having a mobile application to follow up a patient subsequently to a hospital admission caused by a MI.

The development of the questionnaire allowed the team to collect information specific to the area of London which is beneficial in an early stage since the Ortus iHealth project is being piloted at St. Bartholomew's Hospital.

This study suggests having a Virtual Clinic app is potentially interesting to enhance the quality of secondary prevention therapy follow-up and is a service likely to be accepted by patients.

Future work should focus on the acceptability of these innovative technologies also by healthcare professionals.

References

(MHRA), M. and H. products R. A. (2010). Clopidogrel and proton pump inhibitors: interaction. Retrieved September 26, 2019, from https://www.gov.uk/drug-safety-update/clopidogrel-and-proton-pump-inhibitors-interaction-updated-advice

Anchah, L., Hassali, M. A., Lim, M. S. H., Ibrahim, M. I. M., Sim, K. H., & Ong, T. K. (2017). Health related quality of life assessment in acute coronary syndrome patients: The effectiveness of early phase I cardiac rehabilitation. *Health and Quality of Life Outcomes*, *15*(1), 1–14. https://doi.org/10.1186/s12955-016-0583-7

Antoniou, S., & Wright, P. (2013). Percutaneous coronary intervention: indications, types, preparation. *Clinical Pharmacist*, *5*(February). https://doi.org/10.1211/cp.2013.11115813

Ayyaswami, V., Padmanabhan, D. L., Crihalmeanu, T., Thelmo, F., Prabhu, A. V., & Magnani, J. W. (2019). Mobile health applications for atrial fibrillation: A readability and quality assessment. *International Journal of Cardiology*, *293*(xxxx), 288–293. https://doi.org/10.1016/j.ijcard.2019.07.026

Barts Health NHS Trust. (n.d.-a). St Bartholomew's - Our history. Retrieved September 19, 2019, from https://www.bartshealth.nhs.uk/st-bartholomews-our-history

Barts Health NHS Trust. (n.d.-b). St Bartholomew's Hospital - Barts Health NHS Trust. Retrieved September 19, 2019, from https://www.bartshealth.nhs.uk/st-bartholomews

Baxter, K. (2006). Stockley's Drug Interactions, 7th Edition. *Annals of Pharmacotherapy*, *40*(6), 1219–1219. https://doi.org/10.1345/aph.1g691

Brieger, D., Chow, C., Gullick, J., Hyun, K., D'Souza, M., & Briffa, T. (2018). Improving patient adherence to secondary prevention medications 6 months after an acute coronary syndrome: observational cohort study. *Internal Medicine Journal*, *48*(5), 541–549. https://doi.org/10.1111/imj.13736

British Heart Foundation., B. (2019a). Factsheet, (August).

British Heart Foundation., B. (2019b). UK Factsheet. *British Heart Foundation*, (April). https://doi.org/10.1016/j.partic.2008.03.004

Bull, S. (2016). Beyond acceptability and feasibility: moving mHealth into impact. *MHealth*, *2*(12), 45–45. https://doi.org/10.21037/mhealth.2016.12.02

Charles River Associates. (2009). The burden of acute coronary syndromes in the United Kingdom. *AstraZeneca*, 4. Retrieved from

http://www.crai.co.uk/sites/default/files/publications/Burden-of-Acute-Coronary-Syndromes-in-the-UK.pdf

Cherkasov, A., Muratov, E. N., Fourches, D., Varnek, A., Igor, I., Cronin, M., … Cramer, R. (2015). NIH Public Access. *J Med Chem*, *57*(12), 4977–5010. https://doi.org/10.1021/jm4004285.QSAR

Deanfield, J., & Al, E. (2015). Joint British Societies' consensus recommendations for the prevention of cardiovascular disease (JBS3). *Zhonghua Xin Xue Guan Bing Za Zhi*, *43*(7), 573–574. https://doi.org/10.1136/heartjnl-2014-305693

Engberding, N., & Wenger, N. K. (2017). Acute Coronary Syndromes in the Elderly. *F1000 Research*, *6*(0). https://doi.org/10.12688/f1000research.11064.1

Every, K., & British Heart Foundation., B. (2017). Heart Attack: Your quick guide, (225971).

Fischman, D., Leon, M., Baim, D., & et al. (1994). A Randomized Comparison of Coronary-Stent Placement and Balloon angioplasty in the treatment of Coronary Artery Disease. *New England Journal of Medicine*, *330*, 2016.

Galbán, P. A., & Vidal, N. V. (2019). Digital Literacy Program for the Use of Social Media , Aimed at Health Professionals, *0*(October 2018), 4–5. https://doi.org/10.3233/SHTI190701

Gavalova, L. (2016). How NHS cares for patients with heart attack. MINAP Annual Public Report (2011/12). https://doi.org/10.13140/RG.2.1.4919.7043

Herlitz, J., Hjalmarson, A., & Waagstein, F. (1989). Treatment of pain in acute myocardial infarction. *British Heart Journal*, *61*(1), 9–13. https://doi.org/10.1016/s0196-0644(89)80492-5

Ho, P. M., Magid, D. J., Shetterly, S. M., Olson, K. L., Maddox, T. M., Peterson, P. N., … Rumsfeld, J. S. (2008). Medication nonadherence is associated with a broad range of adverse outcomes in patients with coronary artery disease. *American Heart Journal*, *155*(4), 772–779. https://doi.org/10.1016/j.ahj.2007.12.011

Ibanez, B., James, S., Agewall, S., Antunes, M. J., Bucciarelli-Ducci, C., Bueno, H., … Gale, C. P. (2018). 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. *European Heart Journal*, *39*(2), 119–177. https://doi.org/10.1093/eurheartj/ehx393

Infarction, A. M. (1998). Indications for ACE Inhibitors in the Early Treatment of Acute Myocardial Infarction. *Circulation*, *97*(22), 2202–2212.

https://doi.org/10.1161/01.cir.97.22.2202

ISIS-4: A randomised factorial trial assessing early oral captopril, oral mononitrate, and intravenous magnesium sulphate in 58 050 patients with suspected acute myocardial infarction. (1995). *The Lancet*, *345*(8951), 669–685. https://doi.org/10.1016/S0140-6736(95)90865-X

John Wilson, S., E. Newby, D., Dawson, D., & Irving, J. (2017). Duration of dual antiplatelet therapy in acute coronary syndrome. *Heart, Lung and Circulation*, *26*, S71–S72. https://doi.org/10.1016/j.hlc.2017.06.065

Keenan, C., Khatib, R., Lock, J., Ward, T., & Warren, A. (2012). Acute Coronary Syndromes. *Centre for Pharmacy Postgraduate Education*, (July), 27–74.

Mcardle, P., & British Heart Foundation., B. (2017). Beating my Heart attack.

National Institute for Health and Care Excellence. (2014). Acute coronary syndromes in adults. *Quality Standard*, *QS68*(September).

National Institute for Health and Care Excellence (NICE). (2010). Unstable angina and NSTEMI: early management Clinical Guideline, (March 2010), 1–29. Retrieved from https://www.nice.org.uk/guidance/cg94/resources/unstable-angina-and-nstemi-early-management-pdf-975749355205%0Ahttps://www.nice.org.uk/guidance/cg94/chapter/1-Guidance

National Institute for Health Care Excellence. (2016). Cardiovascular disease: risk assessment and reduction, including lipid modification (NICE Clinical Guideline CG181). *Nice*, (July 2014). Retrieved from https://www.nice.org.uk/guidance/cg181

National Institute of Health and Care Excellence. (2013). Clinical Guideline 167: Myocardial infarction with ST-segment elevation: acute management |. Retrieved from https://www.nice.org.uk/guidance/cg167

NHS. (n.d.). NHS Data Dictionary. Retrieved October 15, 2019, from https://www.datadictionary.nhs.uk/items_index_a_child.asp?shownav=1

NHS. (2018). Writing an Effective Questionnaire, 6. Retrieved from https://www.england.nhs.uk/wp-content/uploads/2018/01/bitesize-guide-writing-an-effective-questionnaire.pdf

NICE. (2010). Assessment and immediate management of suspected acute coronary syndrome. *NICE Pathways*, (January), 1–9. Retrieved from https://pathways.nice.org.uk/pathways/chest-pain#content=view-node%3Anodes-immediate-management-of-suspected-acute-coronary-syndrome&path=view%3A/pathways/chest-pain/assessment-and-immediate-

management-of-suspected-acute-coronary-syndrome.xml%0Ahttps://pa

NICE guidelines. (2010). Chest pain of recent onset: assessment Chest pain of recent onset: assessment and diagnosis and diagnosis Clinical guideline, (March 2010).

NICE, N. I. for H. and C. E.-. (2013). My Myocardial infarction : cardiac rehabilitation and prevention of further cardiovascular disease, (November).

NICE Pathways. (2019). Drug treatment after m my yocardial infarction.

Pfizer. (2011). The Newest Vital Sign (NVS). *The Lancet Neurology*, *10*(5), 411. https://doi.org/10.1016/S1474-4422(11)70090-4

Piepoli, M. F., Hoes, A. W., Agewall, S., Albus, C., Brotons, C., Catapano, A. L., … ESC Scientific Document Group. (2016). 2016 European Guidelines on cardiovascular disease prevention in clinical practice. *European Heart Journal*, *37*(29), 2315–2381. https://doi.org/10.1093/eurheartj/ehw106

Pleister, A., Selemon, H., Elton, S. M., & Elton, T. S. (2013). Circulating miRNAs: Novel biomarkers of acute coronary syndrome? *Biomarkers in Medicine*, *7*(2), 287–305. https://doi.org/10.2217/bmm.13.8

Roffi, M., Patrono, C., Collet, J.-P., Mueller, C., Valgimigli, M., Andreotti, F., … Parkhomenko, A. (2016). 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. *European Heart Journal*, *37*(3), 267–315. https://doi.org/10.1093/eurheartj/ehv320

Roffi, M., Patrono, C., Collet, J. P., Mueller, C., Valgimigli, M., Andreotti, F., … Zamorano, J. L. (2016). 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent st-segment elevation: Task force for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation of . *European Heart Journal*, *37*(3), 267–315. https://doi.org/10.1093/eurheartj/ehv320

Royal Pharmaceutical Society. (2013). Medicines Optimisation : Helping patients to make the most of medicines. *RPS Good Practice Guidance*, (May).

Sanchis-Gomar, F., Perez-Quilis, C., Leischik, R., & Lucia, A. (2016). Epidemiology of coronary heart disease and acute coronary syndrome. *Annals of Translational Medicine*, *4*(13), 1–12. https://doi.org/10.21037/atm.2016.06.33

Sattelmair, J., Pertman, J., Ding, E., Kohl, H., & Haskell, W. (2011). Dose-Response Between Physical Activity and Risk of Coronary Heart Disease: A Meta-Analysis, *46*(4), 564–574. https://doi.org/10.1016/j.cortex.2009.08.003.Predictive

Seeley, R. R., Stephens, T. D., & Tate, P. (2003). *Anatomy & Physiology* (6th editio). McGraw-Hill Companies, Inc.

Silbernagl, S., & Despopoulos, A. (2013). *Color Atlas of Physiology* (6th editio). Thieme. Retrieved from http://course.sdu.edu.cn/G2S/eWebEditor/uploadfile/20130328161819736.pdf

Smith, F. (1997). HEALTH SERVICES RESEARCH METHODS IN PHARMACY: Survey research: (2) Survey instruments, reliability and validity. *International Journal of Pharmacy Practice*, *5*(4), 216–226. https://doi.org/10.1111/j.2042-7174.1997.tb00908.x

Stephen S Lim‡, Theo Vos, Abraham D Flaxman, Goodarz Danaei, K. S., Heather Adair-Rohani, Markus Amann*, H Ross Anderson*, K. G. A., Martin Aryee*, Charles Atkinson*, Loraine J Bacchus*, Adil N Bahalim*, K., Balakrishnan*, John Balmes*, S. B.-C., Lim, S. S., Vos, T., … Ezzati, M. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet*, *380*(9859), 2224–2260. https://doi.org/10.1016/S0140-6736(12)61766-8.A

Streiner, D. L., & Norman, G. R. (2003). Health Measurment Scales, 283.

Sullivan, G. M., & Artino, A. R. (2013). Analyzing and Interpreting Data From Likert-Type Scales. *Journal of Graduate Medical Education*, *5*(4), 541–542. https://doi.org/10.4300/jgme-5-4-18

Taber, K. S. (2018). The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education. *Research in Science Education*, *48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Thygesen, K., Alpert, J. S., Jaffe, A. S., Simoons, M. L., Chaitman, B. R., & White, H. D. (2012). ESC / ACCF / AHA / WHF Expert Consensus Document Third Universal Definition of Myocardial Infarction, 2020–2035. https://doi.org/10.1161/CIR.0b013e31826e1058

Vodopivec-Jamsek, V., de Jongh, T., Gurol-Urganci, I., Atun, R., & Car, J. (2012). Mobile phone messaging for preventive health care. *Cochrane Database of Systematic Reviews*, *2017*(12). https://doi.org/10.1002/14651858.CD007457.pub2

World Health Organization. (2016). *Global ehealth diffusion*.

Yusuf, S. (1988). Overview of Results of Randomized Clinical Trials in Heart Disease. *Jama*, *260*(15), 2259. https://doi.org/10.1001/jama.1988.03410150107041

Zoe, R. (2012). The use of technology by the elderly. *Health Science Journal*, *4*(2). Retrieved from http://www.hsj.gr/medicine/the-use-of-technology-by-the-elderly.php?aid=3614

Appendixes

Appendix I - *Virtual Clinics Assessment* Questionnaire

VIRTUAL CLINICS ASSESSEMENT

This questionnaire has been developed to assess barriers and enablers of follow-up using virtual clinics, after a heart attack. Ortus-iHealth is a smartphone app that was developed to empower patients and increase communication between healthcare professionals and patients.

After a heart attack, patients we aim to follow up in an outpatient clinic appointment within 3-6 months, due to capacity this can be challenging. Using this app, healthcare professionals are able to give a personalized care through regular follow-up in a virtual clinic and monitor patient's condition more closely.

This questionnaire shouldn't take more than 5-10 minutes.

1. **Age:**_____

2. **Gender:**

□ Female
□ Male
□ Other

3. **First three letters of post code:** _____

4. **Ethnic origin:**

White
- English / Welsh / Scottish / Northern Irish / British ..... □
- Irish..... □

Mixed / Multiple ethnic groups
- White and Black Caribbean..... □
- White and Black African ..... □
- White and Asian ..... □

Asian / Asian British
- Indian..... □
- Pakistani..... □
- Bangladeshi..... □
- Chinese ..... □

Black
- African ..... □
- Black British..... □
- Caribbean..... □

□ Arab
□ any other ethnic group. Which?_____

5. Education:

□ Less than a high school diploma
□ High school degree or equivalent
□ Bachelor's degree
□ Master's degree
□ Doctorate
□ Other: _____

6. Are you accompanied/ cared for by a family member or a carer?

□Yes. Which? _____
□No

7. Employment status:

□ Employed for wages
□ Self-employed
□ Out of work and looking for work
□ Out of work but not currently looking for work
□ Retired
□ Unable to work
□ Other. Which?_____

8. Language(s) spoken at home (if answer is English, skip question 9):

□ English □ Other: _____

9. If you answered "Other" in question 8, how well do you speak English?

□ Very well □ Well □ Not well □ Not at all

10. Do you have a smartphone?

□Yes
□No

11. If you answered "No" on question 10, do you have someone at home who can help you use a smartphone and apps?

□Yes
□No

Please answer the following statements, indicating your level of agreement with each of them.

12. I have the technological skills to use a smartphone.

□ Strongly agree	□ Agree	□Undecided	□ Disagree	□ Strongly disagree

13. I use my smartphone regularly, on a daily basis.

□ Strongly agree	□ Agree	□Undecided	□ Disagree	□ Strongly disagree

14. I am familiar with smartphone applications (app).

□ Strongly agree □ Agree □Undecided □ Disagree □ Strongly disagree

15. I find apps hard to use so I don't have any on my smartphone.

□ Strongly agree □ Agree □Undecided □ Disagree □ Strongly disagree

16. I use apps frequently.

□ Daily □ Weekly □Monthly □ Once a week □ Never

17. I use my smartphone/computer to research health related subjects on the internet.

□ Strongly agree □ Agree □Undecided □ Disagree □ Strongly disagree

18. I have Health Apps installed on my smartphone.

□ Strongly agree □ Agree □Undecided □ Disagree □ Strongly disagree

19. I would be happy to have an app to monitor and support my condition.

□ Strongly agree □ Agree □Undecided □ Disagree □ Strongly disagree

20. I believe that having access to a healthcare professional through an app would have a great impact on my health.

□ Strongly agree □ Agree □Undecided □ Disagree □ Strongly disagree

21. I would prefer being followed-up by a cardiac specialist from hospital than my general practitioner (GP).

□ Strongly agree □ Agree □Undecided □ Disagree □ Strongly disagree

22. A consultation through an app (video consultation) would more be acceptable compared to a face to face appointment.

□ Strongly agree □ Agree □Undecided □ Disagree □ Strongly disagree

23. Having regular follow-up from a specialist is important to me following my hospital admission.

□ Strongly agree □ Agree □Undecided □ Disagree □ Strongly disagree

24. I would be happy for my specialist follow-up care to take place through an app if it offered more frequent or quicker follow up.

□ Strongly agree □ Agree □Undecided □ Disagree □ Strongly disagree

25. I would be willing to use an app if I was given support on how to use it.

□ Strongly agree □ Agree □Undecided □ Disagree □ Strongly disagree

26. Do you own a blood pressure machine?
□Yes
□No

27. If you answered "NO" on question 26, a blood pressure machine costs around £20, would you be willing to buy one if it was beneficial for your health?
□Yes
□No

28. Are you willing to go to your GP for blood tests?
□Yes
□No

This information is on the back of a container of a pint of ice cream. Please answer the six following questions based on the picture.

Nutrition Facts	
Serving Size	½ cup
Servings per container	4
Amount per serving	
Calories 250	Fat Cal 120
	%DV
Total Fat 13g	20%
Sat Fat 9g	40%
Cholesterol 28mg	12%
Sodium 55mg	2%
Total Carbohydrate 30g	12%
Dietary Fiber 2g	
Sugars 23g	
Protein 4g	8%

*Percentage Daily Values (DV) are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

Ingredients: Cream, Skim Milk, Liquid Sugar, Water, Egg Yolks, Brown Sugar, Milkfat, Peanut Oil, Sugar, Butter, Salt, Carrageenan, Vanilla Extract.

1. **If you eat the entire container, how many calories are you eating?** _____
2. **You are allowed to eat 60g of carbohydrates as a snack, how much ice cream can you have?** _____
3. **You have 42g of saturated fat each day which includes one serving of ice cream. If you stop eating the ice cream, how many grams of saturated fat would you have?** _____
4. **If you usually eat 2,500 calories in a day, what percentage of this will you be eating if you eat one serving of ice cream?** _____
5. **Imagine you are allergic to penicillin, peanuts, latex gloves and bee stings. Is it safe to eat this ice cream?** _____
6. **If you answered NO, why not?**

_____

Thank you for your time.
Comments:

NVS Health Literacy Score: _____

Appendix II – Newest Vital Sign (NVS)

The Newest Vital Sign

Score Sheet for the Newest Vital Sign Questions and Answers

READ TO SUBJECT:
This information is on the back of a container of a pint of ice cream.

	ANSWER CORRECT?	
	yes	no
1. If you eat the entire container, how many calories will you eat? *Answer: 1,000 is the only correct answer*		
2. If you are allowed to eat 60 grams of carbohydrates as a snack, how much ice cream could you have? *Answer: Any of the following is correct: 1 cup (or any amount up to 1 cup), half the container. Note: If patient answers "two servings," ask "How much ice cream would that be if you were to measure it into a bowl?"*		
3. Your doctor advises you to reduce the amount of saturated fat in your diet. You usually have 42 g of saturated fat each day, which includes one serving of ice cream. If you stop eating ice cream, how many grams of saturated fat would you be consuming each day? *Answer: 33 is the only correct answer*		
4. If you usually eat 2,500 calories in a day, what percentage of your daily value of calories will you be eating if you eat one serving? *Answer: 10% is the only correct answer*		
READ TO SUBJECT: **Pretend that you are allergic to the following substances: penicillin, peanuts, latex gloves, and bee stings.**		
5. Is it safe for you to eat this ice cream? *Answer: No*		
6. (Ask only if the patient responds "no" to question 5): Why not? *Answer: Because it has peanut oil.*		
Number of correct answers:		

Interpretation

Score of 0-1 suggests high likelihood (50% or more) of limited literacy.
Score of 2-3 indicates the possibility of limited literacy.
Score of 4-6 almost always indicates adequate literacy.

Nutrition Facts

Serving Size	½ cup
Servings per container	4
Amount per serving	
Calories 250	Fat Cal 120
	%DV
Total Fat 13g	20%
Sat Fat 9g	40%
Cholesterol 28mg	12%
Sodium 55mg	2%
Total Carbohydrate 30g	12%
Dietary Fiber 2g	
Sugars 23g	
Protein 4g	8%

*Percentage Daily Values (DV) are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

Ingredients: Cream, Skim Milk, Liquid Sugar, Water, Egg Yolks, Brown Sugar, Milkfat, Peanut Oil, Sugar, Butter, Salt, Carrageenan, Vanilla Extract.

Appendix III – Ethics Declaration Letter

ETHICS DECLARATION LETTER

I, SADEER FHADIL, Highly Specialist Clinic Pharmacist (name and position) declare that the research project named *"The feasibility of implementing virtual clinics as follow-up of secondary prevention therapy post acute myocardial infarction"* developed by Vanessa Rijo during her internship at St. Bartholomew's Hospital was submitted on the 25 / 06 / 19 to the Clinical Effectiveness Unit (CEU) and approved under the process number 7983.

I declare that the project abides by the ethical and legal principles of the Declaration of Helsinki.

If there is any question about the declaration, please don't hesitate in contacting me.

Best Regards,

SADEER FHADIL